
# Gaming in Action

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# Table of Contents

# Preface

*Homo ludens*, a concept popularised by the Dutch anthropologist Huizinga (1949), reflects on play as being integral, intrinsic and fundamental to the culture of being human. It is one among many concepts introduced by Huizinga that have been influential in game studies, digital game design, and the integration of gamification in education. In addition to the notion of play and game-play, Huizinga's analysis of the 'magic circle' as distinct space where the rules of the real world give way to the rules of the game or play, have been widely applied. The more recent ascendancy of gamification and game-based learning in a growing digital and artificially intelligent world, once again focuses conceptual and practical attention on the value of gaming and game elements in learning.

It is widely assumed that gamification and game-based learning can support engaged, interactive, incentivised learning and can thus enhance learner motivation and learner and teacher engagement, based on well-defined rules and rewards systems. These assumptions underscore ontological and epistemological debates about play, game-play, digital technologies and their relationship to human learning among children and adults.

This thought-provoking volume contributes towards collective knowledge and understanding about shared assumptions on gamification and its role and value in education. The book illuminates research on the design and application of gamification across a range of formal, institutionalised education contexts in secondary and higher education in countries such as Portugal, Romania and Brazil. It provides empirical evidence on the effects of gamification on learner attitude, participation and performance. It also highlights the challenges of integrating gamification in learning design and the limits to its use that are imposed by existing legal and regulatory environments. Some highlight how and under which conditions gamification can improve understanding of learner behaviour and learning styles.

In this respect, the volume also touches on critical contestations in education about learning styles and digital learning and the location of gamification, in the interface between theory, policy and practice. These include crucial questions about the underlying theoretical propositions that inform the design, development and implementation of gamification in education; under which conditions and in which contexts do children and adults learn better with and through gamification and game-based learning strategies. is hoped that it catalyses further robust inquiry and knowledge production on a crucial aspect of learning.

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# Editors' Introduction

When we talk about education in the 21st century, we are sometimes confronted with comments about how teachers' pedagogical practice has remained unchanged, or virtually unchanged, over the last century. When they are heard, sometimes teachers refer to many constraints that oblige them to keep classes essentially expositive, or in a model that values exposure, understanding, and application of learning more formally.

These positions were even more exposed in the last year due to the disease caused by SARS-CoV-2 (Severe Acute Respiratory Syndrome, Coronavirus 2), which the World Health Organization then called Covid-19. With the suspension of face-to-face classes due to the related pandemic, schools and higher education institutions resorted to so-called "emergency remote education" to try to complete the school year. This forced a sudden change to distance education, requiring rapid adaptation by teachers. This raises debates and interrogations: are teachers prepared for the demands of teaching beyond the face-to-face format? As Andreas Schleicher (Director of the OECD Department of Education and Skills, Responsible for PISA tests, 2016) said:

> *A generation ago, teachers had the expectation that what they taught students would be valid throughout life. Today, schools have to prepare students to a faster socio-economic change than it ever was, for jobs that have not even been created, to use technologies that still do not exist and solve problems that we do not yet know will arise. The successful education no longer resides mainly in the reproduction of contents, but in the extrapolation of what we know and in its creative application to new situations. The world no longer rewards people just for what they know – Google knows everything - but for what they can do with it. That is why education has more and more to do with the development of creativity, critical thinking, problem-solving and decision-making.*

Regarding adult education, many times seen as less important training for unmotivated learners, the above considerations are even more evident. Most of the times, trainees of disadvantaged cultural, economic, and family backgrounds tend to reveal more academic difficulties, and those are accentuated over the years. Traditional training methods do not work when facing adults that, like children, live surrounded by technology and arrive in classes tired by their daily obligations. Therefore, we need to engage these learners in a new learning approach to show them how learning can be enjoyable compared to when they were in school.

In order to prepare all trainees for what is to come, we need them to focus on learning, and the training must be up to the requirements of the world of work and an increasingly expectant society. We want an innovative pedagogical scenario that allows trainees to use their learning tools. They experience virtual methods and utilise their strategies while building their knowledge and acquiring experience, motivation, and producing a self-reflection that is fundamental to learning. Due to the challenges identified that trainees with disadvantaged cultural, economic, and family backgrounds face, we believe that the innovative pedagogical scenario that underlies game-based learning and gamification is a valuable approach to prepare today's students to face the new challenges and involve them in answering their needs.

The «Gaming in Action» project, which brought the publicaion of this book, involved institutions from different countries that deal with adult education. For almost three years, the partners worked with teachers and trainers who applied innovative pedagogical scenarios of game-based learning and gamification, all oriented from a rigorous pedagogical perspective. The project's main goal was to increase the acquisition of pedagogical innovation skills in these models and incorporate them into their pedagogical practices. The project searched to highlight the need for quality pedagogical training in a new, technologically digital, era: in this, education has less to do with reproducing information passively and has more to do with the development of creativity, critical thinking, problem-solving and decision-making.

To enrich the project, we invited researchers who have been studying the use of games and gamification in education and training, published for an audience of practising researchers and academics and the general public interested in the theme of games and gamification. With such a 'big umbrella', the book is a collection of twelve chapters from scholarly articles and reports of experiences and perceptions about pedagogical practices.

In the preface, Professor Shafika Isaacs from the University of Johannesburg (South Africa), who has extensive research on the project's topics, sets the scene by reinforcing how gamification and game-based learning can support engaged, interactive and encouraged education and increase student motivation and student and teacher involvement.

# Starting the Game: an introduction to Gamification

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## Introduction

There are references to 'gamification' as early as 1980, when Professor Richard Bartle of the University of Essex, a pioneer in multiplayer online games, says that the term initially referred to as "turning something not a game into a game" (Werbach & Hunter, p. 25).

The first use of gamification in its current sense occurred in 2002 when Nick Pelling referred to the use of game elements in non-game situations while creating game-like interfaces for electronic devices (Domínguez, et al., 2013). The term has fallen out of favour, although during subsequent years, researchers such as James Paul Gee (2003; 2013) began to talk about the potential of video games. However, it was only in 2010 that the term gamification became widely adopted in the sense that we use it nowadays.

Gamification is an intricate word, and game developers and researchers are concerned that this trivializes practical game design complexities. The difficulty is that there is no universally accepted definition of gamification; on the contrary, there are several definitions for the concept. Even after being called "the new trend concept" (King, 2019), the use of the term 'gamification' is often confusing and

misinterpreted. It is easily confused with concepts like game-based learning, gaming, serious games and game theory.

Deterding et al. (2011) explain that "gamification is an informal umbrella term for the use of video game elements in non-game systems to improve the individual's experience and involvement" (p. 2425). Knaving and Björk describe gamification as a way of enriching involvement in activities that lack intrinsic motivation (Knaving & Björk, 2013). For Zichermann and Cunningham (2011), gamification is defined as the use of game mechanics and thinking to solve problems and interact in contexts not related to games. In a similar vein, Werbach and Hunter (2012) explain the concept as "the use of game elements and game-design techniques in non-game contexts" (p. 26).

For this text's purposes, the last definition is the one that works, and we will explain it in detail.

## Game Elements

A game is itself an integrated experience built from many smaller pieces: the elements. So, the elements are a toolkit for creating a game, and obviously we can make a game with game elements. Or we can assemble the elements into something that is not a game. When we take game pieces and incorporate them into research practices, we are in gamification, and the final product is, hopefully, a better and more engaging thing (Lee & Hammer, 2011).

Game elements are described in different ways in the literature. Anderson (2011) places game elements in a model with play as a central component. He argues that what turns a play into a game is the introduction of challenges. The choices involve these challenges that players face. As players go through the experience, the feedback will show their progress. These feedback loops can be extrinsic motivators, such as goals, rewards, badges. Game elements can be considered as a part that make up the whole game, and gamification consists of using these elements in a situation. Gamification uses many different elements of games, some are easy to put into practice, and others are less

straightforward and need more design to be adopted. It all depends on the context in which these elements will be used. Currently, gamification's most popular elements are avatars, points, badges, leader boards, rewards, rankings, levels, challenges, rules, time, teams, goals, competition, cooperation, and feedback (Deterding et al., 2011).

We must not forget that gamification is not about building a game. It is just a matter of using some game elements and, since it operates at the element level, the use of gamification offers more flexibility than the use of a game. With gamification, breaking the rules is what we should be doing. As a gamified system designer, we can adjust the elements to make the experience more engaging or achieve specific goals. The central point is that the game elements can be incorporated into activities that are not games.

According to Werbach and Hunter (2012, pp. 78-83), the game elements are divided into three categories: dynamics, mechanics and components. Adding these three parts together will increase the engagement appeal to the user. These three categories are interconnected; however, all of these parts do not always need to be implemented. And even in each category, not all elements will be used together.

Werbach and Hunter (2012) explain that the dynamics are considered "behind the scenes" of gamification. It states what the game is, describes how gamification will be motivational and fun. Altarriba describes it as "the grammar of a game" (2014). Also, mechanics is the part that helps in the action of the game and gets the user involved. These mechanics connect to the dynamics and helps to accomplish it.

Besides, Werbach and Hunter (2012) describe components as the delicate parts that connect with mechanics or dynamics. They are used to attract users and keep them engaged. Most of them will have a direct connection with the user.

Each category is listed in Table 1.

**Table 1- Dynamics, mechanics and components (Werbach & Hunter, 2012)**

| Game Mechanics | Game Components | Game Dynamics |
|---|---|---|
| Challenges | Achievements | Narrative |
| Chance | Avatars | Emotion |
| Competition | Badges | Emotions |
| Cooperation | Boss Fights | Progression |
| Feedback | Collections | Relationship |
| Resource | Combat | |
| Rewards | Content Unlocking | |
| Transactions | Gifting | |
| Turns | Leader boards | |
| Win States | Levels | |
| | Points | |
| | Quests | |
| | Social Graphs | |
| | Teams | |
| | Virtual Goods | |

The components mentioned above are the elements commonly used in gamification, but there are other elements in games. Any element of the game has the potential to be integrated, depending on the context. Elements such as badges, points, levels and leader boards are considered to be in common use. They quickly impact users' behaviour, even if slightly (Hamari et al., 2014).

## Game-Design Techniques

Gamification also involves the use of game-design techniques. It is easy to accept that it is not a big challenge to get an element of the game, such as a points system and a leader board. However, to approach gamification in this way, we have to know the goal of earning points. Some learners may find it interesting to accumulate a score or reach the top of the leader board. But it can only happen for a while, and these learners can get tired

of just earning points. Other users may get discouraged when they see the top of the leader board very far away.

Deciding which elements of the game to place and how to make the overall gamified experience more significant than the sum of those parts is where game-design techniques have their role. The aspects of the games that make them fun, addictive and challenging cannot be reduced to a list of elements or step-by-step instructions. Game design is laborious, and this is the stage where everything can fail (Kingley & Grabner-Hagen, 2015).

## Non-Game Contexts

The last aspect of our chosen definition is that gamification operates in non-game contexts. This means that the learners are not playing a concrete game; that is, they are not invading a castle, driving a car on a racetrack or cutting fruits while escaping from enemies, but exploring content to solve a teacher's task. They are not killing dragons or collecting sweets, but they are collecting achievements along the way to improve their score on a subject. It is essential to keep this in mind when designing a gamified practice. Our learners are not there to escape from a problematic situation into a fantasy world; they are there to engage more deeply with content, with colleagues, with the subject. However, if the narrative is somehow consistent (Lencastre et al., 2016), it may still seem like a game.

Therefore, the challenge of gamification is to take the elements that generally operate in the game universe and apply them effectively in class. In several situations, teachers discover that gamification turns a tedious but valuable task into an exciting challenge, even producing measurable results. Learners can visually track their progress, compare themselves with colleagues, receive incentives and challenge each other to go further or faster. A good narrative improves the learning experience (Lencastre et al., 2016), and ties each learner in an integrated environment that makes them want more when each challenge is over.

Gamification in education takes the components and characteristics of the game and applies them to a pedagogical situation.

The final output is not a game but a game situation with pedagogical purpose. If gamification is removed from the pedagogical situation, it may still work, but it is not the same situation, with the motivation and involvement that gamification gives. The motivation in gamification is an argument noted in some empirical studies (De Freitas & Oliver, 2006; Linehan et al., 2011). However, we also believe that gamification brings more than just motivation; it requires engagement, relationship and responsibility.

Finally, we want to answer a question that we are often asked when we talk enthusiastically about gamification: why should a game-based practice be taken seriously in education? Perhaps the notion of applying something as fun as a game to something as dull as schoolwork is inherently attractive, or maybe we believe that it can be a stimulating form of advocacy for gamification.

Anyway, we see four particularly compelling reasons why all teachers and trainers should at least consider gamification: (i) Motivation, (ii) Engagement, (iii) Results, and (iv) Research.

### *(i) Motivation*

We are constantly talking that schools do not keep up with what is happening outside them. Who is not prepared for today's learners, digitally insatiable. We think of gamification as a means of designing narratives, that motivate learners to do things. When we prepare a narrative, we want to strengthen our learners' relationship and employ them with the subject's objectives and content, always thinking that this will be good for them.

### *(ii) Engagement*

When we talk about gamification, we say that it has everything to do with learner engagement. The exact human needs that drive engagement with games are present at school or university. According to Werbach and Hunter (2012), the reason for this is that our brains are programmed to crave puzzle-solving, feedback and reinforcement, and many other

experiences that games provide. The authors state that "study after study showed that games activate the brain's dopamine system, which is associated with pleasure, and neuroscientists have also found parallels between the brain's response to games and the engagement process (Werbach & Hunter, 2012, p. 31). Thus, it seems to us that it makes sense to take advantage of the natural emotion that motivates learning and higher engagement levels.

### *(iii) Results*

Another aspect that has interested us so far in gamification is that it really works. Despite the novelty of the practice, the fact is that we have obtained significant positive results with the incorporation of game elements in our teaching and learning processes.

### *(iv) Research*

There is one last reason why we are interested in gamification is to open up the space for research. Like in games, if the game is effective and not too tricky, players will be continually motivated to strive for improvement. And they are encouraged to try new and different approaches to find better solutions. This spirit of constant innovation is ideally suited to today's rapidly changing school or university environment.

## The Narrative

Last but not the least: the narrative (Lencastre et al., 2016). In games, to keep the player interested in the gameplay, they add a narrative to it; games are usually built on a narrative. In the same vein, having a narrative in gamification is a fundamental element, making it exciting and giving meaning to the whole process. The narrative can shape the gamified experience and motivate the learner's involvement; also, can provide a robust set of challenges that are meaningful and intrinsically engaging. The narrative makes each content, each task, each result fit and flow towards the final goal. Therefore, the narrative must be thought and designed very carefully.

McGonigal (2011) argues that a good gamification system presents within a story with a broad objective, and that the players look and feel positive about their own abilities, surpassing them. To paraphrase the author, we say that a sound gamification system in education presents itself within a well-designed narrative with a broad but clear objective. Learners look and feel optimistic about their abilities, continually getting more engaged.

## Final remarks

Gamification is synonymous with learning and understanding. It is the act of solving problems that makes the school fun and gamified as well. Education is an area with a high potential for gamification, as it aims to promote motivation and learner involvement. Gamification can involve the teacher gamifying an activity or teaching a concept by including a narrative and components such as missions, milestones, points, levels and feedback, increasing learner involvement, collaboratively, without being linked to any game. Therefore, learners learn, not playing specific games, but learning the content as if they were playing a game, making the educational experience challenging and fun.

Thus, gamification offers the opportunity to combine 21st-century content, teaching, and learning skills in a surrounding learning environment. The educator will provide specific content with a gamification process adapted to the learning context and learners' profiles. Intuitively, gamification has excellent potential to motivate learners and make the school or university more attractive.

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# A Brief Surf on the Net for Gamification Research

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## 1. A look at changes in the nature of instructional methods

With the improvements in technology, for quite a while instructional approaches having been going through changes and we encounter a variety of forms in education. Some of the means that come to our minds at the outset can be counted as online or distance education programmes, face-to-face or blended courses, flipped classes, education via television broadcasts, live videos, podcasts, web-based or mobile-learning systems, among many others. Each form of education can be said to be designed taking into consideration numerous variables according to the convenience of the target population. Instructional designers put the learners in the centre of the teaching/learning context and utilise various strategies in order to attract the interest and enhance motivation of the course takers. Gamifying the learning environment is one of them.

## 2. Definition of gamification

Groh, 2012; Nah, Zeng, Telaporulu, Ayyappa and Eschenbrenner, 2014; Marcos, Cabot and Lopez (2017) describe gamification using more-or-less similar words as Deterding (2011) who define gamification as "the use of game design elements in non-game contexts". In the same vein,

EduTrends (2016) defines it as the application of game principles and elements in a learning environment to influence students' behaviour, increase their motivation, and drive participation. Zichermann and Cunningham (2011) defined gamification as the process of game-thinking and game mechanics to engage users and solve problems (in Pektas and Kepceoğlu, 2019 p. 65).

Gamification refers to the use of game-design elements such as points and game characteristics such as assessment and challenge (Bedwell, Pavlas, Heyne, Lazzara, & Salas, 2012) in non-game contexts in an attempt to achieve positive outcomes to enhance student learning (Deterding, Khaled, Nacke, and Dixon, 2011). Given the implicit belief that games are enjoyable (Von Ahn & Dabbish, 2008), many instructors have integrated gamification into the classroom and researchers have studied the impact of gamification on classroom learning (Boticki, Baksa, Seow, and Looi, 2015; Hamari et al., 2016; Mekler, Brühlmann, Tuch, and Opwis, 2017, in Sanchez, Langer and Kaur, p. 2).

On the other hand, a critique toward this definition comes from Erenli (2013) where she refers to Deterding, Dixon, Khaled and Nacke who state that "gamification is the use of game design elements in nongame contexts". As she evaluates, this statement is broad and simple but does not define the term "gamification" without further explanation. She suggests in order to determine what "game design elements" are, we have to give preferential consideration to the definition of a "game", thus separating it from "non-game contexts"(p.15). However, she finds Caillois's definition as promising: Caillois defines a game as an activity that must be fun; the activity is chosen for its light-hearted character.

It must be separate: that is, it is circumscribed in time and place. It must also be uncertain; in other words, the outcome of the activity must be unforeseeable and it must be non-productive; namely, participation does not accomplish anything useful. It must be governed by rules; the activity has rules that are different from everyday life, and it must be fictitious: that is, it must be accompanied by the awareness of a different reality. Erenli disagrees with Caillois in that participation does not

accomplish anything useful. She says that this must be discounted since non-productiveness does not apply in the education context. She believes that gamification can prove the opposite. She further claims that the definition of "gamification" should thus be amended to "Gamification is the use of game elements in contexts that originally had no link to game-related elements." The more non-game-related elements receive gamificational treatment, the more they drift towards game-related elements. She concludes that it would be a shame if educators were not able to make teaching and learning a bit more joyful – especially when neither teachers nor students need to learn a new skill to be able to take part in a gamified education class.

## 3. Flow theory

Before moving on to the reasons why we play games, it may be illuminating to refer to the flow theory by Csikszentmihalyi (1975). In positive psychology, a flow state, also known colloquially as being 'in the zone', is the mental state in which a person performing some activity is fully immersed in a feeling of energised focus, full involvement, and enjoyment in the process of the activity. In essence, flow is characterised by the complete absorption in what one does, and a resulting transformation in one's sense of time (Beard, 2014).

Csikszentmihalyi, known for his flow theory, explains that flow is "a state in which people are so involved in an activity that nothing else seems to matter; the experience is so enjoyable that people will continue to do it even at great cost, for the sheer sake of doing it". Csíkszentmihályi identifies six factors encompassing an experience of flow. These are:

1. Intense and focused concentration on the present moment
2. Merging of action and awareness
3. A loss of reflective self-consciousness
4. A sense of personal control or agency over the situation or activity
5. A distortion of temporal experience, one's subjective experience of time is altered
6. Experience of the activity as intrinsically rewarding, also referred to as autotelic experience

As they suggest, those aspects can appear independently of each other, but only in combination do they constitute a so-called flow experience. Additionally, psychology writer Cherry adds three more components as part of the flow experience:

1. Immediate feedback
2. Feeling the potential to succeed
3. Feeling so engrossed in the experience, that other needs become negligible. https://en.wikipedia.org/wiki/Flow_(psychology)

In his later studies, Csikszentmihalyi together with Montijo and Mouton (2018), argue that talent, giftedness, creativity, and elite performance are not solely the products of innate genetic gifts resulting in superior abilities. Instead, he agrees with Simonton, 2014; Subotnik et al., 2011 and says that the most important thing is to understand the dynamic interplay between individual abilities and environmental opportunities. The experience of flow is influential in the development of both the individual and society because it requires an ongoing balance of challenge and skill, immediate feedback, clear and proximate goals, and also serves the development of an increasingly complex self, which is capable of expressing the full range of human potentialities. By providing opportunities for these types of optimal experiences in daily activities, parents, teachers, gatekeepers of social institutions, and policy-makers can serve the development of creative individuals and the evolution of culture (p.225).

Beard (2015) held an interview with this founding father of positive psychology and the creator of flow theory, which he studied for over four decades. In harmony with the above description, Beard writes about flow theory, which was first defined as a holistic sensation that people have when they act with total involvement (Csikszentmihalyi 1975). Beard continues by clarifying the situation as a very positive psychological state that typically occurs when a person perceives a balance between the challenges associated with a situation and their ability to meet the demands of the challenge and accomplish.

In addition, Beard lists the nine elements of flow (p. 353):

1. challenge-skill balance,
2. action-awareness merging,
3. clear goals,
4. unambiguous feedback,
5. concentration on the task at hand,
6. sense of control,
7. loss of self-consciousness,
8. transformation of time, and
9. an autotelic experience.

Gilyazova (2020) writes about how the digital turn in Russian education brings to the fore the problem of students' motivation, engagement and enjoyment. It is one of the most challenging problems inherent in all forms and levels of education, especially in e-Learning. As they claim, gamification may be a partial means to reduce the severity of the educational problems facing learners. This refers to places where gamification has become a recognised technology possessing methodological and didactic advantages that have been actively studied and used over a long period of time.

In their research, they intend to make a theoretical contribution to this field by looking into gamification in terms of philosophical and cultural approaches and analyse motivation theories with regard to gamification. The research results indicate that intrinsic motivation plays an essential role in gamification. It is game thinking that contributes to the formation of internal motivation, in contrast to the game mechanics such as points, badges and leader boards, which is focused on external motivation. Still, they warn that gamification is quite a challenging technology; priority attention should be given to maintaining the balance between its utilitarian (educational) and hedonic (recreational) functions.

In gamification, as distinct from any games (real and digital), entertainment is a method rather than a purpose; forgetting this obvious fact is fraught with negative consequences. However, they conclude that gamification should never be seen as a universal remedy.

## 4. Why do we play games?

According to Šćepanović, Žarić and Matijević (2015) there are numerous reasons for spending significant amounts of time playing games. Whether games are played for relaxation, sheer enjoyment or to satisfy our need to compete, they are a part of our daily life. Nowadays, game concepts are being increasingly incorporated in areas other than just standard playing environments. Every game has a pre-specified goal to be reached and these may take a variety of forms, such as winning a prize, accomplishing an assignment, beating the competitor, or to be ranked first in the leader board: no matter what form the game element takes, it triggers motivation, engagement, emotion and certain behavioural patterns. To harness this, game elements are implemented in non-game contexts like marketing, business, e-commerce, education, work environment, social media, and the like and the process is named as 'gamification' (p.1).

Gamee.medium.com lists five main reasons as to why we need to play games. First of all, games are fun and a source of positive emotions like curiosity, optimism, creativity, which stay enhanced even hours after we play. Second, winning games makes us (feel) heroic as the competition among peers adds adrenaline. After a success in a game, we are more likely to set an ambitious goal for ourselves, even outside of gaming. Third, games are yoga for our mind; every time we let go, we play well. Fourth, games can slow down aging. It is said two hours of puzzle games per week may slow down the degree of mental decay that comes with aging. Finally, games can even make a surgeon betterby means of maintaining eye and hand coordination, especially in fast-paced games.

As a result, we may say that gaming is an inseparable part of today's life and may have a variety of positive consequences on us human beings. Then, we may also need to go through the related literature to find out about the educational field.

## 5. What does the literature say about gamification?

Kusuma, Wgati, Utomo and Suryapranata (2018) view gamification in educational settings as one of techniques that can increase motivation and

encourage the involvement of users, making learning more fun and interesting. They write about four domains in education where gamification was applied; these are:

1. generic,
2. STEM,
3. history, and
4. language.

They suggest some gamification strategies that could be implemented for future works: in order to intensify the effect of gamification, designers need to mix and match various mechanics, because these can give different effects to the player. For example, giving game points and rewards in the form of badges or trophies may lead to a sense of achievement in students and increase their motivation in using the app while learning the subject at the same time. Using a leader board, on the other hand, may create a sense of competition and students may work more to be first one on the board. They further suggest that school-work given as selectable missions or mini-games gives a sensation of playing rather than doing homework. Providing a ground for students to be able to choose the role they want may give them a chance to express themselves and motivate them. A background story may also give more fantasy, feedback to players will guide them, while adding augmented reality through object recognition and social sharing features potentially improves the interactivity of the gamification model that may result in an improved learning process (p.392).

In line with Kusuma et al, Solmaz and Çetin (2017) touch upon the positive outcomes they reached by using a gamification-based Interactive Response Systems (IRS) with university-level students. In their study, they used IRS, which contained gamification elements to maintain a correspondence: through this, students answered their teacher via computers, mobile devices or QR code cards. In their study, they used a variety of IRSs such as Kahoot, Socrative and Plickers.

When they tried to elicit students' views regarding the procedure, the findings demonstrated that students reacted positively toward the use

of gamification-based interactive response systems in their lessons from a variety of standpoints. First of all, satisfaction levels for gamification-based IRS tools are high. Second, the fun and easy-to-use features of the IRSs are viewed as the most popular features by the students. The use of different technologies, such as the QR code cards, colourful interfaces, and immediate feedback in the answers given to the open-ended questions, were favoured by the students. These increased students' interest toward the course and facilitated their learning. Such a procedure was instructive, in that it prevented students' from becoming frustrated and they also learned things while having fun.

Similarly, we find that Yıldırım (2017) also reports his positive research findings on account of the use of gamification elements in mathematics education. In his study he adopted a quantitative research methodology and a true experimental design using pre-test–post-test experimental and control groups. The participants comprised of 97 sophomores from the Department of Elementary Mathematics Education of a state university in Turkey in the 2014–2015 academic year. As he puts forth, the results reveal that gamification-based teaching practices have a positive impact upon student achievement and students' attitudes toward lessons. Still, he refers to Yılmaz (2015) to emphasise that it is inadequate to gamify a process – even when using as many as three components (points, badges, and leader board) – without other procedures (p. 91). Therefore, the use of achievement scores alone cannot be considered a gamification design. In spite of this caution, he still underlines that a growing body of literature indicates the effectiveness of gamification-based teaching practices on student achievement.

In the same vein, Marcos, Cabot and Lopez (2017) define gamification as the use of game mechanics and game design in non-game contexts to engage users and motivate action. Underlining the potential of gamification in higher education in their study, they focused on competitive approaches and presented contrasting evidence. Using a social gamification approach and a tool designed to address the situated motivational affordances of students such as relatedness, competence and

autonomy, they conducted an experiment to compare students' performance with a traditional blended-learning approach at an undergraduate course. Results suggest that social gamification can be used to improve the overall academic performance in practical assignments and to promote social interaction. However, the results also unveil the need for a deep knowledge of the range of motivations among the students and a careful design of the rewards to be used for the ones who are planning to implement game elements in higher education contexts.

In their mixed method research study, Turan, Avinc, Kara and Göktaş (2016) studied the effect of gamification strategies on students' cognitive load levels and achievements was examined along with student opinions about gamification. In the quasi-experimental part of the study, 6th-grade information and technology course students were divided into two groups and the experimental group was conducted using gamification strategies such as Kahoot and Class Dojo while the students in the control group completed the same activities using traditional methods. The teacher taught the topic, and the students did the given activities. The results show a significant difference between the two groups to indicate higher achievement in the experimental group. Regarding the cognitive load levels, the experimental group also scored higher than the control group. As for the qualitative part of the study, students were interviewed and the analysis reveals that the students had positive views about gamification strategies.

Regarding gamification from the assessment point of view, Wood et al (2013) scrutinise the design of assessments within the virtual environment to contribute to authentic learning. Gamification elements and rewind support this: rewind, ghost images, save points, multiple lives, and time-and-space control were all used as game elements in their study. On the basis of their findings, they conclude that these elements lead to positive outcomes, which constitutes support for assessment in authentic learning, increasing efficiency, and providing new opportunities for educators. Incorporating these elements may also provide several opportunities for educators in improving student learning by careful

design of assessments, together with additional benefits such as self-assessment, problem solving, persistence for more attempts, self, peer, or instructor evaluation (p. 521).

Gamification was used in various educational contexts and online education is not an exception. For example, holding the belief that there are only a limited number of studies conducted on gamification in the context of online education at the time of their study, Antonaci, Klemke and Specht 2019) undertook a systematic literature review on the effects of gamification on users' behaviour in online learning. On the basis of the results, the authors identified and mapped the effects. As they put forth, research on the gamification procedures is maturing, however, they quote (Nacke and Deterding 2017, p. 3) "many studies are still to some extent comparing apples with oranges, testing different implementations of design elements with different effect measures" (p. 3). Antonaci et al thus emphasise that gamification and its application in online learning (especially in Massive Online Open Courses) is still a young field, lacking in empirical experiments and evidence with a tendency to use gamification mainly as external rewards. Furthermore, they write that in their future studies, they plan to explore the effects of their gamification design on human behaviour, contributing to the growth of the field with empirical data as well as demonstrating that gamification can be applied in a more sophisticated way.

Bai, Hue and Huang (2020) approach gamification in a cautious way, stating that although gamification is highly evaluated by the majority as an exciting new method to engage students, evidence of its ability to enhance learning is mixed. As they underline, gamification has already attracted considerable controversy. That is, some argued that gamification is an effective means to generate student interest and trigger motivation, while others labelled it as "nonsense" or "exploitationware" (p.1.) Based on these discussions, Bai et al studied with a large population (3,202 participants) and explored student interventions drawn from 24 quantitative studies that have examined the effects of gamification on student academic performance in various educational settings. The results

reveal a significant overall medium size effect in favour of gamification over learning without gamification and that gamification tends to work better in Asian contexts. (The authors warn the readers that they should approach this finding with caution due to the small number of non-Asian experimental studies available for comparison.) The findings also uncover four reasons for learners' enjoyment of gamification. First of all, (1) gamification can foster enthusiasm, second (2) it can provide feedback on performance and (3) fulfil learners' needs for recognition, and finally, (4) it can promote goal setting. On the other hand, the results put forward two reasons for a dislike of gamification. These are the beliefs that (1) gamification does not bring additional utility, furthermore (2) it can cause anxiety or jealousy. Finally, as for future research to be conducted in the field of gamification, Bai et al suggest that future work should concentrate on teachers' and instructors' attitudes toward gamification.

A group of researchers (Sahin et al, 2017) from a Turkish university who cooperated for a research project explored the probable effects of a gamified learning environment in a distance education programme with regard to minimising the lack of student motivation emerging from separation in time and space from teachers, other learners, and learning sources. Within this perspective, they used of "SoruKüp" a gamified web-based quiz application designed for the use of distant learners. Learners from Open Education Faculty and Business Administration Faculty who used the application at high, medium and low frequencies were selected as participants in the study. The findings reveal that students in a distance-education system evaluated the gamified application positively in terms of triggering motivation positively in the learning process. Components such as the leader board enabled them to evaluate their level and see other participants on the board, as a result of this, they had increased perception of social presence. Similarly, qualities such as points, achievement and progress supported their learning experiences and made the learning experience a sustainable process. The participants found the social graph component that enabled communication with other participants unnecessary, and some of them

stated that they were not even aware of this feature. Some of the participants mentioned that they were disturbed by the potential for in-person contact with participants they did not know (p. 389). Still, the researchers underline that there needs to be more studies conducted in the field to be able to suggest that gamified learning activities are definitely fruitful in creating motivation in distance education programmes.

Likewise, Dicheva, Dichev, Agre and Angelova (2015) in their study touch upon some major obstacles and needs, such as the need for proper technological support, and for controlled studies demonstrating reliable positive or negative results from using specific game elements in particular educational contexts when gamifying the environment. They warn that though we encounter promising results about gamification, more substantial empirical research is needed to determine whether both extrinsic and intrinsic motivation of the learners can be influenced by gamification (p.75).

Going through the literature, we come across another study conducted in the Turkish context at university level by Pektas and Kepceoğlu, (2019). In their case study, they investigated what prospective science education teachers think about the use of gamification in education. The researchers elicited forty-four participants' opinions about the use of gamification in education after a four-week implementation of gamification. The results unveil the benefits of gamification as perceived by the prospective teachers. The benefits cited were such as an increase in motivation, saving time, and preventing cheating, as well as limitations such as difficulty in classroom management and technological problems. Furthermore, the participants noted that gamification applications could be used in the assessment of instruction. The researchers warn that the study was carried out with respect to the playing practices in the teacher training period however, it would be beneficial to study the different teaching levels and apply the practices in different courses to diversify the results.

To find out about whether gamification can improve the students' engagement and quality of learning (and by doing so, have a positive

impact on their marks) or is just an *en vogue* notion with no practical application, Laskowski and Badurowicz (2014, p.971) conducted an experimental study with students of Masters' studies. They found that gamification led to higher attendance levels and a higher amount of homework completed per person: on the other hand, higher average final mark in non-gamified groups were also revealed. As the results show lower exam scores on behalf of the gamified groups in this study, the authors underline the need for replications of their study with larger groups to reach more fully proven results.

In order to provide a current state-of-the-art of empirical work regarding gamification in higher education and STEM and to find gaps in existing studies, Ortiz, Chiluiza and Valcke (2016) went through 562 articles in the related literature. They adopted a systematic manner and thus narrowed down their focus by means of pre-set inclusion criteria for the studies to search. They went through Web of Science articles on higher education published between 2000 and 2016 that considered graduate and undergraduate students in the STEM knowledge fields, and finally, were set up on authentic contexts.

The findings reveal that gamification started to appear in scientific articles beginning from the year 2011. The majority of studies conducted on gamification were from European countries followed by the United States of America, Asia and Africa. In general, quantitative research methods were used in the studies, then mixed method and qualitative designs were utilised. Sample sizes of the studies varied from 11 to 2263 participants. Regarding the elements used in the studies, as the most frequently used ones, we encounter a combination of elements. Badges, points, challenge, leader board and quests followed. Computer science, science/technology, maths, and chemistry were the STEM fields that experimented with gamification.

The results reached at the end of the studies show that the majority had positive outcomes, followed by negative, neutral and mixed. The authors suggest that there have to be:

- controlled studies carried out of unique gamification elements to determine their individual effect on students;
- studies set up in other STEM areas;
- development of more complex models to study the impact of gamification through the inclusion of mediating or moderating variables such as motivation, personality, and game preferences; and lastly,
- the design and adoption of high quality research instruments to develop valid and reliable research results (p.6555).

Similarly, researchers from Finland, one of the countries where studies on gamification were most frequently conducted, made and account of the articles published in the field (Majuri, Koivistoa and Hamari, 2018). As they report, gamification appears to signal achievement and progression, however variations in social and immersion-oriented factors are much less common in the studies. The results are mainly focused on quantifiable performance metrics and are strongly positive in their orientation. The writers suggest increased attention on contextual factors and study designs in future research endeavours.

Allabasi (2017) explored gamification from the perspectives of students from a higher education context. The research findings signal a positive attitude toward gamification. On the other hand, for more fruitful learning outcomes, students emphasise the need for effort-demanding, challenging, sophisticated learning systems. These need to increase competency, and enhance recall memory, concentration, attentiveness, commitment, and social interaction.

Similarly, Kirillov, Vinichenko, Melnichuk Melnichuk and Vinogradova (2016) report that gamification enables one to create conditions supporting students' motivation for a long period of time, while turning their training into an interesting educational game. It contributes to the refinement of students' adoption of learning material: it reduces the level of stress while waiting for the evaluation of their skills and knowledge, changes the behaviour of the students, and it promotes the formation of new habits. Furthermore, throughout the study students reported their positive emotions, that they felt alert and alive, which in turn served as the basis for the gamification implementation.

In line with the above discussions, Looyestyn, Kernot, Boshoff, Ryan, Edney and Maher (2017) provide the gamification users with a range of aspects to consider before they come to a totally positive set of conclusions for the usefulness and effectiveness of gamification. As a result of their investigation into conducted studies conducted, they summarise that gamification promises to increase engagement with online programs.

Gamification has been used primarily in education and market research contexts, with reporting standards and methods of engagement varying amongst studies. The results of the studies they analysed imply that gamification positively impacts engagement and downstream behaviours such as academic performance. In addition, leader boards may be a particularly effective gamification feature: however, more research is required to confirm this.

We need more systematic and well planned research studies to be sure about the effectiveness of gamification in different settings, and to investigate how gamification can be used to increase long-term engagement in online programs. In short, if we do not approach gamification with caution and investigate the issue from an objective perspective, we may easily jump into faulty assumptions.

Deif (2017) offers an application in gamification assessment in the context of lean thinking and integrates the social-processing criterion with motivation and cognition used in game education assessment. As a consequence of rigorous statistical and comparative analysis of his data for the study, he finds that in teaching lean thinking, gamification has the potential to motivate students to engage in the classroom. He also concludes that it gives teachers better tools to bring a practical and applied sensibility to students and means students bring their full selves to the pursuit of learning. Finally, as in the other studies above, he underlines the value in selecting carefully, systematically and with well-structured designs. He further suggests that lean games need to be adapted to align with the higher education pedagogical dynamics as well as with the limited industrial experience of students (p.371).

## 6. Conclusion

In the evidence we obtain from most of the studies conducted in the field of gamification, in a variety of educational contexts and with different purposes, we find that in spite of the positive result we observe that almost all studies end with a warning that the results need to be interpreted with caution and that new studies need to be conducted ın order to be able to generalise the findings.

Accordingly, with all that ten-year hype around gamification, it has become a field that still needs further scoping studies, but gamification exists and evolves as a research niche in the area of educational research. The research agenda is far from being straightforward, though it is full of new green shoots. The present-day research goes beyond the early studies on the game potential for education and a limited range of game-based learning technologies. More studies come out to analyse the psychological mechanisms behind gaming for learning purposes and game-based learning; learning theories are explored to find more profound underpinnings for gamification by Raitskaya and Tikhonova, (2019, p.5).

In addition, we need to keep in mind that gamification of education is extremely sensitive to context. There is no once-size-fits-all model for the successful gamification of a classroom. By utilising gamification carefully, teachers can direct their classroom environment towards success in raising both engagement and achievement. As with any pedagogical framework, an educator must be careful to consider the context in which they are teaching: who their students are, and what the shared goals of the class are. When these are considered, and the educator gives themselves the freedom to fail, gamification of the classroom can lead to increased student engagement and success (Stott and Neustaedter, 2013, p.12).

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# Gamifying Soft Skills: A Theoretical Framework

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## Introduction

The present study focuses on evaluating the effectiveness of digital badges-based strategies in motivating students to engage in extra-curricular tasks and how we can link them to the transversal competencies they help develop. We will succinctly go over the various key topics that make up the broader framework of this study in order to understand how micro-credentials and badges come together and how they can benefit research on gamification and education. Afterwards we will surmise how these come into play for our pilot study. This research will be conducted at the University of Aveiro (UA), Portugal. From implementing digital badges in Massive Open Online Courses (MOOCs) to gamifying features on their campus' website, the UA supports research on current strategies of communication and service design (Araújo et al., 2017, 2018). This is because universities should aim to provide their graduates not only with the distinctive curricula offered by their courses, but also with the necessary preparation for a fruitful transition to the job market through the use of validated and recognised micro-credentials for their extracurricular efforts and accomplishments.

## Soft Skills

The value of employees' experience beyond theory grows as the job market becomes more competitive (Andrews & Higson, 2008; Balcar et al., 2011). In several professional fields, applicants do not easily stand-out

from one another since they have academic diplomas that merit approximately the same levels of achievement. The difference, however, can be found amongst their acquired soft skills and micro-credentials, which consist in personal competencies that are relevant to any field of study or position (Andrews & Higson, 2008; Balcar et al., 2011). Nowadays, employers are increasingly more interested in candidates who display these skills, since they provide further insight into the employee's behaviour, beyond their "hard" knowledge. This emerging professional interest in soft skills is why educational institutions have begun to study innovative ways to teach and motivate students in all stages in life to continuously learn new transversal skills to ensure professional success.

One of the first pieces of academic research on "soft skills" was presented in 1972, as part of a series of tests conducted in military schools by Paul G. Whitmore (Whitmore & Fry, 1972). Throughout history, the term has been compounded with other similar expressions, such as "social skills", "emotional intelligence" or "life skills", among others. The latter of which, proposed by the World Health Organization (WHO), aimed to capture the psychosocial competencies that promote a healthier lifestyle for children and adolescents, preparing them for their adult lives in the process (WHO, 1994). However, research showed that "soft skills", as a term, has been mostly employed in contrast to "hard" skills, meaning, for employers, they are a metric for gauging the transferability of the candidate between several professions (Atkinson & Pennington, 2012; Balcar et al., 2011; Whitmore & Fry, 1972). For the purposes of our research, we have decided to focus on Balcar et al.'s work (Balcar et al., 2011) made in association with the European Commission, published in 2011. It sought to define, among others: a comprehensible language for understanding and categorizing soft skills, which are in most demand, adopting methods that are used for both their development and their wider transferability. Even though it was published in 2011, the research was made with future-proof in mind, meaning that it is certified to be relevant up until 2020. Furthermore, Balcar et al. drew upon a plethora of international sources, from the European Union's member states and

partners from the Organization for Economic Cooperation and Development: USA and Canada.

In Balcar et al.'s words, all skills are transferrable, but to different degrees. These can range from "hard" skills, the most job-specific competencies that allow transfer between similar occupations, and "soft skills", coined as the most perfectly transferrable skills and seen by employers as "closely connected with attitudes, which are intangible, and difficult to quantify and develop" (Balcar et al., 2011, p. 9). The present study adopted the following definition: soft skills are a set of personal and interpersonal capacities that, along with transversal hard knowledge, provide the individual with valuable and unique features not only for professional circumstances but also for self-management and self-worth.

## Gamification

There are several ways to implement soft skill training within a higher education plan, such as dedicated training plans, encouragement of socialization, or even including it in formal HE curricula. The latter, however, is not as simple as the rest, since most courses were designed around the 'hard' knowledge they aim to equip their students with (Schulz, 2008). Alternatively, educational institutions also strive to offer enriching extra-curricular activities. The nature of these activities, however, rely on the students' motivation to engage with them. Thus, educational institutions have also been researching ways to encourage them to do so. Gamification, for example, is a user-experience design methodology that serves to create, in the user, a willingness to engage towards a desired activity. Its usage and research in academia has also seen a significant increase with mostly positive results (Koivisto & Hamari, 2019; Majuri et al., 2018).

Since it became a matter of academic study, towards the end of the 00s, it has been subject to a growth in research with significant results. In the field of education, different cases suggest several advantages and disadvantages. Research points to increased efficiency in completing gamified tasks (DeMers, 2018; Zhou et al., 2019) and in minimizing

"deadline oriented" mindsets while encouraging completionism behaviour (Hakulinen et al., 2015). Furthermore, gamification can connect on deeper levels with different students, providing them with significant emotional and social experiences (Domínguez et al., 2013). On the other hand, results also pointed to negative observations. If the process fails to convey a meaningful reward to the user, it can lead to negative behaviour like "procrastination" or lack of engagement towards the gamified task (DeMers, 2018; Domínguez et al., 2013; Zhou et al., 2019). To solve these negative observations, studies pointed to similar conclusions in the field of education, namely that gamified experiences should be designed around intrinsic motivation by having a clearer picture of what is actually meaningful for its end users (DeMers, 2018; Deterding, 2015; Deterding et al., 2011; Domínguez et al., 2013; Koivisto & Hamari, 2019; Majuri et al., 2018; Zhou et al., 2019).

The results yielded from the research on gamification echo many of the points brought up by Sebastian Deterding in his conference talk "Meaningful Play: Getting Gamification Right" (Deterding, 2011). As a response to the then growing gamification trend among software and online companies, Deterding meant to point out why many of them were failing at implementing gamification, while comparing them with successful cases. He described that "Points, Badges, Leaderboards", game elements that were commonly overused at the time, are mere blueprints for gamification, in which Points refer to "Feedback", Badges to a "Reward System" and Leaderboards to a "Competitive Structure". These game elements consist of game design tools that are adopted by gamification to create an experiential goal[1] for the user. In Deterding's view, this goal should be made up of 3 key ingredients:

1. Meaning –Awards in gamified experiences should be aligned with the players' personal goals in using the service or product, so that they may feel like their actions had a meaningful reward.

[1] This relationship between elements and goals is explained in more detail by the "Mechanics, Dynamics Aesthetics framework" (Hunicke et al., 2004)

2. Mastery – Gamification should "provide interesting challenges" with multiple paths to overcome the same goal, so that the player feels as though they were learning how to surpass them.
3. Autonomy – A player should be willing to carry out the experience because they seek an intrinsic sense of fulfilment, instead of playing for the sake of having better grades or a better salary.

Even with some early failures in the business sector, gamification still had the potential to be a valuable tool, and it would continue to motivate a large number of companies to quickly adopt gamified strategies or develop new services altogether, built from the ground up with this methodology, and especially badges, in mind (Deterding, 2011; Koch-Grünberg, 2011).

## Open Badges

Educational and business institutions also began conducting research on digital badges for not only generating more meaningful rewards for their communities, but also for creating shareable digital symbols that would (1.) hold the earner's achievements and (2.) carry that information across institution to institution, adding more badges to their collection in the process (Araujo et al., , 2018;). To this end, Mozilla allied with the MacArthur Foundation (Loughlin et al., 2016; Mozilla, 2017) to launch "Open Badges". The Open Badges initiative consists of creating a world-wide network of institutions that uses digital online badges to credit specific skills (micro-credentials) learned by their respective participants. These badges can be collected by earners via the institutions' own means of attribution which are usually made via digital badge applications following the Open Badges Infrastructure (OBI)[2][3] (Mozilla, 2014). They consist of online platforms where users can create, issue and distribute badges with other users. It is also possible to have several roles, usually divided into Earners and Issuers. The former usually have the option to

[2] See: http://mzl.la/1BsOPmk

[3] The infrastructure developed by Mozilla that developers should follow to keep within the technical specifications of digital Open badges (Dimitrijević et al., 2016; Mozilla, 2014).

create collections of badges that are then shareable across social media platforms (Mozilla, 2014).

So long as the organization follows the OBI, any badge issued can be officially recognised by others that also adhere to it. Thus, Open Badges aim to create a new democratic paradigm for valuing and recognizing what is learned. It seeks to encourage schools, recruitment offices and after-school projects to create and deploy meaningful badges, so that every achievement or acquired skill or ability is duly acknowledged. Within a network of partners of the initiative, they can also serve to establish professional credibility, since the more they are promoted and used as deciding factors for hiring, the more valuable they become towards other institutions. This means earners can have more diverse curricula that more accurately portray their uniqueness among their peers, as they can display the badges they have collected throughout their lives (Duncan, 2011; MacArthur Foundation, 2013).

## Micro-credentials

Mozilla's initiative meant skills that are not usually part of a curriculum plan could receive much more attention and recognition from evaluators and peers. This new opportunity kickstarted a wave of micro-credential recognition that sought to bring these otherwise less visible, 'isolated' skills to the forefront (Mozilla, 2017). In a way, micro-credentials refer to the desired outcome of acquiring a digital badge: knowledge on how to do a specific task. This, in and of itself, is a challenge to more traditional models of education, wherein several individual tasks are usually part of an integrated system designed to teach a specific subject matter with some level of integrity. In other words, micro-credentials are like different waypoints on a map (West & Lockley, 2016). One can look at education programs of any kind (be they crash courses, workshops, BScs, or anything from across the range) as possible routes that go through these different points in a specific order, so that learners can acquire the necessary "fractions" of knowledge to be deemed skilled or proficient in the lectured field. The benefit of "fractioning" these routes is that it allows the learner

the freedom to acquire a specific skill or skills from within that network and being duly recognised for doing so. The MacArthur Foundation and its partners saw this concept as a crucial step towards innovating the modern, technologically enhanced, educational system. They recognised that learning is a life-long experience, and that the ones who are curious enough will constantly come across events or significant points in their lives in which they can develop a specific skill (MacArthur Foundation, 2013).

## Designing the pilot study

The presented topics serve as the theoretical framework of the pilot test we plan to conduct in the University of Aveiro. We aim to evaluate the effectiveness of using a badge-oriented gamification strategy to motivate students to engage in optional or extra-curricular activities. For our study, we propose using an online digital badge platform, compliant with the OBI, to create badges that are to be rewarded for the completion of said activities. We have decided to select a curricular activity with optional elements, since these are not considered for the students' final grading, thus serving as a way for them to willingly develop their transversal competencies. We chose to focus our study on the Project Based Learning activity in which first-year students from the audio-visual branch of the Master's in Multimedia and Communication are engaged in. This activity consists of filming multiple short films using knowledge learned from the classes taught in the first semester. Students are graded based on how they apply what they have learned in each class of that semester, but many of them choose to play roles in these shorts that are not evaluated by the teacher, such as: acting, composing, narrating, applying make-up, among others. These optional activities lend themselves well to our research since they require distinct levels of transversal competencies and, thus, can serve as completable tasks to award badges for. The soft-skills that they help develop will be framed as the micro-credentials that each badge validates.

At the current point of our investigation, we have already gathered a focus group, made up of students and teachers, to help us

understand which activities these subjects deem worthy of a badge award. As for the next step, we plan to understand which transversal competencies could possibly be linked to each badge. For that matter, we will present the badges to a separate group of first- and second-year students who have completed the tasks during previous academic years. They will be asked to establish ranks among competencies for each task they have completed, thus giving us first-hand, experiential opinions on how much these matter to successfully complete the optional activities.

It should be noted that we have already selected the digital badge platform we will work with, that being Badgr[4]. We have arrived at this decision after a detailed study of many other platforms that follow OBI. This prompted us to produce a benchmark table (Tables 1a and 1b), specifying which general features does each platform have. However, our decision is not solely based on this table, because of certain unique functionalities some of these platforms have. Creating "Pathways" is a special feature unique to Badgr. A Pathway consists of a layout of badges like elements in a flowchart, allowing the user to design a flow of micro-credentials that culminate into a broader competency. This feature caught our interest because it makes the platform flexible enough to adapt to several contexts within educational institutions, which is one of our goals. Coupled with its simple, intuitive, and accessible design, we believe that Badgr is the more adequate platform for out study.

[4] https://info.badgr.com

**Table 1a. Benchmark of studied digital badge apps available online. The platforms can be found in the left column while the generic features are at the top;**

| | Badge Creation | | Hierarchy | | Access | | |
|---|---|---|---|---|---|---|---|
| | Create badges? | Use original assets? | User Role hierarchy? | Badge Hierarchy? | Browser | API integration? | Stand-alone app? |
| Badgecraft | X | X | X | X | X | | X |
| Accredible | X | X | X | | X | X | |
| Badgelist | X | X | X | | X | X | |
| Purdue Passport* | X | X | X | X | X | | X |
| BadgeFactor** | X | X | X | | X** | | |
| OpenBadges.me | X | X | X | X | X | X | |
| Badgr | X | X | X (pro) | X (pro) | X | X | |
| Bestr | | | X | | X | | |
| ForAllBadges | X | X | X | | X | | / |

***Purdue Passport requires an Instructor Account, which is only available upon request. Since we have not received a response from Purdue so far, data was gleaned from the information available on their website and tutorials;**
****BadgeFactor is a wordpress plugin; (pro) = refers to a feature only available in the PRO (or premium) version of the platform.**

**Table 1b. Continuation of Benchmark of studied digital badge apps available online shown in Table 1a previously. The platforms can be found in the left**

| | Social Interaction | Issuing Options | | Evidence System | Statistical Data |
|---|---|---|---|---|---|
| | Can users see/interact with each other? | QR/claim code? | Email? | Customizable Evidence System? | Export statistical data? |
| Badgecraft | | X | X | X | X |
| Accredible | | | X | X | X |
| Badgelist | X | | X | X | X |
| Purdue Passport* | X | | X | X | X |
| BadgeFactor | X | | X | X | X |
| OpenBadges.me | | | X | X | X |
| Badgr | X | X (pro) | X | | X (pro) |
| Bestr | | | | | |
| ForAllBadges | X | | X | X | |

**column while the generic features are at the top;**
***As stated for Table 1a, Purdue Passport requires an Instructor Account,**
**** As stated for Table 1a, BadgeFactor is a Wordpress plugin; (pro) = refers to a feature only available in the PRO (or premium) version of the platform.**

By presenting the badges to students, we aim to build with them a strategy that not only follows the results of our theoretical framework, but also aligns with the interests and perceptions of the participants. This is because it is necessary that the students sense a plausible connection between the tasks and the competencies they develop. Apart from badges, we are also interested in presenting titles as rewards for the completion of certain sets of badges, such as "Creative"; "Leader" or "Jack of All Trades" (names that may be subject to change). Together, these titles can provide a contextual narrative to help the students understand how extra-curricular activities and transversal competencies can guide them to become distinguished professionals.

Our goal is to understand whether exposure to these digital badges make the students more inclined to engage in the selected activities, while also registering their experience with the platform. Working directly with them in our investigation will help us tackle the inherent difficulties and obstacles in establishing a successful gamification strategy that is attractive to its intended audience. By allowing them to participate in the decision process on what competencies should be validated by each digital badge, we are building a mutual understanding on how they recognise the acquisition of specific soft-skills from several tasks with distinct characteristics and requirements. Ultimately, we aim to use this knowledge as a fundamental framework for constructing a gamification methodology that institutions may use to make informed decisions on why and how to create digital badges to promote the development of transversal competencies. All while presenting a technological solution that eases the process of badge creation, attribution and skill validation. This framework and resulting methodology will be presented to the University of Aveiro as a guide for implementing Open Badges at an institutional level, which can then be made available to other universities the world over.

## Conclusions

In summary, as soft skills continue to be valued by recruiters across different sectors, research on teaching and training methods is increasingly incentivised. One of these methods – engaging in extra-curricular activities – has proven to be valuable for learners to acquire skills relevant to professional contexts (Atkinson & Pennington, 2012; Kovalchuk et al., 2017). To encourage students into engaging with these activities, a gamification strategy was considered, not only because of its success as a motivational tool at an educational level, but also because of its status as the foundation for digital badges. Open Badges are, as such, an extension of the gamification design methodology that attempts to bring to light the importance of the micro-credentials available to students throughout their academic and professional career, as well as establishing their presence within a wider network of educational institutions and employers. In other words, digital badges lend themselves adequately to gamification strategies that seek to motivate individuals to engage with extra-curricular activities, since they give them not only the intrinsic reward of self-fulfilment and soft-skill development, but also valuable and authenticated micro-credentials that help them stand out among their peers in their respective fields (Brauer, 2019; Coleman, 2018; Lewis et al., 2016).

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# Gamification and game-based learning: strategies to promote positive competitiveness in the teaching and learning processes

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## Introduction

Gamification and game-based learning have attracted the attention of academics, professionals and education professionals. Despite extensive commentary on its merits, little empirical work has sought to validate gamification and game-based learning as meaningful concepts and provide evidence of its effectiveness in motivating and engaging students in non-entertainment contexts.

The use of gamification and game-based learning in education, and its relationship with motivation and positive competitiveness, has deserved increasing attention due to their potential to direct behaviours (Dicheva, Dichev, Agre, Angelova, Salem, Salem, & Carolina, 2015). On the other hand, it also has the merit of allowing a deeper understanding of the concepts, personal appropriation and mastery of complexity, features defended by authors such as James Paul Gee (2008). Good games create

good learning that uses problem-solving to produce deep student engagement and satisfaction (Gee, 2008) and, at the same time, teach students to work for goals, make choices and face the consequences (Trybus, 2014).

This chapter presents a study carried out within the Supervised Teaching Practice of the Masters' Degree in Informatics Teaching at the University of Minho. It seeks to identify the reason for the integration of games and gamification to promote positive competitiveness of vocational training students. To address this goal, we have designed six challenges that seek to focus the student on the learning process and respond to the following research question: *Are gamification and game-based learning the right strategies to promote positive competitiveness in teaching and learning processes?*

In this chapter, we will briefly present the related concepts, the methodology followed in the empirical study, and the results obtained from the data analysis.

## Background

### *Gamification*

Although gamification has recently gained academics and educators' notice, gamification is not a new concept, having roots in marketing endeavours, such as points cards and rewards memberships, educational structures, most notably scholastic levels, grades, and degrees, and workplace productivity (Seaborn & Fels (2014). The re-emergence of gamification is thought to have been brought about by many converging factors, including cheaper technology, personal data tracking, eminent successes, and the game medium's prevalence (Deterding, 2012).

Gamification is a term firstly used by Nick Pelling in 2002 to refer to the use of game elements in non-game situations (Domínguez, Saenz-de-Navarrete, de-Marcos, Fernández-Sanz, Pagés, & Martínez-Herráiz, 2013).

These game elements should only be those that play a significant role in the gameplay, such as rewards, difficulty levels, scoring points, time limits, resource limits, clear objectives (Deterding, Dixon, Khaled, &

Nacke, 2011) and a narrative that contextualises those objectives. However, the use of these game elements does not imply the use of games (Deterding, Sicart, Nacke, O'Hara & Dixon, 2011).

Why gamification? Gamification provides an effective way to keep students active, engaged and motivated for otherwise tedious activities (Fuchs et al., 2014). Gamification can use social competition to encourage collaboration and motivation to foster learning (Hanus & Fox, 2014).

Raftopoulos (2014) states that commitment and motivation are essential gamification factors, and the teacher needs to move away from an approach based on content and use a method that seduces the student in his search for knowledge. According to the author, the most effective use of gamification in education is creating a context and a narrative and selecting the most appropriate elements of the game to create an immersive experience. Seaborn e Fels (2014) summarise the game elements linked to gamification:

**Table 1 - Legend of game element terminology (Seaborn & Fels, 2014)**

| Term | Definition | Alternatives |
|---|---|---|
| **Points** | Numerical units indicating progress. | Experience points; score. |
| **Badges** | Visual icons signifying achievements. | Trophies. |
| **Leaderboards** | Display of ranks for comparison. | Rankings, scoreboard. |
| **Progression** | Milestones indicating progress. | Levelling, level up. |
| **Status** | Textual monikers indicating progress. | Title, ranks. |
| **Levels** | Increasingly difficult environments. | Stage, area, world. |
| **Rewards** | Tangible, desirable items. | Incentives, prizes, gifts. |
| **Roles** | Role-playing elements of character. | Class, character. |

Kapp (2014) states that users engage in games because they have challenging, fun and socialising elements and that these same elements promote learning when used, for example, through the use of challenges.

### *Game-based learning*

The use of games in learning can be an excellent way to use constructivist pedagogies through an active and participatory approach to learning (Whitton, 2012). Many games use learning techniques through problem-solving, providing a contextualised experience that energises learning through practice, error, reflection and repetition, promoting collaboration because players often need to work together towards common goals.

Games also use a wide variety of techniques to ensure engagement and keep players immersed in the activity, which can also be used in learning scenarios. Techniques such as good narrative, clear goals and challenges with different levels of difficulty, rules and rewards, such as getting a higher rank on the leaderboards, or gaining a new skill.

But, despite using the same motivating elements, game-based learning is not the same as gamification (Davis, 2014). When we talk about game-based learning, we are talking about learning through real games and not strategies that use the game elements.

Referring to the educational system, Schell (2008) states that it is, in itself, a game. Students (players) are given work objectives (game missions) that will have to be delivered (completed) by specific dates (time limits); also grades (scores) are attributed as feedback on the work developed (challenges), repeatedly, with increasing difficulty, until the final exam (boss) in which they will only be approved (defeat) if they have developed the skills of the course (game). Students who have a good performance can be part of an honour roll (leaderboard).

However, the author concludes that games can be excellent in education if used as tools and not as a substitute for educational systems.

### *Motivation and positive competitiveness*

The role of motivation in the learning process is of the utmost importance. It is the motivation that makes a student define his goals and use cognition (e.g., planning, monitoring) and behaviours (e.g., persistence, effort) to achieve them (Schunk, 2012). In the learning process, ideas are built about the contents and the didactics itself, which can be stimulating and challenging or tedious and devoid of interest. Associated with these are also the representations that each person builds around themselves (Salé, 1997) and that influences motivation.

One way to stimulate motivation is through competition (Shindler, 2009). Referring to the competition, Plowman (2013) highlights the positive competitiveness as the one desired to exist in workgroups and organizations. Positive competitiveness is a way for individuals to compete to improve their position in the group, in a cooperative manner with mutual respect, and through interactions that do not harm other group members. Additionally, Shindler (2009) refers to the fact that the pressure of competition can potentially increase students' response capacities, keep them motivated to be successful and raise levels of fun in school activities.

We can also add that teachers who teach in competitive environments tend to be better prepared because they also organise the sessions better, always seeking new strategies and teaching methods.

However, says the author, the competition must be exercised with prudence in the classroom, because in the presence of a competitive situation there may be a tendency to increase interest in the processes necessary for victory, to the detriment of learning itself.

## Method

Following Kapp, Blair and Mesch (2012), we imagined a narrative of six different challenges that served the purposes of clear learning objectives, a sense of progress and interconnected learning, instant feedback, transparency, challenge and status. In addition to “time”, other game elements were used in our narrative, such as points, leaderboards and

rewards. Implicit in all challenges was self-discovery and new knowledge or the regeneration of previously acquired knowledge.

To facilitate comparison and encourage positive competitiveness, the results of the challenges were published on an online platform, allowing students to analyse and comment on these results.

We developed the pedagogical intervention in a 10th-grade class of a Vocational Training Course named 'Computer Systems Management and Programming Technician' in the subject 'Computer Architecture'.

We choose the contents syllabus 'Assembly and Computers Configuration' and 'Error Detection', whose objectives were (Rodrigues, 2005, p.9):

1. to provide students with knowledge/skills suitable for assembling and configuring computers and their peripherals, and
2. to provide students with the knowledge to solve minor problems in terms of software and/or hardware.

Since this is a subject "with a formative and professional purpose" (Rodrigues, 2005, p.2), it is recommended that the teacher "adopt strategies that motivate the student to learn and to allow him to develop his autonomy and initiative" (Rodrigues, 2005, p.3).

## *Methods and techniques for collecting data*

*Direct observation* - It serves for the elaboration of a diary where the significant occurrences in the sessions are registered. In our work, these occurrences contribute to (re)defining the strategy from one session to another.

*Focus group interviews* (Courage & Baxter, 2005) Interviewing students is a way to validate the planned strategy. In our case, we used an audio recorder and a tablet for notes. We asked everyone for permission to record the interview on audio, remembering the anonymity associated with the activity. After the sessions were over, we transcribed the recordings and performed a content analysis (Bardin, 1979). To maintain students' confidentiality, we agreed to refer to their participation in the

focus group with "S", which means student, followed by a number that refered to the order in which they intervened, followed by FG (focus group)", for example, S14FG.

### *Participants*

Twenty-three students (organised in two separate groups), with twenty-one boys and two girls, aged between 15 and 19 years old. As for favourite activities in the classroom, the students almost unanimously elected group work and research practices.

## Results

### *First challenge*

The first challenge was to use the multi-choice game called "Quem quer saber? [Who wants to know?]" (*cf.* Barradas & Lencastre, 2015).

> Sort groups of 2 or 3 students, randomly. We will provide students with generic information about different computer component malfunctions and website addresses to search for their resolution. Through Internet searches, one gets the full details on computer errors, their detection and solution. Each group will have 30 minutes to perform this challenge. After 30 minutes, one needs to answer questions on that topic using a game platform: 'Quem quer saber?'. Given the game's eliminatory nature, each group can play up to 3 games, with a maximum of 5 minutes. The sum of the scores obtained is considered for scoring purposes. The group that wins the highest score/minute ratio wins the challenge. The groups grant the points obtained in the sum of the games. The group that is in the last place will receive only 2/3 of the points earned. Individually, each player has the same score as their group.

**Figure 1 - Students playing the multi-choice game "Quem quer saber?"**

Challenge 1 went quite well, and the students had no difficulty playing the multi-choice game "Quem quer saber?". However, due to the game's eliminatory nature and play limit, students could not obtain results as high as expected. This observation led to the idealization of a new challenge, using the same game but with different rules, to be carried out later.

To facilitate comparison and instigate positive competitiveness, we published the results on the score board.

Reflecting on the students' reactions to the results, it was possible to verify the differences between the two groups regarding sensitivity to competitiveness. Despite being curious about the results, the students in one group did not give much importance to the scoreboard and did not note the results until the next face-to-face class. On the other hand, all students in the other group consulted the scoreboard, even making comments. This difference in sensitivity to the competitive element did not affect the levels of interest in the activity or their active commitment to it, which had remained high in both groups.

### *Second challenge*

The second challenge begins with the scoreboard presentation, allowing the students to discuss and ask questions about it. Like the previous

challenge, this second challenge's design includes the applause for the winners and the positive reinforcement for those who were in the last place, this being another way to instigate the competitiveness motivation.

> Sort groups of 2 or 3 students, randomly. Students must use the knowledge obtained in the previous challenge about a computer's errors to create, in 50 minutes, a summary presentation of hypotheses of error, organised by symptoms. Malfunction symptoms considered for this challenge are:
>
> - The computer will not turn on;
> - The computer turns on, but there is no picture;
> - The computer turns on, but freezes;
> - The computer is continuously restarting;
> - The computer works normally except for some components.
>
> For each of these symptoms, students should highlight the possibilities of malfunctions and solutions. A group wins the challenge when creating a complete presentation, considering (1) the number of malfunctions/solutions highlighted, (2) the organization, and (3) the presentation's graphic quality.
>
> Groups will be rating from 0 to 20 points: 11 points for the contents; 1 point for creativity; 2 points for the presentation's technical aspect; 3 points for multimedia elements; 3 points for the attitude/collaborative work, noted in the teacher's diary.
>
> Individually, a student who eventually repeats first place in the classification will have a bonus of 1 point. Individually, a student who repeats the last place will have a penalty of 1 point in the overall classification.

In this challenge it is expected that students reflect on the effect that the *time* element has on their behaviour. Although this challenge is similar to the tasks that students do throughout the school year, the expectation is that the explicit rules, with a time limit for solving tasks, will lead to a

completely different approach to tasks. In reality, collaboration should be the answer for working in a group and the decisive element in victory.

In the second challenge, the influence the *time* element has on students' behaviour was noticeable. This challenge was very similar to what the students have done since the beginning of the school year. However, the fact that there are explicit rules with time limits for solving tasks made the students' approach completely different. Collaboration within the working groups was one of the main factors for winning the challenge. We quickly realised that the best marks were for the most committed students, with a sense of organization, responsibility, and autonomy. Despite all groups' excellent performance in their quest for the best positions in the scoreboard, the students' later comments concluded that this was the challenge they liked least since it deals with tasks similar to those they perform in other subjects.

### *Third challenge*

To consolidate learning about assembling computer components, we designed the following challenge:

> Sort groups of 2 or 3 students, randomly. In 45 minutes, students must use the knowledge obtained in the previous tasks to create a computer configuration with a maximum budget of €1000, using online computer stores for that purpose. Then, each group will have 2 minutes to highlight the strengths of their configuration. The group that presents the best computer at the lowest price wins the challenge, taking into account the characteristics of the computer shown and the justifications given for the choice of components. The benchmarks of processor, motherboard, memory and graphics card will be considered for the analysis. In the case of a tie, the computer with the lowest price wins. The winning group will earn 10 points, then there will be 6 points granted for 2nd place, 4 points for 3rd place and 3 points for 4th place.

> For this challenge, students consider the configuration of a computer for gamers, with all components (processor, motherboard, graphics card, memories, etc.), monitor, keyboard and mouse.

This was the most demanding challenge for the teacher since the diversity of configurations made instant feedback impossible. Only after class was it possible to present the ratings on the scoreboard.

The students liked and engaged well with this third challenge. After the teacher posted the results on the scoreboard, some students even asked how he had evaluated the configurations, since some were very similar. However, all students were satisfied with the teacher's explanation. Once again, the curiosity to know the leaderboards showed that we were dealing with two completely different groups regarding sensitivity to competition. Until that moment, despite the student having different grade levels, the teacher's diary notes led to a direct relationship between positive competitiveness and the teaching / learning processes. This statement is because all the doubts raised showed curiosity and a desire to improve colleagues' results, which was happening. The level of learning and the degree of student commitment were the highest since the beginning of the school year.

### *Fourth challenge*

For this challenge – more hands-on than the previous ones – we developed the following situation:

> Sort two groups of 4 students and a group of 3 students randomly. During 45 minutes, using the knowledge obtained in the previous challenges and using a set of hardware, students must assemble a computer. That computer should be impeccable while only taking one piece at a time from the warehouse then use it in the assembly before taking another. The group that presents the best-assembled computer wins the challenge. In case of an equal number of failures, the

> group that performs the challenge in the shortest time wins. The judges are the members of the other groups, having 10 minutes for the evaluation. The teacher needs to validate the possible failures found. The score attributed to each group's members will be 20 points, subtracting points for the number of errors in their own computer, and adding points for the number of errors the group find in the other groups' computers.

Challenge Four would be considered by students as the best one and the most appreciated. It required two weeks of preparation. It was necessary to find similar computer components to guarantee the same level of difficulty for each group. Also, the game rules had to be carefully prepared so that no one was harmed.

**Figure 2 – "Warehouse" for challenge 4**

Class started, as usual, with the presentation of the scoreboard, with students examining the positions. With the same goal in mind – to stimulate competitiveness – the teacher identified the students who were in first places, and those in last. Then, we described the challenge as to what was already expected as everything was prepared for the activity when the students arrived in the classroom. As in the previous challenges, the groups were randomly formed, allowing them to balance the

individual performances, which was not well undestood by the students in the initial challenges. In this challenge, the students assumed this fact naturally.

Then, because it was manual work with parts, screws, screwdrivers and plates, attention was drawn to the safety precautions to be taken during the activity.

To assess the acquisition of knowledge, there were some incompatible components (memory modules) deliberately supplied to understand whether students would choose them, causing situations that would prevent the computer from working. During the challenge, students could use the Internet to answer any difficulties. Also, we provided the component manuals because, when in doubt, it is convenient to consult the literature to avoid mistakes.

Not forgetting that the rules need to be fulfilled, the group that finished before the time limit made a point of remembering that in case of a tie the group that finished earlier wins.

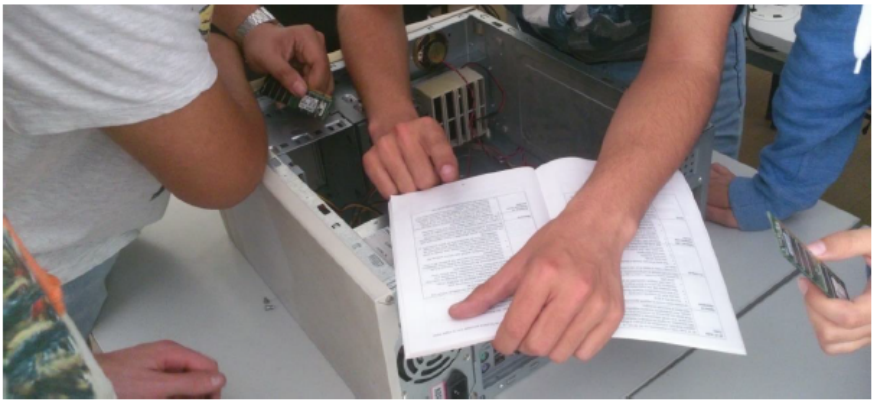

**Figure 3 - Building knowledge with the help of the manual**

We designed the challenge to minimise the chance of uncontrolled assessments. The groups' rotation was thought in advance so that some would evaluate the work of the others. However, as the students were in competition with one another, there would be a possibility of result manipulation. Thus, we decided to keep an element of the group under

assessment together with the verification team, to prevent one group from interfering with another's work after the challenge is over. Concerning this rule, we noted with curiosity that the most competitive group spoke on this subject before the teacher presented this rule. Also, in that group, one student deliberately ignored the rules and tried to hide some hardware pieces from other groups to harm them. However, as this was noticed rapidly, the other groups were not harmed. The student was warned, and the challenge continued. All the mistakes made were used to reflect on the given subject.

At the end of the evaluation and validation of the errors found, one student had a minor complaint about being evaluated by another group that he considered "a strong group", which in theory could have undermined his score. However, after showing the student that his computer assembling had even more errors than his colleagues detected, the results were accepted. Although they refer to it as an additional pressure factor, a constant clock counting down is tolerated well by the group and allows tasks to be carried out within the expected time.

### *Fifth challenge*

For the fifth challenge, we use again the multi-choice game platform "Quem quer saber? [Who wants to know?]", this time individually. In this challenge, we opted for the following structure:

> The students play individually the "Quem quer saber?" game. They have 45 minutes to obtain the maximum score, without being allowed to consult external aids. The total score obtained in the game will be converted into points.

Reflecting on this challenge, it was possible to realise that individual gaming is more suited to the subject's objectives than the multi-choice game platform's previous use. The students learned by 'trial-and-error', and played incessantly in search of the highest score. Gee (2013) states that this helps the student take risks, as failing a game has minor

consequences compared to real life. This allows the students to gain confidence, enabling them to take additional calculated risks.

Competitiveness increased in the classroom because every time a student achieved a high score, they referred to it out loud to inform colleagues of the new limit to be reached. However, the teacher realised that one of the students was (de)complying, announcing higher scores than those he had achieved, to destabilise the colleagues.

**Figure 4 - Figura 8 - Utilização individual do game-based learning**

With this challenging structure, the students could learn and memorise the wrong answers to try and answer correctly later. Gee (2013) states that this way, competence occurs through a game's action, reversing the usual model in which students are forced to learn before acting.

### *Sixth challenge*

We designed Challenge Six to encourage the students with the lowest scores. For this purpose, we created the following situation:

> Students with the bottom three positions will compete with each other. For 45 minutes, using the knowledge obtained in the previous challenges and using a set of hardware pieces, students must assemble a computer and consider that only one piece at a time can be removed from the warehouse for application in the assembly. The student who presents the

> best-assembled computer wins the challenge. In case of an equal number of errors, the student who performs the assembly in the shortest time wins. The evaluation takes 10 minutes and is the responsibility of the students' colleagues. The errors found must be validated by the teacher. The score assigned individually will be 10 points, subtracting points for the number of mistakes they make. The winner of this individual challenge receives five bonus points. The remaining students can bet 20% of their points on the student they believe will win the challenge, thus increasing their points by the amount of the bet. Regarding losses, only the number of points wagered will be considered lost.

The last challenge was designed to stimulate the recovery of students with the lowest scores. To this end, taking advantage of the challenge they liked the most, despite being in the bottom positions on the scoreboard, a new situation was designed. This challenge also aimed to involve the whole class. The betting system created and the fact that this challenge was communicated to students three days in advance allowed students to teach their three colleagues and improve the performance of the one they wanted to bet on, consequently increasing their own points. On this day, the classroom atmosphere was a little less ordered than usual, as the whole class was present and excited.

We started the challenge by reminding the students about the safety rules and receiving the bets on closed paper. The activities went satisfactorily, taking into account that they were students with the lowest scores. However, they have already seen the explanations made in Challenge 4. Also, their colleagues have tried to explain the assembly techniques to them in the previous days. Once again, the teacher used the mistakes made to inspire learning of the subject. the other colleagues in groups established at the time made the evaluation, but always with the teacher's validation.

Inflated by the fact that the students were all together, there was notorious solidarity with the colleagues who were taking the challenge,

even helping (not allowed, but tolerated) those they had not voted for but they perceived to be in trouble. Only one student who bet lost points once the challenge was finished. There was an accumulation of bets on the same element (curiously, the student in the bottom place), which leads us to think that, regardless of the results, the students know each other well and can differentiate by themselves, using their knowledge of each other.

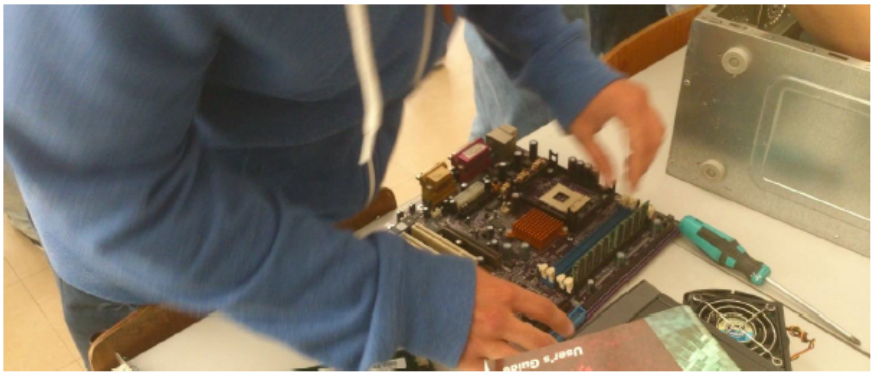

**Figure 5 – A student assembling memory modules**

After counting the gains and losses, the final results were posted on the scoreboard. The students commented on the scores, particularly by those in the first places, trying to understand where they gained or lost points.

At the end of the challenge and after the disclosure of the final classifications, the first seven ones (1/3 of the class) were awarded with a mouse pad, which was much appreciated by the students, not for their value but for their meaning. Deliberately, to minimise external motivation factors, it is only on this day that the students realise that they would receive that award.

## Discussion

We promote two focus groups to evaluate better this pedagogical strategy of gamification and game-based learning and its effects on students. Each focus group lasted about 40 minutes, with twelve and eleven students

respectively. We asked the participants to give their opinion on what they thought of the pedagogical strategy used.

The data collected allowed us to verify the satisfaction with which the students embraced the strategies used, with "motivation" and "fun" being two of the most mentioned words. Even being in the bottom places did not take away the motivation for some of them. They consider game-based learning (through the multi-choice game platform "Quem quer saber?") as an excellent way to learn. Difference and innovation are adjectives that characterised gamification that everyone, except one, liked and would like to repeat. As for positive competitiveness, some of them think it could have been even more visible.

Regarding the fulfilment of the objectives of the subject, particularly:

*(i) to develop skills in the assembly of computers and their peripherals,*

we concluded that these competencies were acquired in a very satisfactory way by analysing the class registration grids with results that indicate:

1. 86.9% have strong interest and commitment,
2. 77.6% demonstrate correct working methods,
3. 78.5% gain a sense of responsibility and autonomy,
4. 72.0% carried out the work challenges successfully.

To develop personal skills, it was necessary to use strategies

*(ii) to promote collaboration among students.*

Using group work as a class strategy, students could develop cooperation and collaboration through content selection and evaluation activities. Additionally, we assessed the group work through students' presentations to the class. The need for students to plan the work and tasks in a group contributed to collaboration. The students found this strategy useful, one stating: "we could be in a group (…) we can help each other (…) we can get to know more about things" (S14, FG). We realised that this objective of collaboration was fulfilled by analysing the class results in conjunction with the group's reflections at the end.

More related to the gamification strategy, there was the objective:

> *(iii) to develop competencies through playfulness in the classroom, stimulating positive competitiveness through a system of rewards and scoreboards.*

The use of a scoreboard was something that students enjoyed, with evidence from statements like "the scores gave motivation to involve ourselves" (S18, FG), and "we guided ourselves well, with the points" (S6, FG).

This guidance increased the competitiveness, turned on the comparison between students, and positively affected students in striving to succeed. This fact is mentioned when students say that "they were competing, researching to try to be the best" (S22, FG). Shindler (2009) talks about the motivation to be successful and raising the level of fun in the schooling activities and, according to students, "the points always gives more motivation to continue" (S17, FG). We noticed, however, through observation and the focus group analysis, that one group of students was not as sensitive to criticism as the others. One of the students stating that for him, "the scoreboard meant nothing" (S13, FG). However, when asked if the motivation to work seriously was the same without the scores, they stated that "if there were no scores, no one was here competing and running for pieces [computer components] during the challenge" (S18, FG). One student, later, in an individual interview, said that his concern was "not to be last" (S13, FG) due to the negative connotation that has.

Some adverse factors also occurred in the presence of competition in the classroom. Shindler (2009) referred to the possibility that a competitive situation could be conducive to an intensified interest in victory to the detriment of the learning itself. In group work, this happened: in the words of one student, in some cases, “the one who knows more tries to work harder to improve the grades for him and for his colleagues” (S7, FG), a fact not considered worrying by the student. In his words, although the colleagues may not understand the content, they “earn more points” (S7, FG). Despite this reference, the results are in line with Cantador and Conde (2010) because the students, despite the competition, managed to focus on the learning objectives.

Ultimately, the goal was

> *(iv) to identify the pedagogical strategy's impact on the students' learning process.*

Overall, the students considered that their learning process "was different from other classes" (S14, FG). "Different and better" (S17, FG). The innovation associated with gamification was considered fundamental for some students' success because "if the classes were normal, we would not be so interested in the subject" (S7 and S9, GF). There would be "people who had no chance of having positive grades on this subject" (S7, GF).

According to the students, "they were all motivated, wanting to get ahead of each other" (S4, FG), including the student, who was always in the bottom place and says that "I stayed last but always wanted to work" (S2, FG). So where does this motivation come from? Much of the motivation is associated with fun. "I enjoyed the activities. They were "fun" (S20, FG), "animated" (S17, FG), "very crazy" (S14, FG) and "captivating" (S4, FG) were some of the expressions used to characterise gamification in the classroom. The students' willingness to be in class and be involved in the challenges was notorious: one of them said he "wanted to come to these classes, and not to the other subject classes" (S6, FG).

It should be noted that, although there were students who did not agree with some rules (negotiated and accepted), they considered their ratings fair because "they were the rules of the game ... We had to play with them" (S6, FG). The time control was one of the rules that had to be met in all challenges. This time control proved effective in raising the students' sense of responsibility since all challenges were completed on time, with no request for postponement of deadlines, contrary to what usually happened in this class.

The game-based learning strategy, implemented using the game platform "Quem quer saber?" was also very much appreciated. Evaluated by the 23 students in terms of satisfaction through a SUS questionnaire - System Usability Scale (Brooke, 1996) - the game obtained an average score of 86.5 points in 100. According to Bangor, Staff, Kortum and

Miller (2009, p.121), it corresponds to a classification of 'Excellent'. Additionally, the content analysis of the focus group also made it possible to assess the use of game-based learning since students consider that "the game the teacher made was brilliant" (S14, FG), saying that it is an exciting way to learn because "we don't want to miss the next one" (S6, FG) and "[with these activities], we are able to recall: even when we fail, that [failure] stays in our mind so we do not fail again."(S17, FG).

However, the pedagogical strategies did not please all students, as one expressed that being lower than he expected in the scoreboard discouraged him a little. Although he liked the challenges, he thinks they undermined them in the assessment. In a subsequent individual interview, this student said that it is easier "to memorise things and take the tests". Although it was only one student to mention this fact, it still makes us reflect.

## Conclusions

The experience of converting the classroom into a playground with challenges was enriching for the students; it allowed them to make mistakes in environments where there are no real consequences and still actively learn, keeping them involved in the process, which facilitates the learning for real-life (Gee, 2013; Trybus, 2014). Also, feeling the desire to participate in classroom activities, be involved, help others and learn was rewarding.

Reflecting on the research question - *Are gamification and game-based learning valuable strategies to promote positive competitiveness in teaching and learning processes?* - our answer is YES.

An analysis of the class grids' indicators, the content analysis made of the focus groups (in which there were 13 positive references to competitiveness and 28 to motivation) point to this. Thus, reinforced by the automatic data from the software logging to the platform: students played until the time limit of the challenges, searching for the maximum score, with no apparent signs of disinterest.

However, as Kapp (2012) stated, these strategies must be used sparingly and are not perfect for all learning circumstances. One student mentioned that they don't like to do the same thing all the time. This leads us to think that using these strategies for a long time can lead to different results, possibly more similar to the studies of Hanus and Fox (2014) in which students showed lighter levels of satisfaction and motivation. The best solutions do not always work the same way with different audiences. In this case, it was possible to verify that not all students showed the same sensitivity to competition, although they liked it. As to teaching in competitive environments, it is neither necessary nor appropriate for students to feel that they have to be the best in everything. As teachers, we must be sure that students understand this.

From the teacher's point of view, these strategies are not easy to design and implement. They require imagination and knowledge of the game elements and their applicability to each situation. Also, the strategies need a reinvention of the teacher's role. Suppose teachers accept their new role of creating opportunities and pleasant environments that promote learning collaboratively and use a pedagogy that sets students' responsibility for learning. In that case, you can become a better educator.

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# Gamification and project-based learning

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## Introduction

According to Gartner, gamification is the use of game mechanics to drive engagement in non-game business scenarios and to change behaviours in a target audience to achieve business outcomes. In our case the non-game domain is a technical course from a master studies program in Industrial Engineering. The context had to take in consideration factors like:

1. Student profile
2. Course learning objectives
3. Course timeline and structure
4. Course profound orientation on Project-Based Learning
5. Course assessment and evaluation

Gamification approaches will need to be built on data-backed activity and in-depth analytics tracking. People are starting to realise that you simply cannot change a behaviour that you cannot measure. This paper will try to present and analyse integration of gamification as a concept together with Project-Based Pedagogy (PBP) in a specific context.

In engineering, successful learning is a combination of three elements:

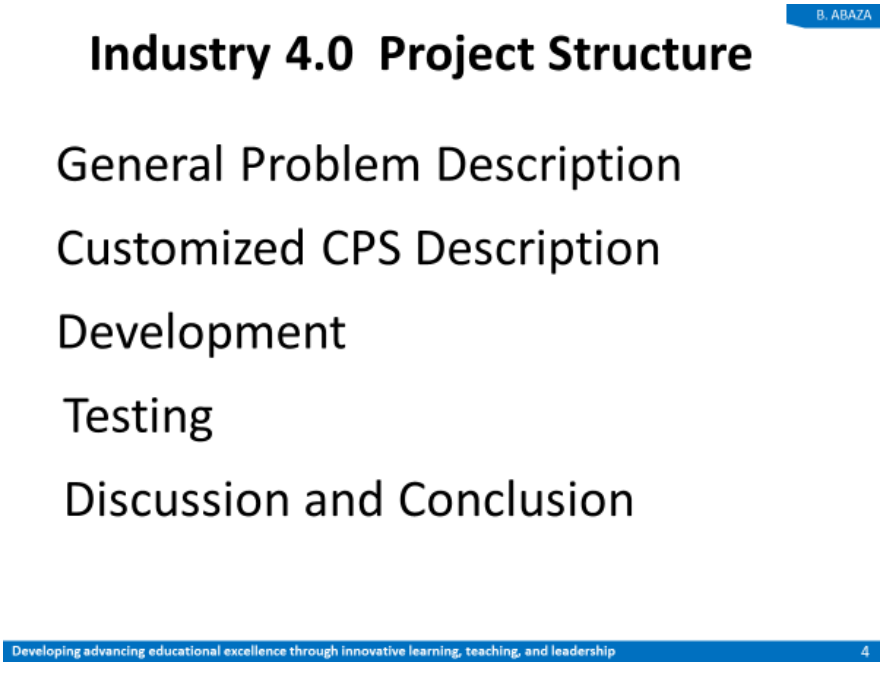
1. real-life and on-the-job experiences, tasks, and problem solving
2. feedback, observing and working in teams
3. formal training

Project-Based Pedagogy (PBP) was defined starting from the concept of Project-Based Learning (PBL), which is already known as a theoretical

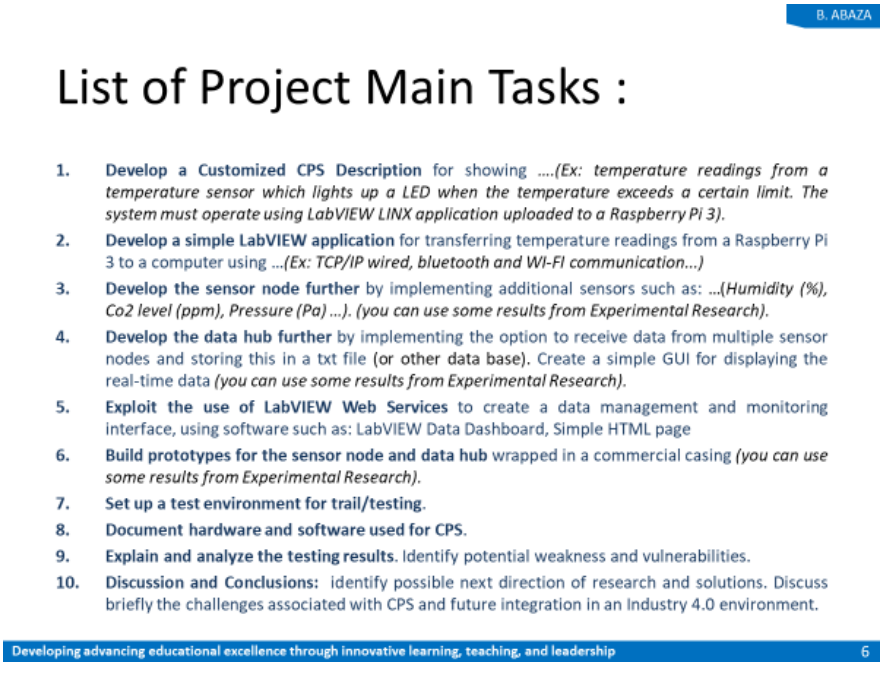
concept designed on a student-centred and student-driven approach. In our case the PBL is applied in the frame of Industry 4.0 course for master students from Industrial Engineering, second semester, first year of studies. Teams were organised, based on:

1. 12 active students grouped in 6 teams
2. Each member assuming individual and collaborative tasks which should be mentioned in the Project Report.

Each team had a specific Project subject related to the Industry 4.0 selected from different Industrial Area of Interests (IAI). The Project structure was defined from the beginning based on the following:



The macroplanning was defined taking into account this list of main tasks:




## *Time frame context*

The course calendar was specific to the second semester 17.02.2020–22.05.2020 with final exam on 06.06.2020. Because of the COVID-19 pandemic, starting with 11.03.2020, all activities were transferred to being online. This is another key element to take into account which influenced teaching-activity development from the perspective of gamification and PBP integration.

## *Learning technologies*

1. Moodle – Online Learning Management System
2. Microsoft Teams – Collaboration app used for staying organised and having conversations all in one place.

### *Gamification and Project-Based Pedagogy integration*

Applying gamification concepts in an educational process, in the frame of a specific course, it is always a challenging task and should be well adapted to the context. Therefore, the next considerations are made based on experimentation, starting from some key gamification attributes: Environment, Engagement, Effect, Immersion, Experimentation and Enjoyment and Events. For each of these, the analyses will always be linked to the applied PBP.

### *Environment*

This is about defining physical triggers for students and professor. In an online environment, for a synchronous meeting via MS Teams the physical triggers were based on videoconference application features and the integration of them in the pedagogy of teaching. These triggers basically are: video camera, chat window and sharing the screen. The way to use these depends on the focus and distraction of students.

### *Engagement*

This is one of the most important and challenging aspects to manage. In our case the engagement is based on professor-student interactions and student-student interactions. Both are critical in the success of the learning process. It starts with defining the instructions to be followed and the way of how these are giving the "lure stimulus" to the students to motivate and incite them to go deeper but also to introduce the "restrictions" or the "rules of play". Most of them are time based. Normally time restriction has completely different perception for the students compare with time restriction in a game context when the player must "beat that time". In a classical course context time restriction are deadlines related with certain activities and they may produce pressure or even negative stress for the learner. In a game context rules of play with all embedded restriction is completely different accepted, and it represents a motivating factor and it has a positive perception for the player. The question is how can we transfer the positive perception into the course context? The answer in our

case it was the "Project-Based Pedagogy (PBP)". Using this pedagogy, we tried to understand and to use some common engagement ingredients that exists in both cases:

1. Outcome rewards
2. Communication
3. Competition
4. Collaboration
5. Self determination
6. Responsibility

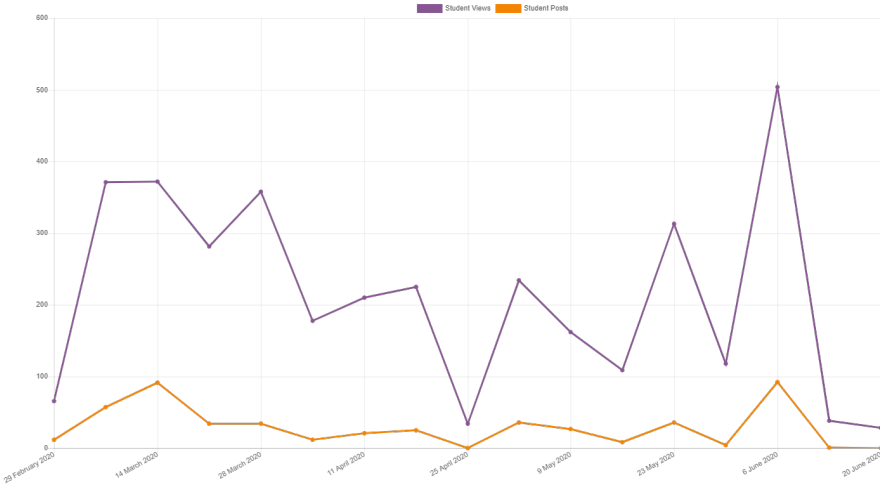
In the case of our course, the engagement metrics were defined according to specific online activities and an applied Project-based Pedagogy. Here are a few of the metrics:

1. Student views
2. Student posts
3. Teacher/professor views
4. Teacher/professor posts

Pageviews are the most basic of user-engagement metrics. It measures an instance of a user visiting a particular page inside the online course platform (website). A higher number can be assumed to be an indicator of interest and/or engagement.

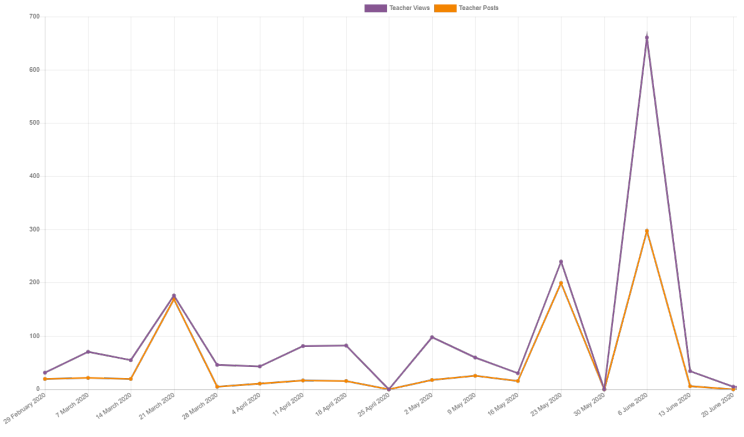
Page-posts are another basic set of metrics of user-engagement. It measures an instance of a user posting a particular response (file or message) inside of the course. In our case in most of the cases the post was a response to a predefined activity inside of the project. A higher number can be assumed to be an indicator of higher interest and/or engagement.

*Engagement metrics for students*



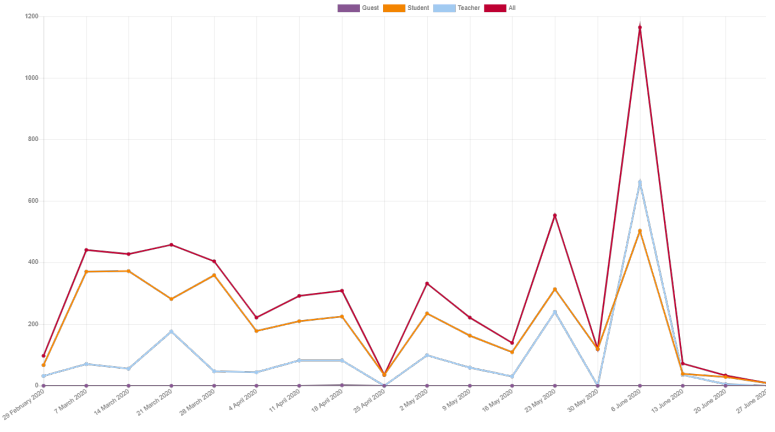

*Engagement views and posts for students on Moodle*

Regarding the student engagement measured through e-Learning platform activity, we can observe a higher number of views compared with the posts, which is normal. There is a small average decrease between 14.03.2020 and the end of the semester on 22.05.2020, but this should be correlated with the pandemic period when all activities were performed online. Then there is spike of interest just before the examination from 06.06.2020. A similar trend is seen for the posts.

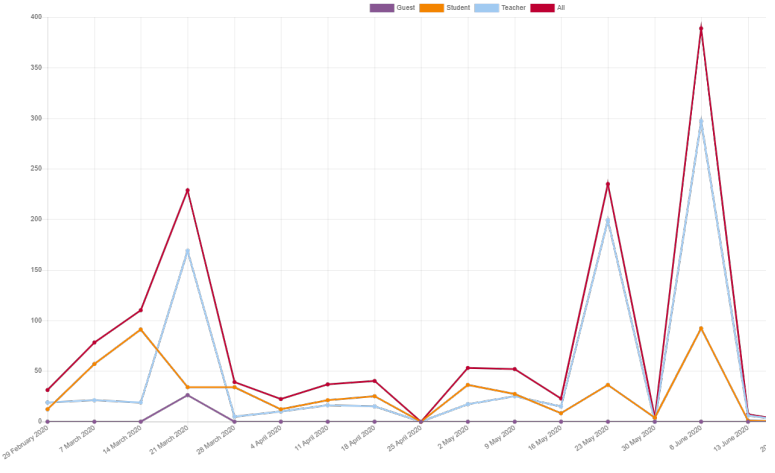


## *Engagement views and posts for teacher on Moodle*

Teacher engagement shows a spike for posts and views just between 14.03.2020–28.03.2020, which is justified by an increase in the online effort for preparation of teaching materials and project activities because of switching 100% to online activities due to the pandemic. There are another two spikes in the semester; one is related to the increased demand from the students for support regarding the finalising the projects, while the other is related to the final exam assessment with project feedback and evaluation.




**Views for all roles on Moodle**

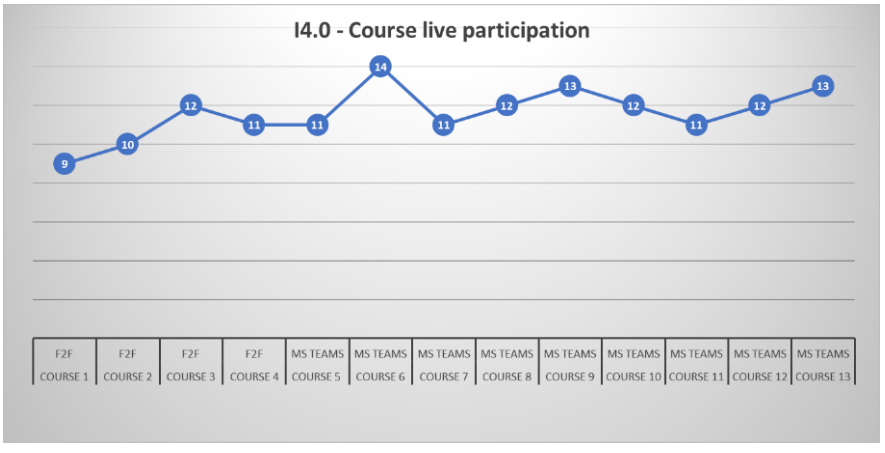


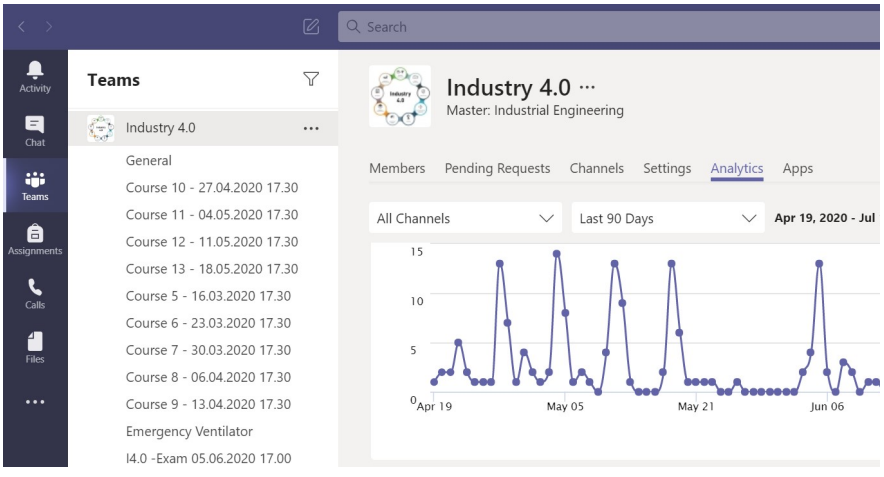

**Posts for all roles on Moodle**

Comparing both students and teacher behaviour through views and posts we can make some general observations:

The engagement of both student and professor was almost always high enough during the semester, even in the pandemic context, meaning the online activities were effective in keeping the interest and motivation. This might be an encouraging argument for justifying the integration of PBP and gamification.

Online synchronous engagement with activities can be described in this context through participation in the live MS Teams meetings. Using videoconference technology, these meetings enable the performance of specific activities related to the gamification and PBP, such as: project teaching and coaching, feedback on a project, collaboration and communication.






**Course live participation on MS Teams meetings**

The figure above shows a list of nine online courses and one evaluation meeting taken on MS Teams specific to the pandemic period. Overall, the presence was quite constant during all 13 courses, endorsing the constant interest and engagement during the whole semester.

## Effect

This is about defining possible outcomes. Here are a few big differences between a game and PBP. In a game case, we might discuss whether there is an "illusion of choice", or about "controlling" the set of outcomes. In a project-based context, the team has real choices to make so as to control its own project progress and results. The project subjects were defined based on student's direct contribution, based on their own research even more so in our case. They generate ideas and they may become very attached by their own contribution. This represents a key emotional element in the PBP. It can also be a tricky element because from the engagement perspective, it can become a very positive motivational lever, but it can also become an external barrier to positive feedback. If this aspect is well managed by the professor and teams, then it can produce more positive results and satisfaction.

Designing the experience in project-based learning relates well to designing the right macro-planning, based on which teams will develop the project and the ways in which students are coached to customise, update, and follow this macro-planning. Defining and planning milestones in the frame of this macro-planning will play a key role too, and it will be directly related to the engagement and environmental aspects.

## Immersion

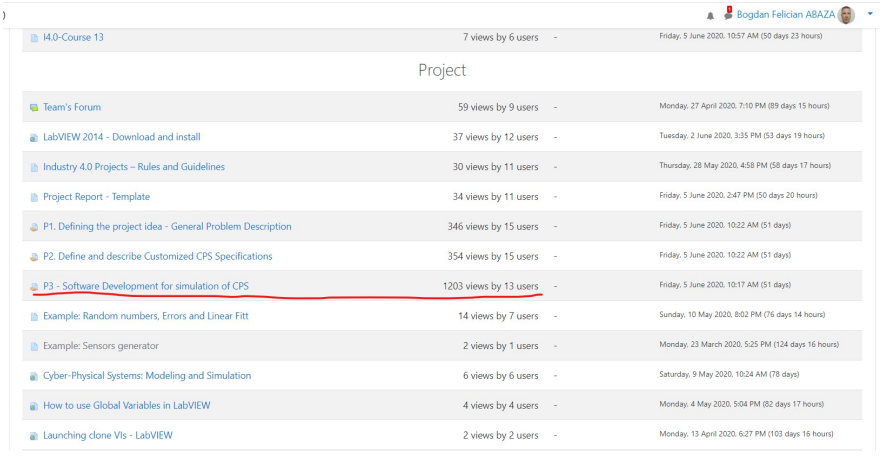
This is about valorisation and the management of positive experience. In the case of a game, we discuss marketing and advertising of the players, creating an "easy and positive experience" that will make customers want to come back. In a course context, this means convincing students that by using an "easy and positive experience", we can build successful projects, generate innovative ideas, and learn how to create added value. Also, this PBP will help us to learn, to create and to achieve at the same time.

## Experimentation

A general approach experimentation is about letting customers use rules and restrictions to create a different experience. A PBP case experimentation can be related to the prototype stage from the process of idea generation of the project when we should understand, define and describe the user needs. In this context, prototyping is getting ideas and explorations out of the student's head into the physical world. A prototype can be any physical form, a role-playing activity, an object, an interface, or even a storyboard.

Prototyping ideas is very useful for gaining better perspectives for:

1. Empathy: Prototyping ideas is a tool to deepen your understanding of the design space and your user, even at a pre-solution phase of your project.
2. Exploration: generate and develop multiple solution options.
3. Testing: Create prototypes (and develop the context) to test and refine solutions with users.
4. Inspiration: Inspire others (teammates, clients, customers, investors) by showing a student's vision.




**Student views on e-Learning project activities**

The figure above shows the section dedicated to the project activities from the online course platform. There is a high number of views on activity "P3 - Software Development for simulation of CPS". This can be explained by the importance and magnitude of this activity in the frame of the project. However, this is related also to this activity type where the process of prototyping a project idea was developed through empathy, exploration, inspiration, and testing.

Role-playing activities can become critical for user understanding and for the process of converting the user needs in functions and afterword into the technical solutions. Therefore, role-playing is integrated within our PBP in one of the key processes of the needs analysis, which defines the user scenarios of utilisation. Based on user scenarios, we can define an external needs analysis and we can define the functions of the product or services in relation to all environmental elements. This is one of the most important inputs for the next process of concept development when generating possible technical solutions.

## Enjoyment and Events

Dopamine is the neuro-transmitter which plays a key role in human brain and body for getting the sensation of pleasure. Recent studies made by

neuroscientists explain that "Dopamine is a critical modulator of both learning and motivation". Dopamine is secreted as a reward anytime that we are focused on something outside of our sphere of experience. This explains what enjoyment is and it should be for our human brain when we want to design a learning environment where 'project events' will play the role of the motivational milestones to be reached in order to feed us with dopamine for getting focused and motivated. Focusing on a well-designed project/game goal, and feeling good while we are following it, should become a key mechanism of the learning process. Therefore, one of the most suitable environments for stimulating this human brain reaction could be the PBP where the motivational milestones could be well overlapped with the project milestones which are guiding the project/game goals.

## Conclusion

Based on the evidence presented in this paper, we can appreciate that the most two important benefits of gamification integrated with PBP are:

1. Better learning experience. Students can experience 'fun' and enjoyment during the project development and still learn if the level of engagement is high. Designing a wise gamification strategy based on a dopamine reward mechanism with high levels of focus and engagement will lead to an increase in recall and retention.
2. Better learning environment. Gamification together with PBP and e-Learning can provide an effective, informal learning environment, helping students practice real-life project situations and challenges in a safe environment (e.g., a university). This is conducive to a more engaged learning experience that facilitates better knowledge retention.

Gamification integrated with PBP has been proved to be an effective accelerator for changing behaviour and enhancing the student willingness to experiment during the learning process. There is more to do and explore in this direction; continuous improvement and evolution are part of the course development. A new and improved version of this course will be available in the next semester.

One of the most sensitive aspects relates to the skill, motivation, and availability of the teacher to design learning content using modern technologies and a pedagogy adapted for a specific learning need (context). Generally, the success of the upskilling process it will be always influenced by the involved actors – professors and students, the learning environment, the context, and by the associated training path. Student learning capacity becomes more dynamic and a more volatile factor that will always be influenced by the previous experience of the learner. However, in these times, gamification is already embedded as a part of a student's learning capacity: it is a matter of pedagogy to be able to activate and exploit it in the modern education process. Hence present and future products or services have already integrated gamification components, and future product developers and product users should be aware of the importance and potential in it.

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# Gamification for High School Level Intensive Summer School Programs in Technical Sciences

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Gamification strategies can be used to fulfil a variety of needs including product sales, customer support, soft skills, awareness creation and compliance (*Molumby M.J., 2016*). An advantage of gamification is that it provides an effective informal learning environment and helps learners practice real-life situations and challenges in a safe environment (*Welbers K. et al., 2019*). Usually, the learner can a 'fun' experience during the activities and still learn if the level of engagement is high. Feedback can be collected instantly so that the learners know what their knowledge level is and what they should improve. Reward systems and status tools can prompt behavioural changes in learners.

Modern teaching techniques, coupled with gamification strategies, can offer a targeted approach that motivates high school students. They can create an avatar, earn points, and feel a more profound sense of accomplishment with gamification (*Yıldırım I. and Şen S., 2019*). Researchers have shown that blended classrooms where students experience traditional and modern styles together tend to be more successful (*Molumby M.J., 2016*). Teamwork and project-based learning have been known to generate the best results within a gamified environment (*Leung E. and Pluskwik E., 2018*). Several research findings have concluded that great theoretical and practical application could be gained from understanding learners' behaviour, motivation, learning styles and preferences concerning gamification (*Nah F.F.H. et al., 2013; Saez-*

*Lopez et al., 2015*). These studies also address research that takes forward promising leads for further integration of gamification strategy in the secondary curriculum development. Nonetheless, developing a highly engaging and multiple objective targeted curricula is difficult and requires specific technical infrastructure and appropriate pedagogical integration (*Dicheva D. et al., 2015*).

Based on the above mentioned, the current study aims to present in detail a learning content gamification for high-school level intensive summer school programs in technical sciences, targeting the improvement of participants attitude, engagement and performance, whilst raising their interest for an engineering educational path. A two-week summer school programme was used as a blank canvas for deploying a mixed pedagogical approach and gamified content. The summer school is designed so as to create an innovative learning experience in order to improve high-school students performance and engagement, allowing them to become more confident in their own competences and encouraging them to successfully follow a technical science higher educational path.

The summer school programme was implemented through a 3-year project awarded to the Politehnica University of Bucharest (UPB) by the World Bank. The project *Mobilization, Organization and Objectives for Future University Education - REASON for the future! (MOTIV)* is addressed to 350 students (direct beneficiaries of the project) from state high schools eligible for grants under the High School Grant Scheme located in four development regions in Romania – South Muntenia, South-East, North-East and South-West.

The risk of early school abandonment and the low participation rate in tertiary education has become a constant concern of the European Union in recent years: the EU's education and training strategy for 2010-2020 (*ET 2020*), together with national strategies or targeted actions, are all attempts to bring about an improvement. In this context, the project aims to increase students' motivation to complete high school with a baccalaureate degree and to later go to tertiary education in technical sciences. Particular attention was paid to the learning conditions of high

school students by ensuring an adequate quality level, aimed at improving the access and participation of disadvantaged people in the higher education system and their results at this level of education. MOTIV also targeted the development and implementation of measures to align higher education with the needs of the labour market.

The general objective of the project is to support 350 high school students, potential future HE students who come mainly from disadvantaged groups. We support them by:

1. promoting the benefits of participating in bridge-type summer programs,
2. orienting them in terms of further study options in technical higher education,
3. facilitating the transition from secondary to tertiary education,
4. providing an integrated package of courses and other relevant activities: i.e., vocational counselling and career guidance, workshops in specific fields, study visits and participation in sports competitions, recreational and cultural activities), These courses and activities are based within the university and in the city where the university is located.

Three specific objectives (SO) define the main activities, like:

SO1 - Carrying out dissemination campaigns in order to increase the number of high school students informed about the educational and professional development opportunities offered through the summer school programme in order to motivate them to complete high school and their orientation to technical higher education;

SO2 - Integration and accommodation of 350 students in the university campus of UPB during a 3 year time frame, by ensuring their travel, accommodation and guidance throughout the duration of the summer school programme;

SO3 - Providing a package of fundamental technical science courses and other relevant activities, for 350 high school students, to guide their options for continuing studies in a higher education environment.

UPB implements the MOTIV project between 2019 and 2022, by involving four of its faculties, namely:

1. Faculty of Industrial Engineering and Robotics (FIIR),
2. Faculty of Applied Sciences (FSA),
3. Faculty of Biotechnical Systems Engineering (FISB),
4. Faculty of Mechanical Engineering and Mechatronics (FIMM).

In order to deploy such a complex project, a management diagram was put together (Figure 1), identifying the information flux, the relationships between project members and their main responsibilities.

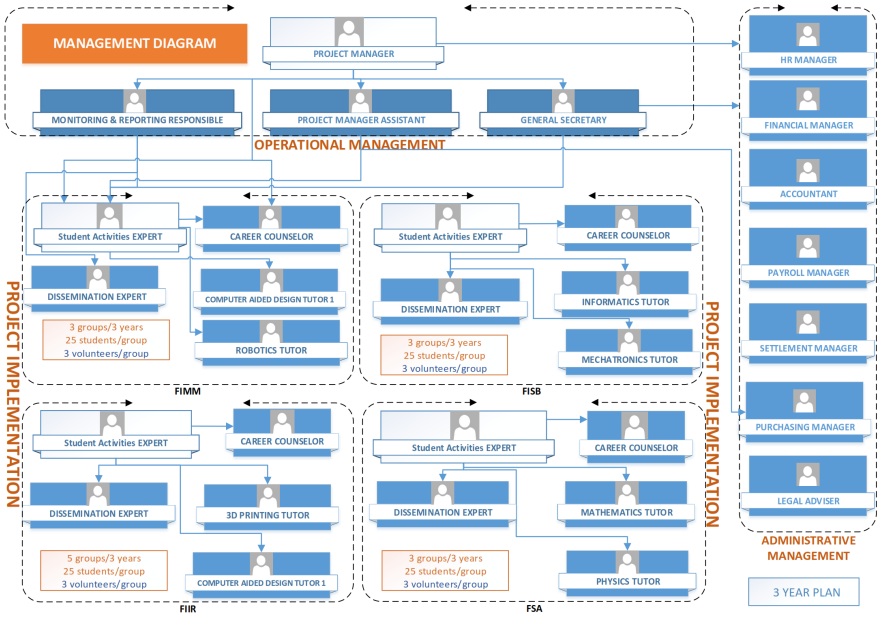


**Figure 1. Management diagram for a 3-year plan of MOTIV project implementation**

Students spent the two weeks on the campus of UPB, where most activities took place (courses, workshops, scientific experiments conducted in the laboratories of participating faculties, sports activities, etc.) to give them the opportunity to learn about: student life, the specific requirements of an academic environment, and the possibilities for both personal and professional development. They would also be able to have direct interaction with high-school students from other regions, students and professors of the university. Recreational and cultural activities took place both on and off campus, in Bucharest. Study visits were implemented at the headquarters of UPB's partner companies within Bucharest / Ilfov County. Offering such a large variety of activities in both formal and

informal environments, the utmost care was spent to decide the delivering formats of the summer school content. After careful consideration, the project management team decided that a gamification strategy might have the best outcome on delivering the appropriate number of fundamental disciplines, whilst keeping participants entertained and engaged.

A gamification framework has three main components, namely: (1) mechanics, (2) dynamics, and (3) aesthetics (*Garone P. and Nesteriuk S., 2019*). Within this framework, the summer school programme content was gamified using several elements, such as: guest, levels, achievements, reward system and time tracking. The reward system included badges, tokens, privileges, incentives, passes, virtual and physical goods.

The 2019 summer school programme was assimilated with a Quest and each fundamental discipline was associated with a Level. Each Level had between two or three Achievements, depending on the complexity of each one. A general Quest map was developed (Figure 2) for the first year of MOTIV project implementation.

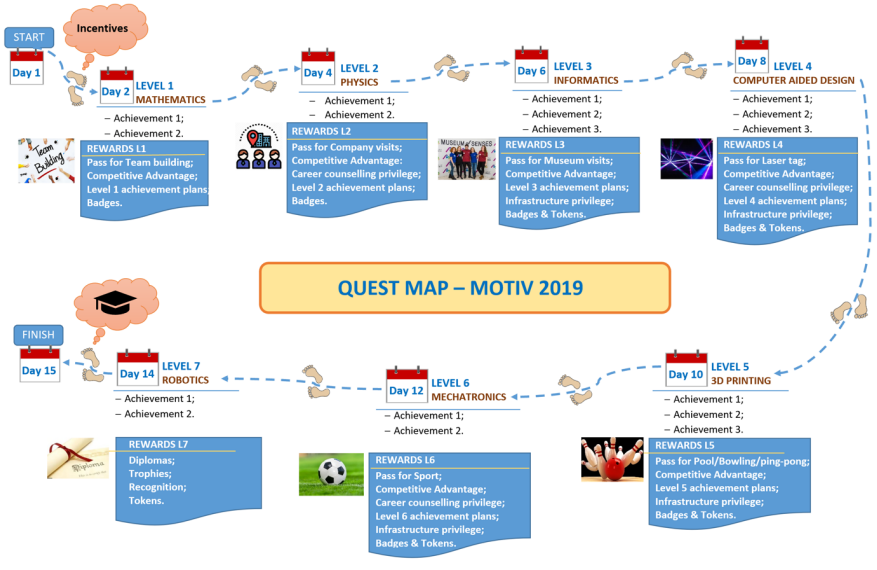


**Figure 2. MOTIV 2019 Quest map**

The complex reward system has been designed and implemented throughout the summer school program duration to facilitate student engagement and performance. The reward system comprised:

1. Financial incentives in the form of individual scholarships that covered accommodation, travel and three meals per day for the duration of the Quest;
2. Incentives given at the beginning of the Quest, as a necessary 'survival kit'. The 'kit' was comprised the following: a backpack; an initiation badge; a Quest map and activity plan; a UPB campus brochure; maths exercise book; a physics exercise book; T-shirt; three notebooks; a pen; geometry kit; a USB stick containing the assignments' presentation for each Level;
3. Level maps and activity plans given at the beginning of each Achievement;
4. Diplomas for each completed Level and for the completion of the Quest;
5. Individual and Team Trophies for completion of the Quest;
6. Public recognition for the best Team that finished a specific Level;
7. Tokens and badges at the end of each Achievement (for example: if they pass a specific progress stage and quality requirements, students receive the functional results of their achievements - 3D models that they designed; products that they 3D-printed; circuits that they designed and manufactured; software models that they wrote, etc);
8. Privileges to use the available infrastructure for implementation of other tasks outside of the quests, after completion of certain Levels (for example: after completion of Level 5 students are allowed to design and 3D-print other products than those identified within the achievements);
9. Pass for participation at social and recreational activities (museum visits, movie nights, pool, laser tag, football, handball, badminton, bowling, ping pong, team building, company visits);
10. Competitive advantage at social and recreational activities based on Level and Achievement performance (Ex: fastest Team to finish an Achievement wins the right to choose the football court);
11. Privileges to benefit from group career counsellor support every two Levels.

Time tracking was used in all achievements and rewards were given based on the results of each Team. Rewarding was implemented throughout the entire time frame of the Guest (Figure 3). The first edition of the summer school was organised for 100 high school students, who were divided into four Teams, namely: (1) The Red Team, (2) The Blue Team, (3) The Green Team and (4) The Yellow Team. Each team was assigned to their own 'headquarters' within UPB, marked with their colour. Although Assignments were based in different areas of the campus, teams always regrouped at their headquarters.


**Figure 3a. Reward system –**
**Top: Diploma awards for all Teams at Quest finish.**
**Bottom: Trophy award ceremony for Green Team at Quest finish.**

**Figure 3b. Reward system –**
**Top: Badges for the Red Team after Level 2 completion.**
**Bottom: Incentives and badge awards for all Teams at Quest start.**

Quest members benefited, as a Level privilege, from counselling activities supported by two accredited counsellors. Within this activity, the students were introduced to the Career Counselling and Guidance Centre of UPB. The counselling sessions were organised in four groups of 25 students, with the following topics:

1. *Which profession suits you according to your personality?* This session allowed the counsellors identify the type of personality which corresponds to certain occupational profiles on the labour market through the theoretical support and the personality test applied to the participants. The aim was to facilitate self-knowledge and awareness of the vocation for the best and most satisfactory integration and professional development.

2. *How to introduce yourself?* This session aimed at preparing for an interview / selection process in public and private companies, through exercises and role-playing games with all Quest participants.

Assessment within the Quest was done using both formative and summative methods (Houston *D. and Thompson J.N., 2017*). The assessment methods used for each Quest Level is detailed in Table 1.

**Table 1. Formative and summative assessment method for individual Quest Levels.**

| Quest Level | Content delivering format | Formative/ summative assessment method |
|---|---|---|
| L1. Mathematics | Interactive lecture<br>Seminar | Questions during learning activities;<br>Feedback / Six types of mathematics baccalaureate problems |
| L2. Physics | Interactive lecture<br>Seminar | Quiz, feedback and discussions / Six types of physics baccalaureate problems |
| L3. Informatics | Seminar<br>Case study | Guided practice; Online-poll; Feedback / Conditionals, loops and other data structures (if, for, case, while and else) |
| L4. Computer Aided Design | Tech laboratory<br>Case study | Guided practice; Journal of CAD versions;<br>Feedback / 3D models of real-life objects |
| L5. 3D printing | Tech laboratory<br>Hands-on workshop | Target setting; Peer and self-assessment;<br>Feedback / Functional 3D printed prototypes |
| L6. Mechatronics | Tech laboratory<br>Hands-on workshop | Flash tasks during hands-on activities;<br>Feedback/ Working electronic circuits for three incremental problems |
| L7. Robotics | Product live demo<br>Best practice-example | Guided debates and feedback /<br>Customised racetrack for a preprogramed robot equipped with an IR contrast sensor |

Implementation of the customised and gamified content for the summer school programme entailed the use of an extensive infrastructure. UPB made available some of the necessary prerequired resources, and others when they were purchased through the project's budget.

As interactive usage of diverse tools and resources (impactful and efficient use of resources, responsible consumption) is seen as the third most important macro competency set (*Marope M. et al., 2017*), the Quest creators ensured that students were in contact with a variety of

equipment, software and mobile applications. If the available infrastructure comprised standard hardware and software UPB solutions, the mobile app usage was tailored specifically for this quest. Mobile phone applications were used throughout all Levels to increase engagement of students during Achievements (Table 2).

**Table 2. Mobile phone applications used to facilitate achievement completion**

| Mobile App | Focus |
|---|---|
| Photomath | Problem explanation, animated solutions, multifunctional scientific calculator, Used in Level 1. |
| Pocket Physics | Physics content focused on key topics with formulae, equations and demonstrations used in Level 2. |
| ArduinoDroid – Arduino IDE | Arduino code compiler and uploader used in Levels 6 & 7. |
| Cam Scanner | Generate scanned images using the phone camera. |
| Lightning QR | QR Code reader for a variety of tasks like: feedback, online polls, pop-up questionnaires on Achievement teaching content; Used in all Levels. |
| Text Fairy | Transformation of text from physical to electronic form. |
| WhatsApp | Communicate efficiently and in real-time amongst Team members; Each Team had a WhatsApp group. |
| Translate | Google Translate application used in research tasks for foreign language references. |
| Facebook<br>Instagram | Increase involvement of students by disseminating their achievements. |
| Waze | Real-time maps used for UPB campus exploration and reward location identification. |

Each Level of the Quest was implemented within a two-day time frame and all achievements were time tracked. For each Quest Level, several cognitive and behavioural learning objectives were established (Table 3). Learning objectives were necessary so as to construct appropriate content for each assignment and correlate that with the previously defined gamification elements.

**Table 3. Cognitive and behavioural learning objectives for Quest Levels**

| Quest Level | Cognitive learning objective | Behavioural learning objective |
|---|---|---|
| L1. Mathematics | Remember information already taught in high school; Select the most appropriate solving method for a specific problem type. | Solve problems from: geometry and trigonometry, algebra and mathematical analysis; Demonstrate working hypothesis and principles. |
| L2. Physics | Explain the working principles applied in:<br>Mechanics, Thermodynamics, Production and use of direct current and Optics; Identify a specific type of solving method for given problems within specified areas. | Solve problems and demonstrate hypothesis and principles from the following areas: Mechanics, Thermodynamics, Production and use of direct current and optics. |
| L3. Informatics | Understand the logical structure of specific problem types; Correlate between given problems and the most appropriate software structure or a combination of them. | Build software applications using conditionals, loops and other data structures (if, for, case, while and else); Demonstrate their functionality. |
| L4. Computer-Aided Design | Understand the 3D modelling software environment; Identify the main volumes, sketches and 3D operations which constitute a virtual model. | Design 3D models of real-life products using CAD software applications; Generate 2D drawings for designed parts; Generate photorealistic renderings of products. |
| L5. 3D-printing | Identify appropriate 3D-printing principles for given applications; Select material and equipment; Validate build plate layout and 3D-printing parameters in correspondence with selected product function. | Optimise build plate layout and process parameters for given application; 3D-print given application; Perform post-processing steps and demonstrate functionality of final product. |

| Quest Level | Cognitive learning objective | Behavioural learning objective |
|---|---|---|
| L6. Mechatronics | Understand the working principles of electronics; Correlate between the learned Arduino code structures and given tasks. | Design simple circuits using Arduino boards and three options of sensors; Design Arduino code structures, compile and test run them on own circuits. |
| L7. Robotics | Identify the characteristics of an IR contrast sensor; Plan the main displacements of the IR equipped robot; Develop an obstacle racetrack for a preprogramed robot. | Demonstrate the working principle of an IR contract sensor; Apply gained knowledge and demonstrate functionality of the developed product. |

Based on the MOTIV 2019 Quest map structure (Figure 2) and the gamified content delivering formats, task structures and rewards have been designed for each cognitive and behavioural learning objective from all seven Levels. The completion stage of the task generates a percentage of the assigned rewards, which have corresponding mastery recognition, as follows:

1. 100% - Master of task;
2. 90% - Expert of task;
3. 80% - Professional of task;
4. 70% - Proficient of task;
5. 60% - Competent of task;
6. 50% - Novice of task.

Achievements comprise several tasks and can be completed in three stages of difficulty: (1) Regular, (2) Advanced or (3) Super player. Here is a presentation of Level-4 task structure and reward system based on learning objectives:

## Cognitive & Behavioural Learning Objective 1

Understand the 3D modelling software environment

### Rewards

L4 achievement plans

Public recognition of knowledge level

### Individual tasks and completion stage

*100% of Rewards* – **Identify** main working spaces of the CAD software. **Correctly** change the unit measurement system. **Correctly** use the View Orientation feature and switch between standard and custom options. **Accurately** explain the role and main features of the Feature Manager Design Tree. **Distinguish** between main tab menus and **state** their role within the 3D modelling process.

*90% of Rewards* – **Identify** main working spaces of the CAD software. **Correctly** change the unit measurement system. **Correctly** use the View Orientation feature and switch between standard and custom options. **Accurately** explain the role and main features of the Feature Manager Design Tree. **Distinguish** between main tab menus, but **unable to state** their role within the 3D modelling process.)

*80 % of Rewards* – **Identify** main working spaces of the CAD software. **Correctly** change the unit measurement system. **Correctly** use the View Orientation feature and switch between standard and custom options. **Accurately** explain the role and main features of the Feature Manager Design Tree.
(Unable to distinguish between main tab menus and state their role within the 3D modelling process.)

*70 % of Rewards* – **Identify** main working spaces of the CAD software. **Correctly** change the unit measurement system. **Correctly** use the View Orientation feature and switch between standard and custom options.
(Unable to accurately explain the role and main features of the Feature Manager Design Tree. Unable to distinguish between main tab menus and state their role within the 3D modelling process.)

*60 % of Rewards* – **Identify** main working spaces of the CAD software. **Correctly** change the unit measurement system.
(Unable to correctly use the View Orientation feature and switch between standard and custom options. Unable to accurately explain the role and main features of the Feature Manager Design Tree. Unable to distinguish between main tab menus and state their role within the 3D modelling process.)

*50 % of Rewards or less* - **Identify** main working spaces of the CAD software.
(Unable to correctly change the unit measurement system. Unable to correctly use the View Orientation feature and switch between standard and custom options. Unable to accurately explain the role and main features of the Feature Manager Design Tree. Unable to distinguish between main tab menus and state their role within the 3D modelling process.)

## Cognitive & Behavioural Learning Objective 2

Identify the main volumes, sketches and 3D operations that constitute a virtual model

### Rewards

Badges for each identified volume and corresponding 3D operation

Public recognition of knowledge level

### Individual tasks and completion stage

*100% of Rewards* – **Identify** main volumes and **specify** all corresponding 3D operations (Extrude, Revolve, Sweep, Loft). **Correctly** define working planes and **accurately** set volumes construction order. **Identify** all plane sketches; **Indicate** the primitives used in their design.

*90% of Rewards* – **Identify** main volumes and **specify** all corresponding 3D operations (Extrude, Revolve, Sweep, Loft). **Correctly** define working planes and **accurately** set volumes construction order. **Identify** all plane sketches;
(Unable to indicate the primitives used in their design.)

*80 % of Rewards* – **Identify** main volumes and **specify** all corresponding 3D operations (Extrude, Revolve, Sweep, Loft). **Correctly** define working planes and **accurately** set volumes construction order.
(Unable to identify all plane sketches; also, Unable to indicate the primitives used in their design.)

*70 % of Rewards* – **Identify** main volumes and **specify** all corresponding 3D operations (Extrude, Revolve, Sweep, Loft). **Correctly** define working planes, but **unable to accurately set** volumes construction order.
(Unable to identify all plane sketches; also, Unable to indicate the primitives used in their design.)

*60 % of Rewards* – **Identify** main volumes and **specify** all corresponding 3D operations (Extrude, Revolve, Sweep, Loft).
(Unable to correctly define working planes; also, Unable to accurately set volumes construction order. Unable to identify all plane sketches; also, Unable to indicate the primitives used in their design.)

50 % of Rewards or less – **Identify** main volumes, but **unable to specify** all corresponding 3D operations (Extrude, Revolve, Sweep, Loft).
(Unable to correctly define working planes; also, Unable to accurately set volumes construction order. Unable to identify all plane sketches; also, Unable to indicate the primitives used in their design**.)**

## Cognitive & Behavioural Learning Objective 3

Design 3D models of real-life products using CAD software applications

### Rewards

Infrastructure privilege

Tokens for each designed 3D model

Public recognition of knowledge level

### Individual tasks and completion stage

*100% of Rewards* – **Select** the correct stat plane and part orientation. **Correctly** use the necessary primitives to construct the volume sketches. **Design** of fully constrained sketches and in correspondence with given indications; **Correctly** identify the order of 3D volumes and appropriate use of 3D operations. **Accurately** deploy finishing operations (fillet, chamfer, thread). **Correctly** use Hole wizard, patterns and reference geometry.

*90% of Rewards* – **Select** the correct stat plane and part orientation. **Correctly** use the necessary primitives to construct the volume sketches. **Design** of fully constrained sketches and in correspondence with given indications; **Correctly** identify the order of 3D volumes and appropriate use of 3D operations. **Accurately** deploy finishing operations (fillet, chamfer, thread). (Unable to correctly use Hole wizard, patterns and reference geometry.)

*80 % of Rewards* – **Select** the correct stat plane & part orientation. **Correctly** use the necessary primitives to construct the volume sketches. **Design** of fully constrained sketches and in correspondence with given indications; **Correctly** identify the order of 3D volumes and appropriate use of 3D operations.
(Unable to accurately deploy finishing operations (fillet, chamfer, thread). Unable to correctly use Hole wizard, patterns and reference geometry.)

*70 % of Rewards* – **Select** the correct stat plane and part orientation. **Correctly** use the necessary primitives to construct the volume sketches. **Design** of fully constrained sketches and in correspondence with given indications;
(Unable to correctly identify the order of 3D volumes and appropriate use of 3D operations. Unable to accurately deploy finishing operations (fillet, chamfer, thread). Unable to correctly use Hole wizard, patterns and reference geometry.)

*60 % of Rewards* – **Select** the correct stat plane and part orientation. **Correctly** use the necessary primitives to construct the volume sketches.
(Unable to design fully constrained sketches and in correspondence with given indications; Unable to correctly identify the order of 3D volumes and appropriate use of 3D operations. Unable to accurately deploy finishing operations (fillet, chamfer, thread). Unable to correctly use Hole wizard, patterns and reference geometry.)

*50 % of Rewards or less* – **Select** the correct stat plane and part orientation.
(Unable to correctly use the necessary primitives to construct the volume sketches. Unable to design fully constrained sketches and in correspondence with given indications; Unable to correctly identify the order of 3D volumes and appropriate use of 3D operations. Unable to accurately deploy finishing operations (fillet, chamfer, thread). Unable to correctly use Hole wizard, patterns and reference geometry.)

## Cognitive & Behavioural Learning Objective 4

Generate 2D drawings for designed parts

### Rewards

Competitive advantage for recreational activities – pick court for Laser Tag

Public recognition of knowledge level

### Individual tasks and completion stage

*100% of Rewards* – **Use** *Make drawing from part* Feature. **Select** the appropriate sheet format and part scale. **Change** between display styles (shaded, shaded with edges, hidden lines removed, hidden lines visible, wire frame). **Correctly** use the *Standard 3View* Feature. **Accurately** place overall dimensions. **Accurately** use the following features: Projected view, Section view, Auxiliary view, Detail view, Broken out section. **Correctly** define characteristics of drawing views (reference configuration, display state, scale, dimension type, alignment, layers etc.). **Use** other annotation features (model items, note, surface finish, datum feature, centreline, centre mark, etc.).

*90% of Rewards* – **Use** *Make drawing from part* Feature. **Select** the appropriate sheet format and part scale. **Change** between display styles. **Correctly** use the *Standard 3View* Feature. **Accurately** place overall dimensions. **Accurately** use the predefined view features. **Correctly** define characteristics of drawing views.
(Unable to correctly use other annotation features.)

*80 % of Rewards* – **Select** the appropriate sheet format and part scale. **Change** between display styles. **Correctly** use the *Standard 3View* Feature. **Accurately** place overall dimensions. **Accurately** use the predefined view features.
(Unable to correctly define characteristics of drawing views. Unable to correctly use other annotation features.)

*70 % of Rewards* – **Select** the appropriate sheet format and part scale. **Change** between display styles. **Correctly** use the *Standard 3View* Feature.
(Unable to accurately place overall dimensions and use the predefined view features. Unable to correctly define characteristics of drawing views. Unable to correctly use other annotation features.)

*60 % of Rewards* – **Select** the appropriate sheet format and part scale. **Change** between display styles.
(Unable to correctly use the *Standard 3View* Feature. Unable to accurately place overall dimensions and use the predefined view features. Unable to correctly define characteristics of drawing views. Unable to correctly use other annotation features.)

*50 % of Rewards or less* – **Select** the appropriate sheet format and part scale.
(Unable to change between display styles. Unable to correctly use the *Standard 3View* Feature. Unable to accurately place overall dimensions and use the predefined view features. Unable to correctly define characteristics of drawing views. Unable to correctly use other annotation features.)

## Cognitive & Behavioural Learning Objective 5

Generate photorealistic renderings of products

### Rewards

Career counselling privilege

Pass for Laser tag games (no.)

Public recognition of knowledge level

### Individual tasks and completion stage

*100% of Rewards* – **Launch** PhotoView 360 add-in. **Correctly** use the *Edit appearance* Feature and assign materials to each volume of the 3D model. **Correctly** use the *Edit scene* Feature and distinguish between basic, studio, presentation scenes and backgrounds. **Appropriately** use decals on cylindrical surfaces. **Launch** the *Preview window* and *Render region* Features and define scenes, lights and cameras. **Generate** *Final render* of the photorealistic 3D model.

*90% of Rewards* – **Launch** PhotoView 360 add-in. **Correctly** use the *Edit appearance* Feature and assign materials. **Correctly** use the *Edit scene* Feature and distinguish between basic, studio, presentation scenes and backgrounds. **Appropriately** use decals and **launch** the *Preview window* and *Render region* Features and define scenes, lights and cameras. (Unable to generate *Final render* of the photorealistic 3D model.)

*80 % of Rewards* – **Launch** PhotoView 360 add-in. **Correctly** use the *Edit appearance* Feature and assign materials. **Correctly** use the *Edit scene* Feature and distinguish between basic, studio, presentation scenes and backgrounds. **Appropriately** use decals. (Unable to launch the *Preview window* and *Render region* Features. Unable to generate *Final render* of the photorealistic 3D model.)

*70 % of Rewards* – **Launch** PhotoView 360 add-in. **Correctly** use the *Edit appearance* Feature and assign materials. **Correctly** use the *Edit scene* Feature.
(Unable to distinguish between basic, studio, presentation scenes and backgrounds. Unable to appropriately use decals and launch the *Preview window* and *Render region* Features. Unable to generate *Final render* of the photorealistic 3D model.)

*60 % of Rewards* – **Launch** PhotoView 360 add-in. **Correctly** use the *Edit appearance* Feature and assign materials.
(Unable to correctly use the *Edit scene* Feature. Unable to distinguish between basic, studio, presentation scenes and backgrounds. Unable to appropriately use decals and launch the *Preview window* and *Render region* Features. Unable to generate *Final render* of the photorealistic 3D model.)

*50 % of Rewards or less* – **Launch** PhotoView 360 add-in.
(Unable to correctly use the *Edit appearance* Feature and assign materials. Unable to correctly use the *Edit scene* Feature. Unable to distinguish between basic, studio, presentation scenes and backgrounds. Unable to appropriately use decals and launch the *Preview window* and *Render region* Features. Unable to generate *Final render* of the photorealistic 3D model.

Rewards were given as presented in Figure 2 and the five Cognitive and Behavioural Learning Objectives, based on the task mastery recognition level and achievement stages of difficulty obtained by each student.

The Quest ended with an award ceremony during which each of the four teams were recognised for their achievement performance and outstanding contributions to different Levels. Motivational speeches were given by all Team's tutors and by students who expressed their intent to do so. Final student speeches were a good source of positive feedback for the organisers of the event.

Generally, feedback was collected both live during each Level and at the end of the Quest, as a survey (Figure 4). Engagement of students was so positive that during the last week of the quest, students created their own activities and implemented them between Quest Levels.


**Figure 4. Final feedback session for all teams**

Teams also cashed in on rewards involving extra activities, like privilege to use the available infrastructure for implementation of other tasks outside of the quest. After completion of Levels teams designed and 3D printed their own products. They were usually small tokens made for family members or friends. In this way, the fundamental knowledge accumulated during Levels 4 and 5 was used and sedimented by students' initiative, extending the learning experience outside the given tasks of the program.

The feedback on the learning content was positive, with students appreciating the teaching strategies and the tools used. The high level of digitalisation and the available infrastructure of UPB was also received well by participants. Usage of a multitude of complementary IT tools and software throughout the program was evaluated as an important asset.

When asked about their main accomplishments during the Quest, students cited a new positive outlook on the technical science educational path and making friends around the country as being most important.

Time tracking was perceived as stressful, as some students felt pressured to fit the achievements within a specific time frame. Also, they did not see the time-based system as a positive element as they wanted more flexibility between Levels.

Future research will involve improvement of the current applied gamification strategy based on the feedback received.

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# Gamification in Higher Education Technical Disciplines

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Gamification frameworks are applied in a variety of domains such as health, business, sustainability and education (*Deterding et al., 2011*). Implemented gamification initiatives aim to influence how participants behave when they perform regular activities like learning, exercising and shopping, often improving engagement in the undertaken activity.

Interactive learning environments promote a creative approach in the teaching process, which allows the design and development of gamified content aimed at enhancing student performance. Gamification of teaching content in higher education environments has been shown to improve student attitude, engagement and performance (*S. Subhash and E.A. Cudney, 2018*). The variety of gamified learning systems and available frameworks for higher education enables educators to easily create and adapt learning strategies in accordance with the teaching environment.

Early on, it is important to make a clear distinction between gamification and game-based learning. While game-based learning integrates games into the learning process to achieve a specific learning goal, gamification transforms the learning experience into a game by using game strategies. The focus of this study is on non-game context learning experiences which are applied in higher education technical disciplines in such a way that it does not change the learning content, but rather targets the design of more engaging and challenging experiences for students.

Applying gamification strategies into higher education scenarios has been proven to be quite a challenging task with several restrictions

imposed by existing regulations. In order to proactively compensate these, four gamification elements are considered representative in a higher education environment, namely: (1) narrative, (2) challenge, (3) progression and (4) feedback (*Langendah P.A. et al., 2016*). Accurate implementation of all four elements can be achieved with the use of mixed pedagogic approaches, targeted on content and participants structure.

In a fast-changing environment, it is impossible to forecast what technological advances will be achieved in 30 years or what the job market will look like. Current predictions place at the top of the list the following macro competencies: lifelong learning (curiosity, creativity, critical thinking); self-agency (initiative, motivation, resilience, responsibility) and interactive use of diverse tools and resources (impactful and efficient use of resources, responsible consumption) (*Marope M. et al., 2017*).

Curriculum should be adapted so as students are prepared for the uncertainty of future developments. Gamification is known to develop critical thinking skills, and embedding an entrepreneurial mindset, helping students to adapt to coming challenges (*Rahman Ab. R. et al. 2018*).

The current study details the design and development of gamified learning content for an Additive Manufacturing (AM) discipline, implemented for 1st year masters' students at a technical higher education institution. Several online tools were used to deliver the course, such as: a Moodle learning platform, Microsoft Teams dedicated channel, WIX web design cloud tool. A detailed overview of the main learning tools and equipment is presented in Tables 1 and 2, in correlation with the corresponding learning activity.

The variety of used learning tools has several advantages, among which we can mention:

1. using optimised gamification elements available;
2. addressing the different learning styles of students;
3. promoting creativity and innovation through flexibility in the application of tools and content;
4. enhancing communication, management and IOT skills.

Nevertheless, this multi-tool learning approach, could confuse a student with a non-technical background knowledge.

**Table 1. Learning tools and activities for deploying a gamified learning content in an AM discipline**

| Learning tool | Activity |
|---|---|
| Moodle learning platform | Provide lecture notes, case study notes & workshop presentations; Define assignments; Implement quizzes. |
| Microsoft Teams private channel | Deliver interactive lectures, webinars, workshops and project work; Defend course levels and final evaluations. |
| WIX web design cloud tool | Design individual presentation websites for course achievements. |
| CAD software (SolidWorks, Inventor, Catia, Fusion 360 - cloud based solution) | Design and develop the 3D models and STL files of the desired part. |
| Mesh software (Meshmixer) | Manipulate and optimise mesh and cloud point objects. |
| Slice software (Cura, ZSuite, Simplify 3D) | Optimise the build plate layout, 3D printing parameters and create the Gcode. |
| Remote access software | Access computers remotely to benefit from all licensed software within the university. |
| 3D Hubs open base knowledge platform | Provide case studies and best practice-examples. |

**Table 2. Learning equipment and activities for deploying a gamified learning content in an AM discipline**

| Learning equipment | Activity |
|---|---|
| 3D printers | Manufacture 3D printed parts |
| | Perform maintenance routines |
| Post processing kits | Perform post processing and assembly operations |
| Vacuum chamber | Degas 3D printed master parts for silicone moulds |
| Video projector | Deliver case study and level presentations |
| Personal computers | Perform learning tasks (R&D, CAD, optimise 3D print jobs, prepare pitch presentations etc.) |
| Microsoft Surface Hub | Deliver technical pitch presentations |

Before the gamification of content, it was mandatory to accurately identify the main learning strategies used in the implementation of the AM discipline. Furthermore, each learning strategy was paired with optimum delivering formats and assessment methods (Table 3). Based on these, the most appropriate gamification framework could be identified and applied.

**Table 3. Correlation between learning strategies, delivering formats and assessment methods for AM**

| Learning strategy | Delivering format for AM | Formative/ summative assessment method |
|---|---|---|
| Project based | Hands-on workshop | Flash tasks during hands-on activities; Pitch presentations / |
| | Group project assignment | Functional complex prototypes manufactured with MEX, SLA, DLP or BJ |
| Team based | Tech laboratory | Guided debates / Range of 3D printed products |
| Individual | Live technology quest | Questions during learning activities / Technology demonstration |
| Self-paced | Case study | On-line polls / Case study presentation |
| | Best-practice example | |
| Group based | Interactive lecture | Quiz, Feedback and discussions / Short presentations |
| | Product live demo | |

The AM discipline was delivered in a 14-week format with activities structured as follows: Two hours of group-based activities per week; four hours of team-based activities every two weeks; four hours of project based activities every two weeks; four hours of individual and self-paced activities per week.

Three laboratories were used to deliver all course activities, each with specific equipment aimed at developing targeted tasks. The Product Design and Development laboratory (Figure 1) was used to deliver group project assignments and hands-on workshops. Laboratories and practical case study defences were delivered within the Additive Manufacturing Technologies laboratory. Interactive lectures, webinars and remote access were implemented within the Complex Project laboratory.


**Figure 1. Product Design and Development Laboratory – project work with two series of 1st year master students**

Capabilities of available infrastructure (Table 4) is key for the definition and structure of the course learning levels and learning objectives. All activities and tasks are corelated with the AM technology requirements, facilitating the implementation of the gamification framework. Being a technology intensive course, AM content was easily adapted to the usage of gamification strategies.

**Table 4. Capabilities of available infrastructure**

| AM technology | 3D printer | No. of 3D printers | Capabilities |
|---|---|---|---|
| Material Extrusion (MEX) | Zortrax M300 | 15 | 3D-print large final parts and functional prototypes |
| | Zortrax M300+ | 3 | 3D-print large final parts and functional prototypes (can be accessed remotely and has memory function for builds) |
| | Zortrax M300 Dual | 2 | 3D-print small to medium sized prototypes and functional parts with high production rates |
| | BCN SigmaX | 2 | 3D-print large final parts and functional prototypes with high productivity |
| | Creality CR20 - Pro | 20 | 3D-print small initial prototypes |
| | 3D Kreator | 10 | 3D-print medium sized initial and final prototypes |
| Stereolithography (SLA) | Zortrax Inkspire | 5 | 3D-print small detailed functional models |
| | Ultrasound washing unit | 1 | Post processing of 3D-printed parts for SLA |
| Digital Light Processing (DLP) | Projet 1500 | 1 | 3D-print large detailed functional models |
| | UV curing unit | 1 | Post processing of 3D-printed parts for DLP |
| Binder Jetting (BJ) | ZCorp 310 | 1 | 3D-print visual detailed models |
| | Powder recycling unit | 1 | Post processing of 3D-printed parts for BJ |

When designing the gamified learning content, a basic three-tiered framework (S. Scepanovic and N. Zaric, 2015) was considered: (1) goal-

focused activities, (2) reward mechanisms and (3) progress tracking. To address these, some of the most used elements in gamifications (S. Subhash and E.A. Cudney, 2018) were considered: credit points (CP), progress & ranking graphs and levels. Learning levels and objectives are defined in correlation with the available infrastructure, mainly the type of equipment and technology and its capabilities.

Based on the structure of the AM discipline, the available infrastructure and the base knowledge of the students, the gamification process of the teaching content started with the definition of seven course levels (L1 – L7), as follows:

Level 1 – Design and 3D-print a master part; manufacture a silicone mould for rapid casting of epoxy resin (recommended application – company logo);

Level 2 – Design and 3D-print a functional gear assembly (use cylindrical, helical, conical or rack gears)

Level 3 – Design and 3D-print demountable and non-demountable bearing assemblies;

Level 4 – Design and 3D-print a simple product with one of three joint types - cylindrical, spherical/toroidal, universal joints (recommended application – omni wheel);

Level 5 – Design and 3D-print a simple product with a threaded demountable assembly and a spherical joint (recommended application – mechanical vise);

Level 6 – Design and 3D-print a lithophane application (pictures of its use are taken during the laboratory; a support must be designed for the 3D-printed picture to incorporate the light source);

Level 7 – Design and 3D-print a complex product assembly with at least eight moving parts and incorporating at least two engineering principles learned in the previous levels (creativity and innovation will receive extra credit points).

Usually, one level was implemented within a two-week time frame. For each course level, several cognitive and behavioural learning objectives were established (Table 5). To define learning objectives, Bloom's revised taxonomy for learning levels, (LL1- LL6) was used (*Gershon M., 2018).*

**Table 5. Cognitive and behavioural learning objectives, based on course and learning levels for AM**

| Course Level | Learning Level* | Cognitive learning objective | Behavioural learning objective |
|---|---|---|---|
| Level 1 | LL1<br>LL2 | Remember the information already learnt about CAD software;<br>Explain the advantages of CAD software in product design and development;<br>Identify main design challenges for AM. | Recognise and locate main components of an AM equipment;<br>3D-model and obtain CAD files for part products;<br>3D-print single component assembly. |
| Level 2 | LL2<br>LL3 | Remember 3D-printing defects; Explain possible visual and tactile defects in a functional gear<br>Select appropriate equipment/ technology for gear function;<br>Identify appropriate 3D-printing principle for current application. | Demonstrate the working principle of an AM equipment for a cylindrical gear;<br>Indicate the physical components which create the X, Y and Z axis movements necessary for 3D-printing of helical, conical or rack gears;<br>3D-print gear assemblies. |
| Level 3 | LL3 | Select material and equipment in relation to bearing assembly functionality;<br>Identify appropriate 3D-printing principle for current application. | Perform "Change Filament", "Calibration", "Bed Levelling" functions;<br>3D-print demountable and non-demountable bearing assemblies. |
| Level 4 | LL4 | Correlate between printing parameters and part function and quality<br>Point out main advantages/ disadvantages of the 3D-printed parts. | Design three types of joints based on 3D printing principles for MEX/ SLA;<br>Optimise build plate layout and process parameters for spherical joints;<br>3D-print demountable joints. |

| Course Level | Learning Level* | Cognitive learning objective | Behavioural learning objective |
|---|---|---|---|
| Level 5 | LL5 | Validate build plate layout in correspondence with thread feature function and used technology. | Manage technology restrictions with thread restrictions;<br>Repair mesh for enhanced thread details in STL files;<br>3D print a threaded assembly. |
| Level 6 | LL3<br>LL4<br>LL6 | Select the appropriate technology and material for the lithophane application;<br>Develop final product concept with detailed requirements. | Calculate material consumption and estimate costs for at least two technology options;<br>Calibrate 3D printing picture parameters;<br>3D print lithophane applications. |
| Level 7 | LL5<br>LL7 | Plan entire product range;<br>Develop product identity features;<br>Develop a website structure to showcase the creativity of ones' work.<br>Enhance product value by identifying and showcasing competitive advantage. | Plan time frame for building a product of min. 8 moving parts;<br>Asses optimum geometry for minimum costs and time;<br>Simulate and demonstrate functionality of final developed product. |

*According to Bloom's revised taxonomy (Gershon M., 2018)

All seven levels are divided into three stages of difficulty, as follows:

1. Novice – Levels 1, 2, 3;
2. Professional – Levels 4, 5;
3. Expert – Levels 6, 7.

Thus, in each time frame of the course students have labels such as *Level 4 Professional* or *Level 7 Expert*.

Each learning objective within a single course level was divided in specific tasks and each task was attributed with a corresponding number of credit points. Over the 14-week period, students were given the chance

to go up in levels, by accumulating extra credit points from supplementary tasks using the individual or self-paced learning strategies. For each level, the learning objectives of the previous levels are mandatory prerequisites.

Progress tracking was made during each learning session, whether it was an interactive lecture, a laboratory, a workshop or a project activity. Student overall progress and rankings within course levels were announced at the end of each session, depending on the current task completion. Figure 2 shows an example of laboratory task presentation.

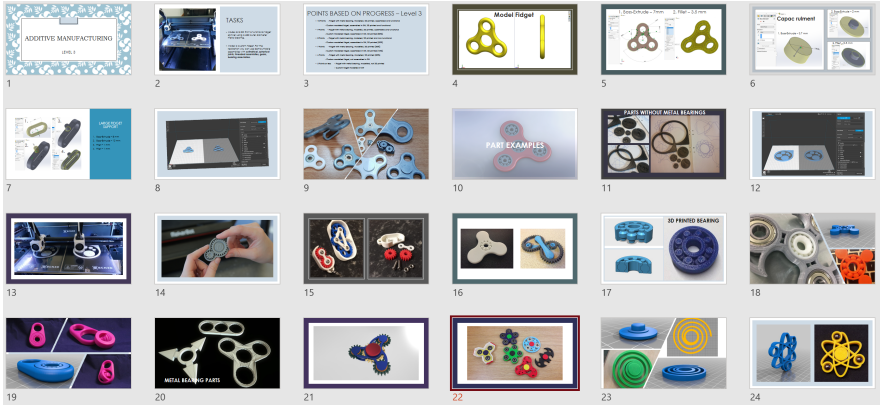



**Figure 2. Level 3 laboratory task with points based on progress teamwork**

Each student must follow the given global tasks of the learning objective by taking active part in all learning strategies. An example of how credit points are divided on each course level in correlation with individual tasks is presented in 'Cognitive & Behavioural Learning Objectives 1–4' below, which presents Level 3. Extra credit activities can have tasks from any of the cognitive and behavioural learning objectives and has a maximum of five credit points per entire AM course. Each task is graded based on the degree of completion which is given to students at the beginning of the 14-week AM course. Similarly, all cognitive and behavioural learning objectives are divided into individual tasks and are awarded credit points for each completion stage. A learning strategy is selected as optimum for each learning objective.

### Cognitive & Behavioural Learning Objective 1

Select material and equipment in relation to bearing assembly functionality

### Learning Strategy / Maximum CP

Group based / 2.1 CP

### Level 3 Credit Points, Individual Tasks and Completion Stage of CP

*100% of CP* – Accurately identify the function of the product and define the technology requirements; Correctly identify the appropriate technology; Correctly select the equipment and material.

*90% of CP* – Accurately identify the function of the product and define the technology requirements; Correctly identify the appropriate technology and equipment; Unable to select the appropriate material.

*80 % of CP* – Accurately identify the function of the product and define the technology requirements; Correctly identify the appropriate technology; Unable to identify the correct equipment and select the appropriate material.

*70 % of CP* – Accurately identify the function of the product and define the technology requirements; Partially identify the appropriate technology, but correctly justify 3D printing technology differences (advantages/ disadvantages); Unable to identify the correct equipment and select the appropriate material.

*60 % of CP* – Accurately identify the function of the product and define the technology requirements; Unable to identify the appropriate technology, the correct equipment and select the appropriate material.

*50 % of CP or less* – Accurately identify the function of the product, but unable to define the technology requirements in correlation with product functions; Unable to identify the appropriate technology, the correct equipment and select the appropriate material.

### Cognitive & Behavioural Learning Objective 2

Identify appropriate 3D printing principle for current application

### Learning Strategy / Maximum CP

Individual / 1.4 CP. Self-paced / 1.4 CP

### Level 3 Credit Points, Individual Tasks and Completion Stage of CP

*100% of CP* – **Identify** all four 3D printing design principles which apply to 3D printing of bearing assemblies and **perform** necessary CAD tasks to adapt parts.

*90% of CP* – **Identify** three 3D printing design principles which apply to 3D printing of bearing assemblies and **perform** necessary CAD tasks to adapt parts.

*80 % of CP* – **Identify** two 3D printing design principles which apply to 3D printing of bearing assemblies and **perform** necessary CAD tasks to adapt parts.

*70 % of CP* – **Identify** all four 3D printing design principles which apply to 3D printing of bearing assemblies and
(cannot perform necessary CAD tasks to adapt designed parts.)

*60 % of CP* – **Identify** two 3D printing design principles which apply to 3D printing of bearing assemblies
(cannot perform necessary CAD tasks to adapt designed parts.)

*50 % of CP or less* – **Identify** one 3D printing design principle which apply to 3D printing of bearing assemblies
(cannot perform necessary CAD tasks to adapt designed parts.)

### Cognitive & Behavioural Learning Objective 3

Perform "Change Filament", "Calibration", "Bed Levelling" functions;

### Learning Strategy / Maximum CP

Team based / 4.2 CP

### Level 3 Credit Points, Individual Tasks and Completion Stage of CP

*100% of CP* – **Perform** all three maintenance functions for a MEX equipment **using** 3 types of filament.

*90% of CP* – **Perform** all three maintenance functions for a MEX equipment **using** 1 type of filament.

*80 % of CP* – **Perform** "Change Filament" and "Calibration"/ "Bed Levelling" functions for a MEX equipment **using** 3 types of filament.

*70 % of CP* – **Perform** "Change Filament" and "Calibration" / "Bed Levelling" functions for a MEX equipment **using** 1 type of filament.

*60 % of CP* – **Perform** only "Change Filament" maintenance function for a MEX equipment **using** 3 types of filament.

*50 % of CP or less* – **Perform** only "Change Filament" maintenance function for a MEX equipment **using** 1 type of filament.

### Cognitive & Behavioural Learning Objective 4

3D-print demountable and non-demountable bearing assemblies.

### Learning Strategy / Maximum CP

Project based / 5 CP

### Level 3 Credit Points, Individual Tasks and Completion Stage of CP

*100% of CP* – **Fidget** with metal bearing, modelled, 3D printed, assembled and functional; **Custom** modelled fidget, assembled in SW, 3D printed and functional.

*90% of CP* – **Fidget** with metal bearing, modelled, 3D printed, assembled and functional; **Custom** modelled fidget, assembled in SW, 3D printed (80%).

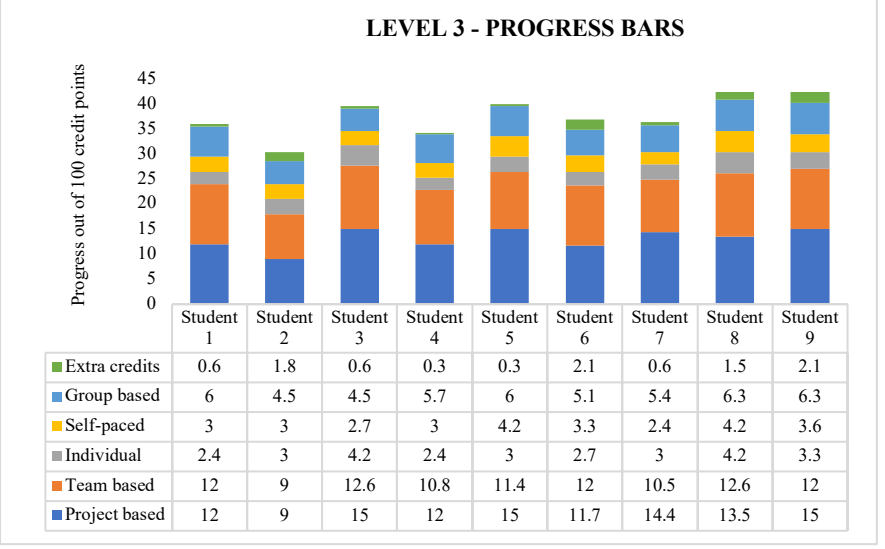
*80 % of CP* – **Fidget** with metal bearing, modelled, 3D printed and non-functional; **Custom** modelled fidget, assembled in SW, 3D printed (50%).

*70 % of CP* – **Fidget** with metal bearing, modelled, 3D printed (50%); **Custom** modelled fidget, assembled in SW, 3D printed (10%).

*60 % of CP* – **Fidget** with metal bearing, modelled, 3D printed (20%); **Custom** modelled fidget, not assembled in SW.

*50 % of CP or less* – **Fidget** with metal bearing, modelled, not 3D printed; **Custom** fidget modelled in SW.

When levelling up, all credit points achieved in previous levels are added to the final score of the student. Ranking is done based on interim progress of each student at the completion of each level. An overall ranking for Level 3 progress is given in Figure 3. Final rankings are compiled at the end of the course after passing through all seven levels. The course grade is given by the final credit points achieved by each student. Each rank has an associated title, regardless of the accumulated points. Thus, the first rank is given to the Superhero, the second rank to the Wizard, the third rank to the Master, while Minions are on the fourth rank and lower.




| | Student 1 | Student 2 | Student 3 | Student 4 | Student 5 | Student 6 | Student 7 | Student 8 | Student 9 |
|---|---|---|---|---|---|---|---|---|---|
| Extra credits | 0.6 | 1.8 | 0.6 | 0.3 | 0.3 | 2.1 | 0.6 | 1.5 | 2.1 |
| Group based | 6 | 4.5 | 4.5 | 5.7 | 6 | 5.1 | 5.4 | 6.3 | 6.3 |
| Self-paced | 3 | 3 | 2.7 | 3 | 4.2 | 3.3 | 2.4 | 4.2 | 3.6 |
| Individual | 2.4 | 3 | 4.2 | 2.4 | 3 | 2.7 | 3 | 4.2 | 3.3 |
| Team based | 12 | 9 | 12.6 | 10.8 | 11.4 | 12 | 10.5 | 12.6 | 12 |
| Project based | 12 | 9 | 15 | 12 | 15 | 11.7 | 14.4 | 13.5 | 15 |

**Figure 3. Level 3 rankings, credit points and progress bar for AM discipline**

Student Credit and Ranking Scores

| Student | Credit Points (/100) | Ranking |
|---|---|---|
| 1 | 36.0 | 6 |
| 2 | 30.3 | 8 |
| 3 | 39.6 | 3 |
| 4 | 34.2 | 7 |
| 5 | 39.9 | 2 |
| 6 | 36.9 | 4 |
| 7 | 36.3 | 5 |
| 8 | 42.3 | 1 |
| 9 | 42.3 | 1 |

The course is generally ended with a team-based achievement presentation. Students are required to showcase their accumulated knowledge and their course results by demonstrating the functionality of their products (Figure 4), emphasizing the design process and team evolution and development. Peer and self-assessment are usually conducted during the pitch presentation stage.

**Figure 4. Project prototypes designed and 3D printed by 1st year master student teams – Level 7**

Feedback was gathered throughout the course implementation period and at the end, using surveys.

One of the most appreciated aspects of the AM discipline gamification process was that students enjoyed having clear overview about their progress during the entire course. Levels were seen as motivation boosters to "graduate" to the next difficulty stage. As activities were clearly defined within a specific time frame, students found that time tracking was a helpful endeavour to plan their given tasks for a particular course level. Competition was seen as a negative aspect, as students argued back and forth mainly because students felt pressure to go up in rankings.

Overall, students enjoyed the process and an increase in hands-on engagement was noted. Also, students felt that they had more initiative and developed more creative solutions to the given tasks, as compared to similar technical disciplines.

Future research involves restructuring the content in modules and delivering the course as an intensive training program, in a significantly

smaller time frame. Feedback will be collected and compared with the currently implemented AM discipline.

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# What Has Been Studied on Gamification in Higher Education in Portugal and Brazil?

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## 1. Introduction

The presence of games in the daily lives of young people is a consolidated fact mainly among the new generations, known as Generation Y or Millennials and Generation Z or iGeneration. For this reason, it is understood that such generations require new forms of teaching at school, with more dynamic and challenging approaches. Gamification has appeared in the literature precisely as an alternative to motivate students, as it manages to make the process more interesting and more dynamic.

As for these young people, the use of digital resources is a natural activity, it is expected that education can take advantage of their great ease and their effective competence in the use of digital technologies to provide teaching situations and opportunities of learning in which they can use digital devices and environments that resemble those they use in their daily lives, projecting them in a way that also promotes greater involvement in learning activities and, willingly, better academic performance. To this purpose, Prensky (2012) states that learning based on digital games is important because it meets the needs and learning styles of this current generation; that can be adapted and used in different areas and, when used properly, be effective beyond fun. In the area of business and also inspired by the culture of game-playing, gamification

has been expanding for several years, with approaches to its application that involve attracting and retaining customers to companies. According to Carvalho (2012), creating games to attract consumers to stores or motivate their employees is also nothing new. The novelty is chiefly in the introduction of technology in this process, with many cases of technology companies having entered the gamification world – such as Microsoft, Samsung, or SAP – to increase the involvement of their employees and customers, using concepts related to games in their daily tasks.

In higher education, gamification appears recurrently in reaction to the problem of students' demotivation and frustration and school dropout (Viamonte, 2018; Oliveira and Bittencourt, 2017; Tenório et al., 2016). This is due to the way curriculum is worked in HE, providing markedly uniform and standardised teaching, offering the same to everyone, regardless of the differences of the individuals to whom it is addressed and the ambitions and personal characteristics of each one. The approach to learning through gamification thus emerges as a response to students' lack of interest in learning (Mazur, 2020; Hassan et al, 2019), since it aims to make the experience of learning at the university itself much more fun, interesting, appealing and, as a result, more successful.

Concerning the students' perception of this type of alternative learning experience, Bai, Hew, & Huang (2020) identify four main orders of arguments stated by the students to justify their appreciation for gamification. Unlike a monotonous and uninteresting school, students recognise that gamification, in general, stimulates their taste and enthusiasm for what they are learning. On the other hand, students highlight, in particular, the effective utility they recognise for immediate feedback on their performance, as it contributes to the maintenance of their motivational indices to the tasks to be performed. They also underline the possibility that gamification can satisfy the need for recognition. Finally, students report that they are involved in a gamified teaching and learning process, encouraging them to establish their own goals. In their opinion, this turns out to be decisive in terms of greater

control over the process itself: in normal non-gamified teaching situations, this does not always happen.

Taking advantage of the natural enthusiasm that young people manifest to the gaming experience in general (for the pleasure, adrenaline, and challenge that the games provide), it seemed pertinent to know what is being done at this level specifically in the context of Portuguese-speaking countries.

In particular, from the pedagogical point of view, interest is being reported in the literature on the gamification experiences in which students are involved – and on a worldwide scale. So, here we will present the study we carried out on academic work (masters' dissertations and doctoral theses) developed in the last five years in the area of gamification of learning in the context of higher education in Portugal and Brazil.

## Methodology

### *Nature of the study*

Given that this is a first approach to the work carried out on gamification in higher education in the context of Portuguese-speaking countries, we have chosen to proceed with a systematic review of the literature following a set of usual procedures suggested for this type of work (i.e., purpose of the study; data sources; construction of the analysis corpus; inclusion and quality assurance criteria, etc.)

### *Purpose*

Through a systematic review process based on dissertations reporting experiences of gamification in higher education, we specifically intended:

1. to understand what has been studied in general regarding gamification in the area of Social and Human Sciences (thematics)
2. to identify approaches, models and frameworks taken as a reference (theories)
3. to identify the main methodologies used; and, finally, d) to know the main results and conclusions reached by these studies.

### *Data sources*

To carry out the study, we used the Portuguese database of open scientific production known as Portal RCAAP (Scientific Repositories of Open Access in Portugal), as it is the main database validated by the scientific community and allows open access to a number significant number of documents. Despite being a Portuguese repository, since 2010 this database started to aggregate scientific content from the Brazilian Institute of Information in Science and Technology (IBICT), which would also allow access to scientific production in Brazil.

### *Construction of the analysis corpus*

In the first stage of the process, carried out between December 2019 and February 2020, the descriptors "Gamificação", "Gamificar" and "Gamificado" were used, identifing 337 documents. In a second step, to proceed to the debugging and final selection of the documents that would constitute the corpus for analysis, we carefully read the title, keywords, summary, final considerations and in some cases the introduction to apply the inclusion and exclusion criteria showed in Table 1 (Selection criteria).

**Table 1: Selection criteria**

| Inclusion criteria | Exclusion criteria |
|---|---|
| Master's Dissertations and Doctoral Theses on Gamification in Higher Education in the area of Human or Social Sciences | Any type of document other than a thesis or dissertation in the area of Human or Social Sciences |
| Publications from January 2015 to February 2020 | Publications before January 2015 |
| Documents with open access in RCAAP | Documents with embargoed or restricted access |
| | Duplicate documents |

From the successive application of the aforementioned criteria, a total of 74 documents covering applications of gamification in higher education were initially obtained. However, when the exclusion criteria are applied,

namely the criteria related to the area of knowledge, the number of studies is reduced to a total of 26 studies.

### *Content analysis procedures*

A qualitative analysis of the abstracts content of the selected texts was carried out to identify elements that would allow each investigation to be framed in previously established criteria. For this, an analysis structure was built based on the objectives mentioned above. The aims were to understand what subjects has been studied in general regarding gamification in the area of Social and Human Sciences, to identify approaches taken as a reference, to identify the main methodologies used, and, finally, to know the main results and conclusions of the selected studies.

Concerning the identification of the studied subjects, we took the analysis of keywords and titles of the academic works (Imbelloni, 2012). Then, in a second step and to better understand the main focus of the studies, we used the proposal of Martí-Pareño, Méndez-Ibañez, and Alonso-Arroyo (2016), who suggest a specific taxonomy for gamification studies. For these authors, there are four dimensions to be considered in the analysis: effectiveness, acceptance, engagement, and social interactions.

For the characterization of the gamification experiences themselves, we focus on the authors' explicit references on the main concepts and models underlying the organisation of the teaching and learning process: that is, the principles that contribute to the configuration of the respective pedagogical proposals, but also the elements of the game (Deterding et. al. 2011) and the digital technologies used.

To characterise the methodology used in the studies, attention was focused on explicit references on the nature of the research (qualitative or quantitative, mixed approach or development methodology) and the type of instruments prevalent in terms of data collection.

Finally, to understand the main results obtained, we took the authors' considerations, either in terms of the themes that recur most (for example, pedagogical innovation or student learning), or in terms of the general evaluation (satisfactory balance versus unsatisfactory balance), but also in terms of the limits and challenges that have been indicated.

## Summary of the Main Results

Even before proceeding with the characterisation of the selected studies, we start by mentioning their distribution by country and respective publishing dates. With this objective in mind and following Table 2 (a & b – Year and Source), we start to remark that the investment in gamification works has been considerably higher in the context of Brazilian higher education, with around two-thirds (19 titles). There is also an evident increase in interest in this type of study (21 works between the years 2017 and 2019).

**Table 2a. Year and source of works – P1–14.**

| Author | Year | | | | | | Source | |
|---|---|---|---|---|---|---|---|---|
| | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | Brasil | Portugal |
| (P1) Santos | | | | X | | | X | |
| (P2) Quadros | | X | | | | | X | |
| (P3) França | | X | | | | | X | |
| (P4) Sataka | | | | | X | | X | |
| (P5) Corcini | | X | | | | | X | |
| (P6) Jacobsen | | | | X | | | X | |
| (P7) Rodrigues | | | | X | | | | X |
| (P8) Crespo | | | | | X | | X | |
| (P9) Guedes | | | X | | | | X | |
| (P10) Duarte | | | X | | | | X | |
| (P11) Pessi | | | | X | | | X | |
| (P12) Tristão | | | | X | | | X | |
| (P13) Gomes | | | X | | | | X | |
| (P14) Silva | | | | | X | | | X |

**Table 2b. Year and source of works – P15–26.**

| Author | Year | | | | | | Source | |
|---|---|---|---|---|---|---|---|---|
| | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | Brasil | Portugal |
| (P15) Gomes | | | | X | | | | X |
| (P16) Saraiva | | | | X | | | | X |
| (P17) Simba | | | X | | | | | X |
| (P18) Gervásio | | | | | X | | X | |
| (P19) Gomes | | | X | | | | X | |
| (P20) Pombo | | | | | X | | | X |
| (P21) Ferreira | X | | | | | | X | |
| (P22) Alexandre | | | | | | X | X | |
| (P23) Sobreiro | | | X | | | | X | |
| (P24) Caixado | | | | | X | | | X |
| (P25) Quaresma | | | | | X | | X | |
| (P26) Coelho | | | X | | | | X | |
| **Total (%)** | **1 (4)** | **3 (11)** | **7 (27)** | **7 (27)** | **7 (27)** | **1 (4)** | **19 (73)** | **7 (27)** |

## *Identification of the studied areas and dimensions*

To identify the main areas of education in which the selected works took place, we first used an analysis strategy based on the titles, keywords, and the respective abstracts. According to Table 3 (Teaching areas), there is a great diversity of teaching areas, with most gamification experiences developed in the context of teaching foreign languages (8 studies) followed by teaching either Mathematics or Education subjects (6 works each).

In the case of gamification experiences for teaching languages, we highlight the research conducted by Quadros (2016). The goal is to understand how the elements of gamification may or may not offer the conditions for learners to approach the "state of flow" proposed by Csikszentmihalyi (1990) during the process of learning a foreign language with an online authoring tool.

**Table 3. Teaching areas**

| **Author** | **Teaching Areas** *[1–Languages. 2–Mathematics. 3–History. 4–Administration. 5–Education. 6–Health. 7–Marketing. 8–Psychology. 9–Information]* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** |
| (P1) Santos, 2018 | | | | | X | | | | |
| (P2) Quadros, 2016 | X | | | | | | | | |
| (P3) França, 2016 | | | | X | | | | | |
| (P4) Sataka, 2019 | X | | | | | | | | |
| (P5) Corcini, 2016 | | | | | X | | | | |
| (P6) Jacobsen, 2018 | | X | | | | | | | |
| (P7) Rodrigues, 2018 | | | | | | X | | | |
| (P8) Crespo, 2019 | X | | | | | | | | |
| (P9) Guedes, 2017 | | | X | | | | | | |
| (P10) Duarte, 2017 | X | | | | | | | | |
| (P11) Pessi, 2018 | | | | | X | | | | |
| (P12) Tristão, 2018 | | | | | X | | | | |
| (P13) Gomes, 2017 | | X | | | | | | | |
| (P14) Silva, 2019 | | | | | | | X | | |
| (P15) Gomes, 2018 | X | | | | | | | | |
| (P16) Saraiva, 2018 | | | | | X | | | | |
| (P17) Simba, 2017 | | | | | | | | X | |
| (P18) Gervásio, 2019 | X | | | | | | | | |
| (P19) Gomes, 2017 | | X | | | | | | | |
| (P20) Pombo, 2019 | X | | | | | | | | |
| (P21) Ferreira, 2015 | | X | | | | | | | |
| (P22) Alexandre, 2020 | X | | | | | | | | |
| (P23) Sobreiro, 2017 | | | | | | | | | X |
| (P24) Caixado, 2019 | | | | | X | | | | |
| (P25) Quaresma, 2019 | | X | | | | | | | |
| (P26) Coelho, 2017 | | X | | | | | | | |
| **Total (%)** | **8 (31)** | **6 (23)** | **1 (4)** | **1 (4)** | **6 (23)** | **1 (4)** | **1 (4)** | **1 (4)** | **1 (4)** |

Supported by the taxonomy proposed by Martí-Pareño, Méndez-Ibañez, and Alonso-Arroyo (2016), in a second step, it was possible to conclude that main issues are related to the engagement of students in learning, with six studies. The acceptance of gamification as an alternative strategy and questions regarding its effectiveness are also prominent, with five and four studies respectively.

The observation of Table 4 (a & b – Dimensions studied) also allows us to notice that only two of the analysed studies simultaneously include the three dimensions previously mentioned. It can be seen, on the other hand, that social-interaction, with only two works, was the dimension to which researchers paid less attention. In the table, we can observe that about half of the studies focus on other aspects, of which we highlight the students' perspective on elements of the game made available, or on the technologies used in the creation of the gamification experiences.

**Table 4a. Dimensions studied – P1–13**

| **Author** | **Focus** [1–Engagement. 2–Acceptance. 3–Effectiveness. 4–Social Interaction. 5–Other.] | | | | |
|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** |
| (P1) Santos, 2018 | | | | | |
| (P2) Quadros, 2016 | X | | | | |
| (P3) França, 2016 | | | | X | |
| (P4) Sataka, 2019 | | | | | |
| (P5) Corcini, 2016 | | | | | X |
| (P6) Jacobsen, 2018 | | | | | X |
| (P7) Rodrigues, 2018 | | | X | | |
| (P8) Crespo, 2019 | X | | | | X |
| (P9) Guedes, 2017 | X | X | X | | |
| (P10) Duarte, 2017 | | | | | |
| (P11) Pessi, 2018 | | | | | |
| (P12) Tristão, 2018 | | | | | X |
| (P13) Gomes, 2017 | | | | | |

**Table 4b. Dimensions studied – P14–26**

| Author | Focus | | | | |
|---|---|---|---|---|---|
| *[Key to numbers listed above]* | **1** | **2** | **3** | **4** | **5** |
| (P14) Silva, 2019 | X | X | X | | X |
| (P15) Gomes, 2018 | | | | | |
| (P16) Saraiva, 2018 | | | | X | X |
| (P17) Simba, 2017 | X | | | | X |
| (P18) Gervásio, 2019 | | | | | X |
| (P19) Gomes, 2017 | | | | | |
| (P20) Pombo, 2019 | | | | | X |
| (P21) Ferreira, 2015 | | X | | | X |
| (P22) Alexandre, 2020 | | | | | |
| (P23) Sobreiro, 2017 | X | | X | | |
| (P24) Caixado, 2019 | | X | | | |
| (P25) Quaresma, 2019 | | | | | |
| (P26) Coelho, 2017 | | X | | | X |
| **Total (%)** | **6 (23)** | **5 (19)** | **4 (15)** | **2 (8)** | **11 (42)** |

## *Characterization of gamification experiences*

For the characterization of the experiences of gamification, we took into account all the authors' references on the principles considered in the configuration of the respective pedagogical proposals. We also considered the mentions made to the elements of the game considered and, finally, to the technologies mobilised for the realization of those same gamified teaching and learning experiences.

Regarding the theoretical & conceptual framework as a reference, the results presented in Table 5 (a & b – Principles and theoretical approaches) allow us to conclude on the predominance of studies that are based on questions related to student motivation (16 studies). Second, there are studies that take the promotion of meaningful learning in the creation of gamified learning experiences as a reference (five studies).

**Table 5a. Principles and theoretical approaches – P1–22**

| **Author** | **Principles and Approaches** [1–Meaningful Learning. 2–Project-based Learning. 3–Socio-constructivism. 4–Theory of Didactic Situations. 5–Constuctivism. 6–Theory of Motivation. 7–Theory of Learning Styles.] | | | | | | |
|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| (P1) Santos, 2018 | | | | | | X | |
| (P2) Quadros, 2016 | | | | | | X | |
| (P3) França, 2016 | | X | | | | | |
| (P4) Sataka, 2019 | X | | | | | | |
| (P5) Corcini, 2016 | | | | | | X | |
| (P6) Jacobsen, 2018 | | | | | | X | |
| (P7) Rodrigues, 2018 | | | | | | X | |
| (P8) Crespo, 2019 | | | | | | X | |
| (P9) Guedes, 2017 | | | | | | X | |
| (P10) Duarte, 2017 | | | | | | X | |
| (P11) Pessi, 2018 | X | | | | | | |
| (P12) Tristão, 2018 | | | | | | X | |
| (P13) Gomes, 2017 | | | | X | | | |
| (P14) Silva, 2019 | | | | | | X | |
| (P15) Gomes, 2018 | | | | | | X | |
| (P16) Saraiva, 2018 | | | | | X | | |
| (P17) Simba, 2017 | | | | | | X | |
| (P18) Gervásio, 2019 | X | | | | | | |
| (P19) Gomes, 2017 | X | | | | | | |
| (P20) Pombo, 2019 | | | X | | | | |
| (P21) Ferreira, 2015 | | | | | | | X |
| (P22) Alexandre, 2020 | | | | | | X | |

**Table 5b. Principles and theoretical approaches – P23–26**

| Author | Principles and Approaches | | | | | | |
|---|---|---|---|---|---|---|---|
| [*Key to numbers listed above*] | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| (P23) Sobreiro, 2017 | | | | | | X | |
| (P24) Caixado, 2019 | | | | | | X | |
| (P25) Quaresma, 2019 | X | | | | | | |
| (P26) Coelho, 2017 | | | | | | X | |
| **Total (%)** | **5 (19)** | **1 (4)** | **1 (4)** | **1 (4)** | **1 (4)** | **16 (61)** | **1 (4)** |

About the use of motivation theory, we highlight the investigation by Tristão (2018) that sought to analyse the influence of gamification on the motivation and engagement of students. It sought to identify as well the positive and negative aspects from the perspective of the teacher and proposing a gamification model using badges and a progress bar as motivating factors.

Concerning the elements of the game mobilised to configure the gamified learning experiences, in Table 6 (a & b – Elements of the game), it is possible to observe the richness and variety of resources used in the set of the 26 studies. On the other hand, it is also possible to see that almost all gamified experiences use five or more elements. In the search for an eventual dominant pattern, the attribution of points (65% of studies), the availability of feedback (58%), the establishment of rankings (50%), and levels (42%) stand out. Soon afterward, challenges and the attribution of badges emerge in 31% of the studies, with the remaining elements of the game mentioned having less expression, with percentages below 30%.

**Table 6a. Elements of the game – P1–12**

| **Author** | **Elements of the game**<br>[1–Badges. 2–Progress Bar. 3–Missions. 4–Challenges. 5–Points.<br>6–Levels. 7–Ranking. 8–Collaborative-experience Board.<br>9–Serious Games. 10–Support Videos. 11–Quizzes.<br>12–Leader Board. 13–Reward. 14–Avatar. 15–Feedback.<br>16–Competence Tree.] | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** |
| (P1) Santos, 2018 | | | | | | | | | | | | | | | | |
| (P2) Quadros, 2016 | | X | | X | X | X | X | | | | | | X | | X | |
| (P3) França, 2016 | | | | | X | X | X | X | | | | | | | | |
| (P4) Sataka, 2019 | | | | X | | X | X | | | | | | X | | X | |
| (P5) Corcini, 2016 | | X | X | X | X | | X | | | | | | X | X | | |
| (P6) Jacobsen, 2018 | | | X | X | X | X | | | | | | | X | | X | |
| (P7) Rodrigues, 2018 | X | | X | X | X | X | X | | | | | | X | | | |
| (P8) Crespo, 2019 | | | | | | | | | | | | | | | | |
| (P9) Guedes, 2017 | | | X | X | X | X | | | X | | | | | | X | |
| (P10) Duarte, 2017 | | | | | | | | | | X | | | | | X | |
| (P11) Pessi, 2018 | | | | | X | | X | | | | | | X | | | |
| (P12) Tristão, 2018 | X | X | | | | | | | | | | | | | X | |

**Table 6b. Elements of the game – P13–26**

| **Author** | **Elements of the game** | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *[Key to numbers listed above]* | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** |
| (P13) Gomes, 2017 | | | | | | | | | | | | | | | | |
| (P14) Silva, 2019 | | | | | X | | X | | X | | | | | | X | |
| (P15) Gomes, 2018 | X | | | X | X | | X | | | X | X | X | | | X | |
| (P16) Saraiva, 2018 | | | | | | | X | | | | | | X | X | | |
| (P17) Simba, 2017 | | | X | | X | X | | | | | | | X | | X | |
| (P18) Gervásio, 2019 | | | | | X | X | | | | X | X | | | | | |
| (P19) Gomes, 2017 | X | | | | X | | X | | | X | | X | X | X | X | |
| (P20) Pombo, 2019 | X | | | | | | | | | | X | | | X | X | |
| (P21) Ferreira, 2015 | | | | | X | X | X | | | | | | | | X | |
| (P22) Alexandre, 2020 | | | | | X | | | | | | | | | X | X | X |
| (P23) Sobreiro, 2017 | X | X | | X | X | X | X | | | | | | X | | X | |
| (P24) Caixado, 2019 | X | | | | X | | | | | | | | | X | | |
| (P25) Quaresma, 2019 | | | | | X | X | | | | | | | X | X | X | |
| (P26) Coelho, 2017 | X | X | | | | | X | | | X | | | | | | |
| **Total (%)** | 8 (31) | 5 (19) | 5 (19) | 8 (31) | 17 (65) | 11 (42) | 13 (50) | 1 (4) | 2 (8) | 5 (19) | 3 (11) | 2 (8) | 11 (42) | 7 (27) | 15 (58) | 1 (4) |

The study by Gomes (2018), aiming to create a differentiated gamified design in online higher education, can be an illustrative example of the combination of different game elements. The gamification strategy in this case includes narrative, narrative support videos, quizzes, points, badges, leaderboard, avatar, challenges, and feedback of various kinds, such as feedback from the project team to students and feedback from peers.

With regard to the use of digital technology, the selected studies show that all researchers used a type of technology in the configuration of gamification experiences shown in Table 7 (a, b & c – Technologies used). A great diversity of tools – between platforms, applications, and other software – are visible here; all of them having the purpose of allowing the realization of the different components of the game.

**Table 7a. Technologies used – P1–7**

| **Author** | **Platforms, Applications and Software**<br>[1– Kahoot. 2– Quizz. 3– Wiki. 4– Mooc. 5– Duolingo.<br>6– Blog. 7– Elo System. 8– Moodle. 9– Sol Network.<br>10–3D Immersive Virtual Environment. 11– GGBook. 12– Elgg.<br>13– Social Networks. 14– SIGA. 15– Google Classroom.<br>16– Storytelling. 17– Private Platforms.] | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** |
| (P1) Santos, 2018 | | | | | | | | X | | | | | | | | | |
| (P2) Quadros, 2016 | | X | | | | | X | | | | | | | | | | |
| (P3) França, 2016 | | | | | | | | X | | | | | | | | | |
| (P4) Sataka, 2019 | | | | | X | | | | | | | | | | | | |
| (P5) Corcini, 2016 | | | | | | | | | | X | | | | | | | |
| (P6) Jacobsen, 2018 | | | | | | | | X | | | | | | | | | |
| (P7) Rodrigues, 2018 | X | | | | | | | | | | | | | | | | |

**Table 7b. Technologies used – P8–24**

| Author | Platforms, Applications and Software | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *[Key to numbers listed above]* | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| (P8) Crespo, 2019 | X | | | | | | | | | | | | | | | | |
| (P9) Guedes, 2017 | | | | | | | | | | | | | X | | | X | |
| (P10) Duarte, 2017 | | | | | | | X | | | | | | | | | | |
| (P11) Pessi, 2018 | X | | | | | | | | | | | | | | X | | |
| (P12) Tristão, 2018 | | | | | | | | X | | | | | | | | | |
| (P13) Gomes, 2017 | | | | | | | | | | | | | | | | | |
| (P14) Silva, 2019 | | | | | | | | | | | | | | | | | X |
| (P15) Gomes, 2018 | | | | | | | | X | X | | | | | | | | |
| (P16) Saraiva, 2018 | | | | | | | | | X | | | X | | | | | |
| (P17) Simba, 2017 | | | X | | | | | | | | | | | | | | |
| (P18) Gervásio, 2019 | | | | | | | | X | | | | | | | | | |
| (P19) Gomes, 2017 | | | | | | | | X | | | | | | | | | |
| (P20) Pombo, 2019 | | X | X | | | | | X | | | | | X | | | | |
| (P21) Ferreira, 2015 | | | | | | | | | | | X | | X | X | | | |
| (P22) Alexandre, 2020 | | | | | | X | | | | | | | | | | | |
| (P23) Sobreiro, 2017 | | X | | | | X | | | | | | | | | | | |
| (P24) Caixado, 2019 | | | | | | | | | | | | | X | | | | |

**Table 7c. Technologies used – P25–26**

| Author | Platforms, Applications and Software | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *[Key to numbers listed above]* | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** |
| (P25) Quaresma, 2019 | | | | | | | | X | | | | | | | | | |
| (P26) Coelho, 2017 | | | | X | | | | X | | | | | | | | | |
| **Total (%)** | 3 (11) | 3 (11) | 2 (8) | 1 (4) | 1 (4) | 2 (8) | 2 (8) | 10 (38) | 2 (8) | 1 (4) | 1 (4) | 1 (4) | 4 (15) | 1 (4) | 1 (4) | 1 (4) | 1 (4) |

The Moodle platform, used as a basis for gamification in ten studies (38%), stands out as being the most used resource in the studies considered here. On the other hand, we observed that only one of the cases uses a platform specially designed to promote the teaching of foreign languages (Duolingo). Most of the other digital tools, mainly open access tools and not being expressly designed for gamification of learning, end up being adapted for that purpose, individually or in combinations as the case may be. As an example of using one of these applications, we refer to the study by Crespo (2019) that analyses German classes in a Language course, in which Kahoot! was used to provide activities involving the playful dimension in its configuration.

## *Main methodologies used in research*

Concerning the choices of the selected authors about scientific methods adopted to carry out their studies, there is a predominance of qualitative studies over quantitative studies, with a total of fifteen (58%) in the first case, only two (8%) in the second case, and six of them use mixed methodologies, as seen in Table 8. (Research methodologies).

**Table 8. Research methodologies**

| Author | Nature of Research | | | |
|---|---|---|---|---|
| | Quantitative | Qualitative | Mixed | DBR |
| (P1) Santos, 2018 | | X | | |
| (P2) Quadros, 2016 | | | X | |
| (P3) França, 2016 | | | X | |
| (P4) Sataka, 2019 | | X | | |
| (P5) Corcini, 2016 | | X | | |
| (P6) Jacobsen, 2018 | | X | | |
| (P7) Rodrigues, 2018 | | X | | |
| (P8) Crespo, 2019 | | | X | |
| (P9) Guedes, 2017 | | | X | |
| (P10) Duarte, 2017 | | X | | |
| (P11) Pessi, 2018 | | X | | |
| (P12) Tristão, 2018 | | X | | |
| (P13) Gomes, 2017 | | X | | |
| (P14) Silva, 2019 | X | | | |
| (P15) Gomes, 2018 | | | | X |
| (P16) Saraiva, 2018 | | | | X |
| (P17) Simba, 2017 | | | X | |
| (P18) Gervásio, 2019 | | X | | |
| (P19) Gomes, 2017 | | X | | |
| (P20) Pombo, 2019 | | | | X |
| (P21) Ferreira, 2015 | | X | | |
| (P22) Alexandre, 2020 | | X | | |
| (P23) Sobreiro, 2017 | | X | | |
| (P24) Caixado, 2019 | X | | | |
| (P25) Quaresma, 2019 | | | X | |
| (P26) Coelho, 2017 | | X | | |
| Total (%) | 2 (8%) | 15 (58%) | 6 (23%) | 3 (11%) |

On the other hand, only three of the studies analysed opted for a development methodology approach (Design-Based Research). Design-Based Research (DBR) is a methodology that has been increasingly used in research in Education, particularly when the precise objective is the design, implementation, and evaluation of new teaching and learning proposals, as is the case of gamification strategy development. In the case of the study by Saraiva (2018), the author justifies the use of this methodology precisely because it was the first time that this strategy would be tried, based on the use of an academic network already existing in a Virtual University. Data collection was carried out through semi-structured interviews to get the students' views for its evaluation after implementation. In the Pombo study (2019), the use of the development methodology was justified insofar as this approach allows the development itself to be supported by certain "principles of design" which can guide, inform and optimise the gamification experiences to implement.

### *Main results*

To understand the main results using gamification experiences in higher education, the content analysis focused on the identification of benefits and advantages mentioned by the authors, as well as references to possible difficulties and limitations checked, shown in Table 9. (a & b – Results of the studies). The set of works gives emphasis to the pedagogical innovation of the experiences as a benefit (in 81% of the cases). In general, gamification is understood as a pedagogical strategy that increases student motivation. Gamification is seen also as a way of promoting interaction between students and increasing their engagement with learning. As an example, this view can be seen in the work of Tristão (2018) when he mentioned that from the results obtained in the data analysis, it was possible to identify that the progress bar motivated more than the badges, and compared to the previous class, there was an increase in access to the course environment and the profiles of the participants were viewed much more. From the teacher perspective, gamification has increased student involvement, and the quality of the work developed.

Although in all studies there are references to the advantages that this type of experience can bring to the teaching and learning process, only five studies (19%) make more explicit references to the effective learning gains through use of the gamification experiences carried out. Gervásio (2019) suggests this when he states that these resources favour teaching languages more dynamically and interactively, in addition to promoting meaningful learning, since the plug-ins allow the creation of activities that explore multimodal elements, facilitating a more active learning process.

**Table 9a. Studies results – P1–16**

| Author | Results | | |
|---|---|---|---|
| | Benefits | | Limitations |
| | Pedagogical Innovation | Learning | |
| (P1) Santos, 2018 | X | | |
| (P2) Quadros, 2016 | | X | |
| (P3) França, 2016 | X | | |
| (P4) Sataka, 2019 | X | | |
| (P5) Corcini, 2016 | X | | X |
| (P6) Jacobsen, 2018 | X | | |
| (P7) Rodrigues, 2018 | X | | X |
| (P8) Crespo, 2019 | X | | X |
| (P9) Guedes, 2017 | X | | |
| (P10) Duarte, 2017 | X | | |
| (P11) Pessi, 2018 | X | | X |
| (P12) Tristão, 2018 | X | | |
| (P13) Gomes, 2017 | | X | |
| (P14) Silva, 2019 | X | | |
| (P15) Gomes, 2018 | X | | |
| (P16) Saraiva, 2018 | X | | |

**Table 9b. Studies results – P17–26**

| Author | Results | | |
|---|---|---|---|
| | Benefits | | Limitations |
| | Pedagogical Innovation | Learning | |
| (P17) Simba, 2017 | X | | |
| (P18) Gervásio, 2019 | | X | X |
| (P19) Gomes, 2017 | X | | X |
| (P20) Pombo, 2019 | X | | |
| (P21) Ferreira, 2015 | | X | |
| (P22) Alexandre, 2020 | | X | |
| (P23) Sobreiro, 2017 | X | | X |
| (P24) Caixado, 2019 | X | | |
| (P25) Quaresma, 2019 | X | | |
| (P26) Coelho, 2017 | X | | |
| **Total (%)** | **21 (81)** | **5 (19)** | **7 (27)** |

Although in the totality of studies analysed, the respective authors are globally satisfied with the gamification experiences implemented, some of the limitations or disadvantages pointed out by some of the authors should be mentioned, such as issues related to the new requirements that gamification brings, for example in terms of time management, the organization of learning assessment itself, or even from the necessary technological skills, both by the teacher and by the students. Regarding the challenges in terms of learning assessment, the case of Pessi (2018) is elucidating when he states that right at the beginning of classes, when the discipline's activity plan was presented to students, they questioned whether the score obtained would have a relationship with bi-monthly notes. Because of this experience, he opted to gamify the evaluation, leading to reflection on the importance of creating new evaluation models, models that come out of formal standards and become truly meaningful instruments for student learning.

The difficulties related to the technological elements are mentioned, for example, in the study by Rodrigues (2018): here he mentions:

1. the delay in making the virtual environment available so that the discipline could start its activities together with the other on-site ones;
2. the limitations presented by the portal in receiving the activities in video format. This forced the teacher to make her e-mail available for sending the work, making it difficult for the researcher to control the compliance with the deadline for the second unit of the discipline;
3. the fluctuations in the availability of internet connection, forcing the postponement of activities and compromising the effectiveness of the results.

## Final Considerations

As we can see in the previous paragraphs, the analysis of the results of the selected studies shows that, in one way or another, all investigations generally make a positive assessment of the use of gamification strategies in the teaching and learning process. This positivity is mainly associated with issues involving gamification as a pedagogical innovation: a pedagogical strategy is capable of generating increased motivation, more interaction and approximation between students and teachers, and greater engagement in the academic work. Although not all of the studies analysed explicitly refer to the benefits for learning, references to a positive assessment suggest that, in some way, gamification may be an effective alternative in the academic context.

Although it is still a recent area of study, there is an increasing number of academic works focusing on experiences of gamification of learning implemented in the context of higher education. Based on the implementation of a playful dimension, these pedagogical experiences constitute a research opportunity. In particular, because researchers who conduct the studies also design and implement the gamified learning experiences that are the object of analysis. In fact, from a research perspective, this raises new challenges in terms of objectivity of analysis. Furthermore, it will be a unique opportunity in terms of reflection on teaching and on teaching professional development. Highly demanding, but necessary if the goal is to change the organisation of teaching and

learning in higher education institutions. Any changes are to take place in a context strongly marked by technological development and the natural adhesion of young people to games and digital technologies that are now a part of their daily lives.

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## List of Selected Studies

| | Author | Title |
|---|---|---|
| P1 | **Santos,** Lidiane Rocha dos | *A cognição inventiva na docência universitária: das narrativas de si aos relatos de experiências de práticas pedagógicas gamificadas* |
| P2 | **Quadros,** Gerson Bruno Forgiarini de | *A gamificação no ensino de línguas online* |
| P3 | **França,** Rômulo Martins | *Ambiente gamificado de aprendizagem baseada em projetos* |
| P4 | **Sataka,** Mayara Mayumi | *Análise do aplicativo Duolingo para aprendizagem de Língua Espanhola: uma pesquisa narrativa* |
| P5 | **Corcini,** Luiz Fernando | *Cenários imersivos de aprendizagem: a construção do conhecimento em ambientes de pós-graduação.* |
| P6 | **Jacobsen,** Daniel de Melo | *Contribuições da gamificação para o ensino e a aprendizagem: uma proposta de ensino para matemática financeira* |

| | | |
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| P7 | **Rodrigues,** Larissa Berredo | *Educação e tecnologias digitais: a gestão escolar que alia a estratégia da gamificação ao processo de ensino-aprendizagem* |
| P8 | **Crespo,** Arthur Heredia | *Elementos do Estado de Fluxo durante atividades com Kahoot!: um estudo de casos múltiplos em aulas de alemão* |
| P9 | **Guedes,** Anibal Lopes | *Emancipação digital cidadã de jovens do campo num contexto híbrido, multimodal e ubíquo* |
| P10 | **Duarte,** Gabriela Bohlmann | *Eventos complexos de letramentos na aprendizagem de inglês: relações entre práticas de letramentos, gamificação e motivação* |
| P11 | **Pessi,** Ingrid Gayer | *Gamificação como estratégia pedagógica na formação do pedagogo* |
| P12 | **Tristão,** Patrícia da Silva | *Gamificação da disciplina metodologia da pesquisa no ensino superior: estudo de caso* |
| P13 | **Gomes,** Marcelo dos Santos | *Gamificação e Educação Matemática: uma reflexão pela óptica da teoria das situações didáticas* |
| P14 | **Silva,** Rui Jorge Rodrigues | *Gamificação no Ensino da Gestão* |
| P15 | **Gomes,** Cláudia | *Gamificação no ensino superior online* |
| P16 | **Saraiva,** Fernando José Vaz Guedes Bacelar | *Gamificação numa rede social duma universidade virtual: o caso da Rede SOL* |
| P17 | **Simba Paucar,** Sandra Lucia | *Gamificación como estrategia de motivación en la plataforma virtual de la Educación Superior Presencial* |
| P18 | **Gervásio,** João Roberto Ricalde | *Investigação da customização da plataforma AVA "Moodle" para uso no ensino de línguas a distância* |
| P19 | **Gomes,** Adilson Fernandes | *Material didático digital, games e gamification: conexões no design para implementação de cursos online* |

| | | |
|---|---|---|
| P20 | **Pombo,** Cândida Perpétua | *Mobile learning e educação em línguas: contributos para a aprendizagem do inglês no ensino superior online* |
| P21 | **Ferreira,** Bruno Santos | *O uso da gamificação como estratégia didática na capacitação de professores para o uso de softwares educativos* |
| P22 | **Alexandre,** Gabriel Guimarães | *Práticas letradas de gamificação: estudo do processo de textualização no ensino superior* |
| P23 | **Sobreiro,** Jason Antonio Pedroso | *Proposta de desenvolvimento de instrumento de aplicação de atividades gamificadas para disciplinas do ensino* |
| P24 | **Caixado,** Duarte Manuel Farinha | *The gamification features' effect on the training effectiveness in organizational context* |
| P25 | **Quaresma,** José Augusto de Sena | *Um framework gamificado para a disciplina algoritmos ou equivalente* |
| P26 | **Coelho,** Janaina Aparecida Ponté | *Uso de gamificação em cursos online abertos e massivos para formação continuada de docentes de matemática* |

# Games and Gamification in Education: what does Portuguese research tell us from the perspective of the Adult Learners?

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## Introduction and brief theoretical contextualization

The research, in general, can evolve by the development of original studies and by the development of state-of-the-art studies. These have been termed according to different labels, such as, among others, the following: systematic literature review, narrative literature review, integrative literature review, synthesis of literature, knowledge mapping, meta-synthesis, meta-analysis (cf. e.g., Cardoso, 2007; Fernandes, 2007; Cardoso, Alarcão & Celorico, 2010; Weed, 2005). Even if the terminology may vary, what seems to be consensual is that through this type of study new original research studies emerge, which can account for it having gained increasing importance as a primary research activity (cf. e.g., Cardoso & Marques, 2020; Pestana & Cardoso, 2020).

Therefore, a quick search for that specific type of research studies, in online repositories, will most probably deliver a great number of results – at least, this has been our experience (cf. e.g., Pinto, Cardoso & Pestana, 2019). Even when focusing on a detailed research object, we can still encounter to many documents to treat or a limited span of time to analyse

the studies (especially with a limited research team), or too a few documents to gain results with a usual approach – but if that is so, some conclusions may emerge through specific research object mapping.

This was the case, as will be explained later, when we decided to outline a first portrait of the research developed on the theme of games and gamification from the perspective of the adult learners. Hence, and in order to make such an exploratory study possible, the mapping of knowledge was restricted to the research published in open access and indexed on a scientific repository, on those two topics and within that perspective. In this context the following question emerged as the research problem: how has knowledge about this theme been progressing in such a scenario? It is then aimed at presenting what such research tells us about games and gamification from the perspective of the adult learners.

Games have long caught the attention of practitioners, researchers and teachers, probably because of their main features, decisive for those who play them throughout life – cognitive stimulation, critical and creative thinking, developing competences, entertainment, experiencing emotions, learning, problem solving, simulation of real situations, socialization, team/individual work, or testing hypotheses (cf. Johnson et al, 2013; Vygotsky, 2007; Kishimoto, 2002; Piaget, 1990; Chapman, 1988; Bruner, 1966). A game is actually more than a physiological phenomenon or a psychological reflex, it goes beyond the limits of purely physical or biological activities (Huizinga, 1993). In contrast,

> *Gamification is a relatively new trend that focuses on applying game mechanics to non-game contexts in order to engage audiences and to inject a little fun into mundane activities besides generating motivational and cognitive benefits. While many fields such as Business, Marketing and e-Learning have taken advantage of the potential of gamification, the digital healthcare domain has also started to exploit this emerging trend.* [cf. Sardi et al, 2017[1]]

[1] N.B. the quotations that are presented without the corresponding page(s) refer to the abstract of the document. Moreover, in some cases, the translation is provided by the

Another feature that makes games so appealing is the fact that they have been evolving with a strong link to technology. Thus, they have become available online and on digital scenarios, making access extremely easy, including on mobile devices. This is also a consequence of the new social paradigm in which we live, where information circulates intensely through networks mediated by technology (Cardoso, Pestana & Brás, 2018). Our participation in these networks determines our access to knowledge and the reconfiguration of relational processes that, in turn, trigger great challenges and simultaneous opportunities to learn and evolve, to respond better to our personal or professional needs (Pinto & Cardoso, 2017).

We could refer to additional characteristics and references to theoretically frame the contextualization of this study. Nevertheless, the author hopes the knowledge mapped within it will provide some useful insights and point towards those other main directions to explore in the future. In the next section, there is a brief description of the methodological options of the study and the procedures followed in the definition of the corpus of analysis.

## Methodological design and presentation of the corpus of analysis

This study is of an exploratory, descriptive and interpretative nature. We opted for a mixed methodology, following quantitative and qualitative approaches, guided by a multimodal meta-analytical strategy, inspired by the MAECC®, the meta-model of analysis and exploration of scientific knowledge® (Cardoso, 2007). Hence, the methodological design comprises the data collection, organization, and analysis.

Taking into account that it is impossible to previously predict the number of documents that a documental search, on a given repository, will provide, the recommendation is to follow a rigorous and iterative process, as we did in the constitution of our corpus of analysis. That is not

author of this chapter – i.e., whenever the abstract is only available in Portuguese, the English version was made available.

the only challenge to consider we must face others, namely in the definition of a corpus as a primary step to put forward a literature review and knowledge systematization or a meta-analytical study (Cardoso, Alarcão & Celorico, 2010 and 2013). Being aware of the risks and challenges that such a type of study involves, we started the documental analysis process, targeted at balancing between "no documents match your query" and 'too many documents match your query'.

Since the first two trials proved to be unproductive, as is explained afterwards, we moved to a third open-access repository, the OASISBR, which is hosted by the *Instituto Brasileiro de Informação em Ciência e Tecnologia* (IBICT, i.e., the Brazilian Institute of Information in Science and Technology). As we can read on their website, "[t]he Brazilian Portal of open-access scientific publications – OASISBR is a multidisciplinary search engine that allows free access to the scientific production of authors linked to Brazilian universities and research institutes. Through OASISBR it is also possible to search Portuguese information sources."[2]

We had anticipated that it would have been possible to find the 'right' number of documents at the *Repositórios Científicos de Acesso Aberto de Portugal* (RCAAP, the Scientific Repositories of Open Access of Portugal)[3], within the scope of our exploratory study. However, after several attempts in trying out different strategies according to the advanced search options available, and bearing in mind our research goals, no record was found – "the search did not return any documents". We had already experienced that defining a corpus based on the documents of the RCAAP can be a challenging and a stimulating task too (cf. e.g., Cardoso, 2012 and 2018; Cardoso & Marques, 2020; Pinto, Cardoso & Pestana, 2019; Pinto, Pestana & Cardoso 2018), namely because, as stated, we can end up with too many or, on the contrary, with too few (or even no) documents.

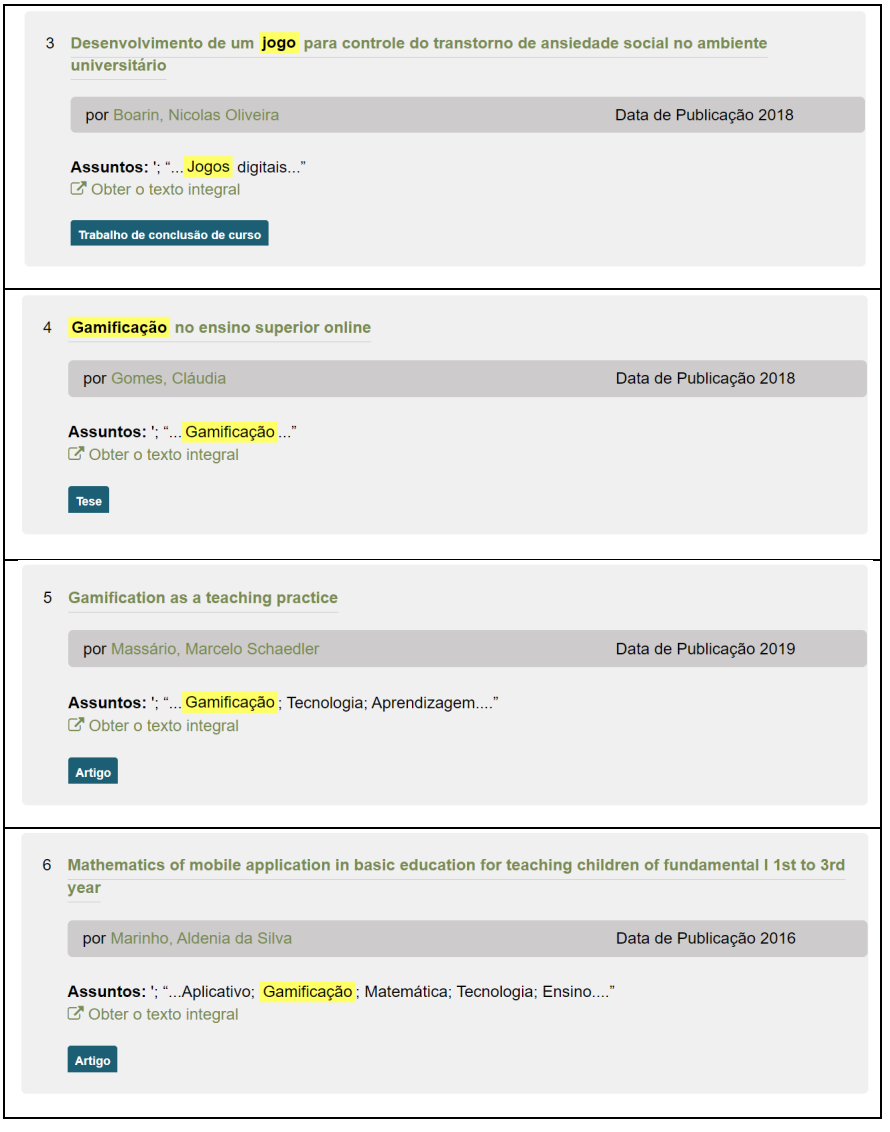
The same procedures were tested, this time at the *Repositório Aberto*, "[t]he institutional repository of the Open University [Portugal] (UAb) [that] aims to store, preserve, disseminate and give access to UAb's

[2] http://oasisbr.ibict.br/vufind/
[3] https://www.rcaap.pt/

academic and scientific production. By bringing together, in a single place, the set of scientific publications of the University, it is intended to contribute to the increase of its visibility and impact and to guarantee the preservation of its intellectual memory".[4] However, and unlike the attempt at the RCAAP, the records were too many to manage, given the nature of the study (and the time to accomplish it).

Therefore, we decided to search at the OASISBR, as it aggregates documents from different institutional open-access repositories, and also because it refers to a broad Portuguese speaking research community (including that represented at the RCAAP). It should be highlighted that one of the partners of OASISBR is the *Comunidade dos Países de Língua Portuguesa* (CPLP, i.e., the Community of Portuguese Speaking Countries). So, having dealt with the previously mentioned constraints, after our several attempts, revisited and updated on September 2, 2020, those iterative searches led us to consider a corpus of eight documents, sorted by "Relevance" by the OASISBR portal, in a descendent order, as listed below in Figure 1; the descriptors were evidenced in yellow, as our print screens illustrate.


[4] https://repositorioaberto.uab.pt/



3 **Desenvolvimento de um jogo para controle do transtorno de ansiedade social no ambiente universitário**

por Boarin, Nicolas Oliveira Data de Publicação 2018

**Assuntos:** '; "... Jogos digitais..."
Obter o texto integral

Trabalho de conclusão de curso

4 **Gamificação no ensino superior online**

por Gomes, Cláudia Data de Publicação 2018

**Assuntos:** '; "... Gamificação ..."
Obter o texto integral

Tese

5 **Gamification as a teaching practice**

por Massário, Marcelo Schaedler Data de Publicação 2019

**Assuntos:** '; "... Gamificação ; Tecnologia; Aprendizagem...."
Obter o texto integral

Artigo

6 **Mathematics of mobile application in basic education for teaching children of fundamental I 1st to 3rd year**

por Marinho, Aldenia da Silva Data de Publicação 2016

**Assuntos:** '; "...Aplicativo; Gamificação ; Matemática; Tecnologia; Ensino...."
Obter o texto integral

Artigo

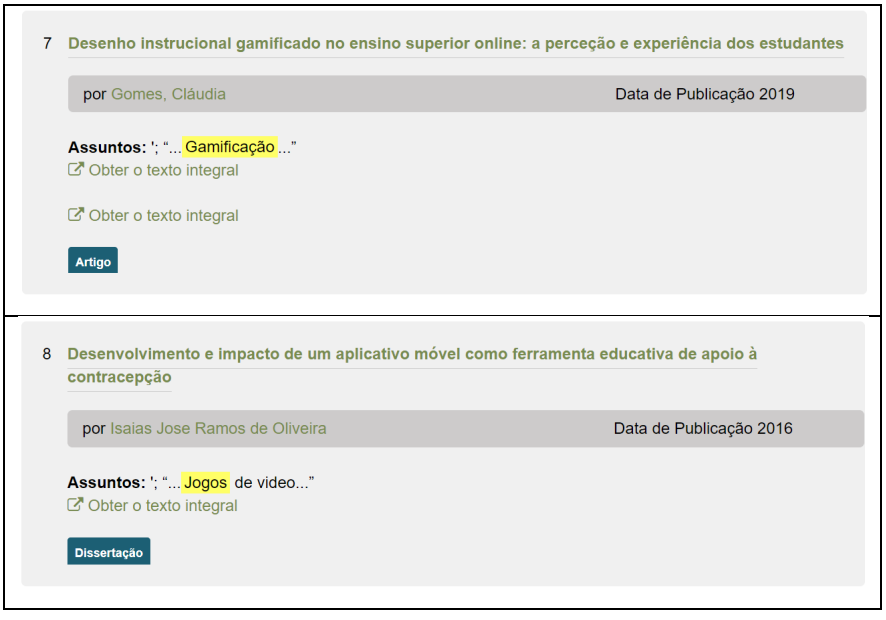



**Figure 1. Corpus of analysis resulting from the described OASISBR search**
[The data was collected for this study.]

The list of these 8 documents indicated above (Figure 1) resulted from the advanced search represented below on Figure 2, that is, by combining the descriptors *"jogos"* (games), *"gamificação"* (gamification) and *"adultos"* (adults), using the Boolean operator 'AND', in every item of the OASISBR metadata provided. Those documents are all available in open access, as we later confirmed. At the initial stages, and given the challenges met, we decided not to consider any filter in the advanced search (other than the three descriptors and the Boolean operator already detailed and referred to). In other words, and as further perceived, it proved to be unnecessary to set geographic limits, or to define chronological and linguistic boundaries for the search, because the number of documents was possible to analyse within the scope and length of this exploratory study. For instance, by analysing the *"Idioma"* (i.e., the language) metadata, we can conclude that all of the documents are written in Portuguese.

Regarding the *"Tipo de Documento"* (i.e., the Type of Document) metadata, four categories emerged, distributed as follows:

"*Artigo*"
(i.e., Research Article) - 3;
"*Trabalho de conclusão de curso*" (TCC)
(i.e., Work for Course Completion) - 2;
"*Dissertação*"
(i.e., Master's Dissertation) - 2;
"*Tese*"
(i.e., PhD Thesis) - 1.

With regard to the "Fonte" (i.e., the Source) metadata, four categories emerged as well, distributed as follows:

"*Repositório Científico de Acesso Aberto de Portugal*"
(i.e., the Scientific Repositories of Open Access of Portugal) - 3;
"*Biblioteca Digital de Monografias da UNB*"
(i.e., UNB Digital Library of Monographies) - 2;
"*Research, Society and Development*" - 2;
"*Repositório Institucional da UFMG*"
(i.e., UFMG Institutional Repository) - 1.

Finally, with regard to the "Instituição" (i.e., the Institution) metadata, four categories emerged too, distributed as follows:

"RCAAP" - 3;
"GPMEAC" - 2;
"UNB" - 2;
"UFMG" - 1.

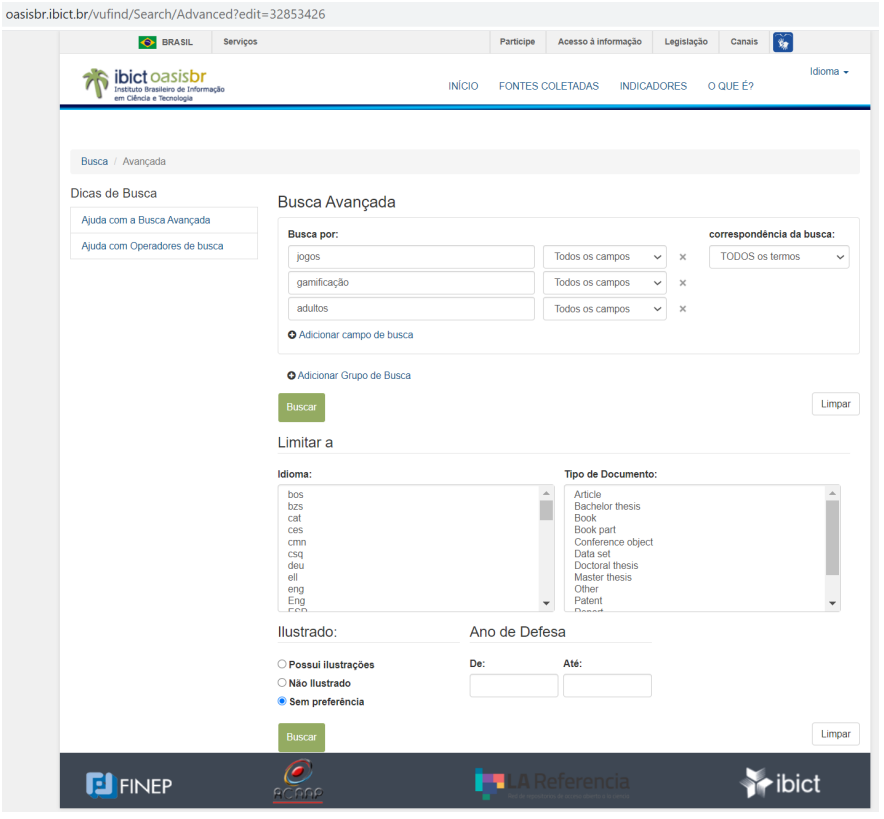



**Figure 2. Advanced search on OASISBR**
[The data was collected for this study.]

A deeper look at other OASISBR metadata enables us to present the documents otherwise, for example, as represented in Table 1. This metadata can be recovered from the information shown in the blue columns that appear on the left side of the OASISBR website (Figure 3): it adds to most of the metadata description of each of the documents, which is available by clicking on the *"Obter o texto integral"* (i.e., Gain access to the full text) link, It also makes it possible to proceed to the analysis of the corpus that is synthetised in Table 1 and in the following section.

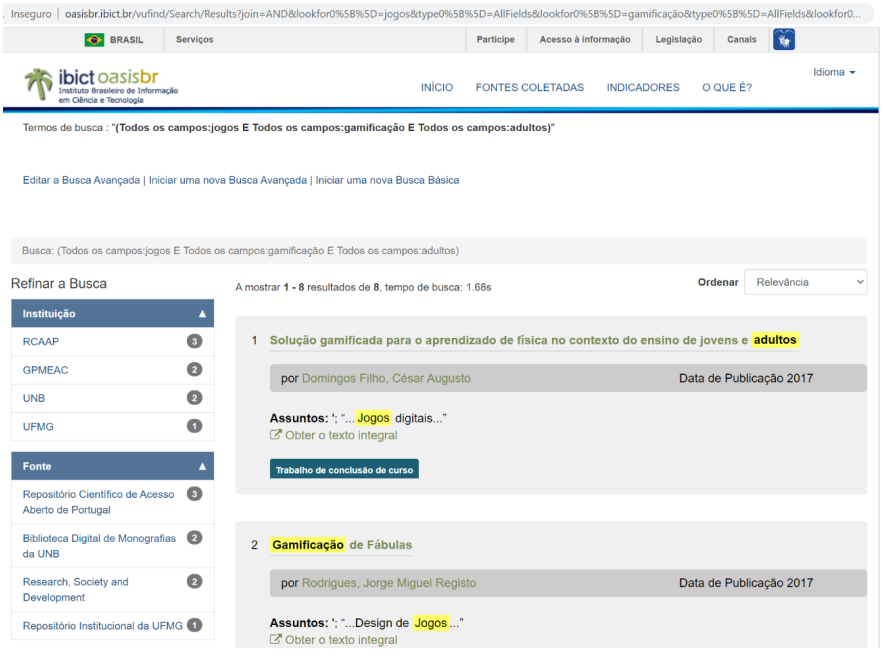



**Figure 3. Some of the Results of the search on OASISBR leading to the definition of the corpus**
[The data was collected for this study.]

It is worth mentioning again that regarding the *"Nível de Acesso"* (i.e., the level of access) all of the 8 documents are "openAccess", which is why this metadata is not included in Table 1. Moreover, the *"Registros relacionados"* (i.e., related records) suggested in each document's detailed description were not considered for analysis either, as they were not deemed fit for the specific purpose of our study. Nevertheless, they can be considered in a future follow-up of this exploratory research, integrating its (new) corpus of analysis.

**Table 1. Corpus of analysis according to OASISBR and main repository metadata**

[The data was collected for this study.]

| Author(s) | Date | Document Type | Source (and Institution) | Descriptors in the title | Content Representation |
|---|---|---|---|---|---|
| *DESENHO INSTRUCIONAL GAMIFICADO NO ENSINO SUPERIOR ONLINE: A PERCEÇÃO E EXPERIÊNCIA DOS ESTUDANTES* | | | | | |
| Gomes, Cláudia<br>Pereira, Alda, Nobre, Ana | 2019 | Research article | *Repositório Científico de Acesso Aberto de Portugal* (RCAAP) | --- | Keywords: Gamification; Distance education; Higher education; Gamified curricular design. |
| GAMIFICATION AS A TEACHING PRACTICE | | | | | |
| Massário, Marcelo Schaedler<br>Barreto, Carlos Henrique da Costa, Knoll, Graziela Frainer, Ghisleni, Taís Steffenello | 2019 | Research article | Research, Society and Development<br>(GPMEAC) | *Gamificação* | Subject(s) / Keywords: Gamification; Technology; Learning. |
| *DESENVOLVIMENTO DE UM JOGO PARA CONTROLE DO TRANSTORNO DE ANSIEDADE SOCIAL NO AMBIENTE UNIVERSITÁRIO* | | | | | |
| Boarin, Nicolas Oliveira | 2018 | Work for Course Completion<br>Advisor – Silva, Wander Cleber Maria Pereira da<br>Scientific Field – *Engenharia de Software* | *Biblioteca Digital de Monografias da UNB* (UNB) | *Jogo* | *Assunto: Transtorno de ansiedade; Jogos digitais; Estudantes universitários - ansiedade; Gamificação.*<br>[Subject: Anxiety disorder; Digital games; College students - anxiety; Gamification.] |

| *GAMIFICAÇÃO NO ENSINO SUPERIOR ONLINE* | | | | | |
|---|---|---|---|---|---|
| Author(s) | Date | Document Type | Source (and Institution) | Descriptors in the title | Content Representation |
| Gomes, Cláudia | 2018 | PhD Thesis<br><br>**Advisors**<br>Pereira, Alda, Nobre, Ana<br><br>Scientific Field<br>Distance Education and Elearning | *Repositório Científico de Acesso Aberto de Portugal* (RCAAP) | *Gamificação* | Keywords: Elearning; Design-based research; Instructional design; Gamification; Online higher education; Distance education. |
| *SOLUÇÃO GAMIFICADA PARA O APRENDIZADO DE FÍSICA NO CONTEXTO DO ENSINO DE JOVENS E ADULTOS* | | | | | |
| Domingos Filho, César Augusto<br><br>Vale, Marcelo Egídio Brasileiro do | 2017 | Work for Course Completion<br><br>**Advisor**<br>Silva, Tiago Barros Pontes e<br><br>Scientific Field<br>Desenho Industrial - Programação Visual | *Biblioteca Digital de Monografias da UNB* (UNB) | *Adultos* | Assunto: Jogos digitais; Educação de Jovens e Adultos (EJA); Gamificação.<br><br>[Subject: Digital games; Youth and Adult Education; Gamification.] |

| *GAMIFICAÇÃO DE FÁBULAS* | | | | | |
|---|---|---|---|---|---|
| Author(s) | Date | Document Type | Source (and Institution) | Descriptors in the title | Content Representation |
| Rodrigues, Jorge Miguel Registo | 2017 | Master's Dissertation<br><br>**Advisors**<br>Filgueiras, Ernesto Vilar,<br>Machado, Luis Manuel de Frias<br><br>Scientific Field<br>Design *e Desenvolvimento de Jogos Digitais* | *Repositório Científico de Acesso Aberto de Portugal* (RCAAP) | *Gamificação* | *Palavras-chave: Aprendizagem;* Card Sorting*; Crianças; Criatividade;* Design *de Jogos; Fábulas; Gamificação; Imaginação;* Minecraft; Storytelling.<br><br>[Keywords: Learning; Card Sorting; Children; Creativity; Game Design; Fables; Gamification; Imagination; Minecraft; Storytelling.] |
| MATHEMATICS OF MOBILE APPLICATION IN BASIC EDUCATION FOR TEACHING CHILDREN OF FUNDAMENTAL I 1ST TO 3RD YEAR | | | | | |
| Marinho, Aldenia da Silva<br>Melo, Alexander Von Cernik, Poggi, Gianpierre Herrera, Kosiur, Marianne Bállico, Marrane, Wagner Rosa, Boghi, Cláudio | 2016 | Research article | Research, Society and Development (GPMEAC) | --- | Subject(s) / Keywords: Application; Gamification; Mathematics; Technology; Teaching. |

*DESENVOLVIMENTO E IMPACTO DE UM APLICATIVO MÓVEL COMO FERRAMENTA EDUCATIVA DE APOIO À CONTRACEPÇÃO*

| Author(s) | Date | Document Type | Source (and Institution) | Descriptors in the title | Content Representation |
|---|---|---|---|---|---|
| Isaias Jose Ramos de Oliveira | 2016 | Master's Dissertation<br><br>**Advisor**<br>Zilma Silveira Nogueira Reis<br>**Co-advisor**<br>Mario Dias Correa Junior<br><br>Scientific Field<br>Technology applied to Women's Health | *Repositório Institucional da UFMG* (UFMG) | --- | *Assuntos: Métodos contraceptivos; Controle de natalidade; Atividades educacionais; Planejamento familiar; Aplicativos* mobile.<br>[Subjects: Contraceptive methods; Birth control; Educational activities; Family planning; Mobile apps.]<br>*Assunto: Anticoncepção; Jogos de video; Saúde da mulher; Educação em saúde; Tecnologia educacional; Serviços de planejamento familiar; Medicina; Recursos audiovisuais.*<br>[Subject / Keywords: Contraception; Video games; Women's health; Health education; Educational technology; Family planning services; Medicine; Audiovisual resources.] |

The analysis of the Table 1 enables us to conclude:

1. The documents of the corpus of analysis **Date** from 2016 to 2019 (2 out of the total 8 in each year).
2. Only 3 documents have one **Author** alone (1 "PhD Thesis" – Gomes, 2018; and 2 "Master's Dissertation" – Rodrigues, 2017; Oliveira, 2016), and only one author has more than one document (Gomes *et al*, 2019; Gomes, 2018).
3. The most prevailing **Type of Document** is the "Research article" (3 out of 8, i.e., Gomes *et al*, 2019; Massário *et al*, 2019; Marinho *et al*, 2016), followed by the "Master's Dissertation" and the "Work for Course Completion" (2 documents each – Boarin, 2018; Domingos Filho & Vale, 2017), and 1 "PhD Thesis".
4. The most represented **Source** is the "*Repositório Científico de Acesso Aberto de Portugal* - RCAAP" (with 3 documents, namely 2 Research articles and 1 Master's Dissertation), followed by the "Research, Society and Development / GPMEAC" and the "*Biblioteca Digital de Monografias da UNB* / UNB" (2 documents each, respectively Research articles and Works for Course Completion), and 1 "*Repositório Institucional da UFMG* / UFMG" (1 Master's Dissertation); all documents except 3 are originally indexed in institutional repositories (the exception being the Research articles, which are originally indexed in the corresponding journal's platform).
5. The 3 **descriptors** used for the definition of the corpus in the OASISBR advanced search, are not combined in any of the document titles – *"gamificação"* appears in the title of 3 documents (Massário *et al*, 2019; Gomes, 2018; Rodrigues, 2017), *"adultos"* in another 1 (Domingos Filho & Vale, 2017), and *jogo* (the singular noun of *"jogos"*) in yet another 1 (Boarin, 2018); the remaining 3 documents do not include in their title any of the descriptors used; moreover, "gamification" is listed in all except one of the documents' content representative **words** (Oliveira, 2016), and in 4 of the documents' metadata. They are also indicated in English (in the other 4 documents' metadata, those words are only indicated in Portuguese).
6. The scientific field, when included as metadata, offers 5 documents, all of an academic nature – (2 Master's Dissertation, 1 PhD Thesis or 2 Work for Course Completion: Boarin, 2018; Domingos Filho & Vale, 2017; Gomes, 2018; Rodrigues, 2017; Oliveira, 2016). These point to the following: "*Engenharia de Software*" (Software Engineering); "Distance Education and Elearning"; "*Desenho Industrial - Programação Visual*" (Industrial Design - Visual Programming); "*Design e Desenvolvimento de Jogos Digitais*" (Design and Development of Digital Games); "Technology applied to Women's Health" – that is, a prevalence on areas of the exact sciences and technology is perceived on 4 of these documents.

The mere exercise of recovering and analysing the OASISBR and main repository metadata, as retrieved and systematised in Table 1, points to the following further conclusions, which corroborate those of Cardoso (2019), among others:

1. The information available in the OASISBR document description is not always the same for each document, as the metadata in each main repository might be different (i.e., it may vary from repository to repository) – e.g., subject(s) and/or keywords;
2. The information available through the OASISBR does not always match the information available in the document's main repository – e.g., the scientific field can be reached only in the main repository metadata.

It also provides evidence that in some cases it is only by observing at the main original repository metadata that we can get access to the documents' content representative words, which, according to the repository, can appear under the label "*assunto*" (subject) or "*palavras-chave*" (keywords). Consequently, we decided to list in black the content representative words provided by OASISBR itself, and in grey those provided by the document´s main repository. Besides, a translation is indicated in brackets, when the corresponding terms in English is not provided through the documents' metadata.

Another important conclusion that emerges from the analysis of the documents' titles and their content representative words is the fact that in two cases the focus may not be the perspective of the adult learners (cf. Marinho *et al,* 2016; Rodrigues, 2017), which we had not anticipated. However, at this stage of the research analysis, we decided to keep the corpus as it was, namely as results came in the OASISBR search previously described, and not narrowing it down to six documents. More conclusions can be withdrawn from an in-deeper exploratory analysis of the corpus, inspired by some the categories of the MAECC®, as will be presented in the next section.

## Meta-interpretation, discussion of the data and knowledge mapping

In addition to the three descriptors used in the advanced Boolean search – as already mentioned: *"jogos"* (games), *"gamificação"* (gamification) and *"adultos"* (adults) – the content representative **words**, as we named them reporting to the document's subject(s) and/or keywords, are quoted in Table 1 exactly as they are shown in the OASISBR and/or main repository metadata description. By analysing those 28 words (18 from the "Subject(s) / Keywords" or "Keywords" OASISBR metadata, and 10 from the "Keywords" or "Subject" original repository metadata), we only recognise one common term/concept, that of *"gamificação"* (gamification). Then, with further analysis, we observe that the most prevailing words are those represented in Chart 1, presented below – each mentioned twice, whereas *"gamificação"* (gamification) is mentioned seven times. Moreover, the majority is collected from the OASISBR metadata ("Distance Education" and "Higher Education" were only accessed from the main original repository when directed there; thus, these two words are not cited in full capital letters). Still, if we further analyse, by comparing the words from the metadata with those of the documents' titles, again the only the common word is *gamificação"* (gamification), but this is solely included in three titles (Massário *et al*, 2019; Gomes, 2018; Rodrigues, 2017). Besides, and considering the set of the eight words that most prevail, only three of them – "application/app", "digital games", "technology" – seem to be more connected to the areas of the exact sciences and technology. However, we had identified, from the scientific field, when indicated in the metadata, four documents (Boarin, 2018; Domingos Filho & Vale, 2017; Rodrigues, 2017; Oliveira, 2016) pertaining to those areas or domains.

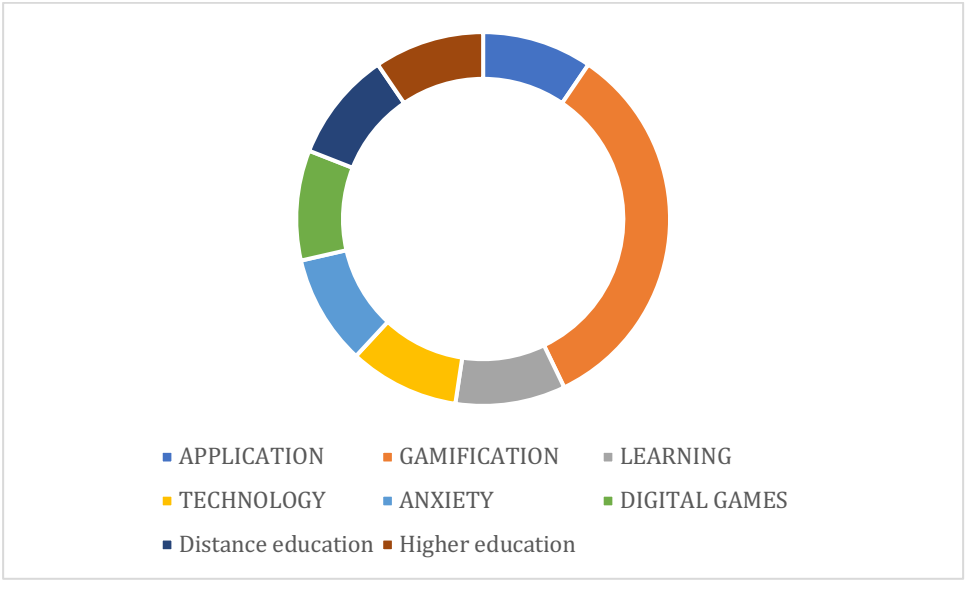



**Chart 1. Total number of prevailing terms/concepts in the words' metadata of the analysed documents**
[The data was collected for this study.]

As acknowledged in the previous paragraph, gamification is the predominant word, but is this concept defined, for instance, in the abstract of the documents? That is not the case in Rodrigues (2017), who does refer to gamification (15 times) albeit not defining it, nor identifying there whose authors his perspective on this key concept was inspired from; the same can be observed in the abstracts of Boarin (2018), Gomes (2018), Marinho *et al* (2016) and Oliveira (2016), the difference being that they only refer once to the word gamification; Massário *et al* (2019) also mention gamification (three times) on their abstract, without defining or characterizing it. In the abstract of Gomes *et al* (2019), the word gamification is not used (the adjective "gamified" is mentioned twice, and the noun "game" once). On the contrary, Domingos, Filho & Vale (2017) state that "Gamification is a modern approach that seeks to insert game mechanisms in a non-game situation, which can make an activity more motivating". This "modern approach" that Domingos, Filho & Vale

(2017) refer to, in their abstract, is a feature that other authors have been highlighting in their research abstracts too. Assunção (2018), for example, includes gamification in "a set of new teaching strategies that promote student learning". Moreover, he states that:

> *gamification has been presented as a powerful tool that can be used in several contexts, namely in Education. Gamification means the use of game elements in non-game contexts. It's a concept that reflects motivation, engagement, gameplay, reward systems and collaborative teaching. It makes the classroom more innovative and interactive where students become active agents of the teaching-learning process.*

A similar understanding can be read in the abstract of Silva (2019), since he states that:

> *The gamification concept more often found in the literature and more widely accepted refers to the use of game design elements in non-game contexts, targeting an audience that uses them to acquire certain knowledge (Deterding, Dixon, Khaled, & Nacke, 2011). In that sense, gamification is applied in different areas, including education, and may be used as tool to enhance students' Motivation (MOT), Flow (FLO), Attitude (ATT) and Perceived Learning (PLE), allowing for significant improvement of the teaching/learning process. It has been used in different fields of knowledge, such as marketing, medicine, sports, engineering, mathematics, computing, history, languages, physics, chemistry, biology, among others.*

Taking again into account the documents of our corpus of analysis, we can identify through metadata and abstracts that education also plays a central role. The role could be either in setting a broader context (e.g. "Higher Education", as in Gomes *et al*, 2019; "Educational Activities", as in Oliveira, 2016), or in focusing on specific contexts (e.g. "Youth and Adult Education", as in Domingos Filho & Vale, 2017; "Health Education", as in Oliveira, 2016). In reaching this conclusion, we are bearing in mind the theoretical roots of the key concept gamification,

other than the exact sciences and technology. We could add the psychology field too as an important scientific domain within the research presented in the documents of our corpus of analysis. We can see that a cognitive-behavioural branch may emerge from the "anxiety" word, mentioned twice in the "subject" metadata of Boarin (2018) – cf. "Anxiety disorder" and "College [university] students - anxiety".

Analysing once more the prevailing terms/concepts in the documents' content representative words metadata (Table 1 and Chart 1), a visual systematization can be provided as represented in Figure 4.

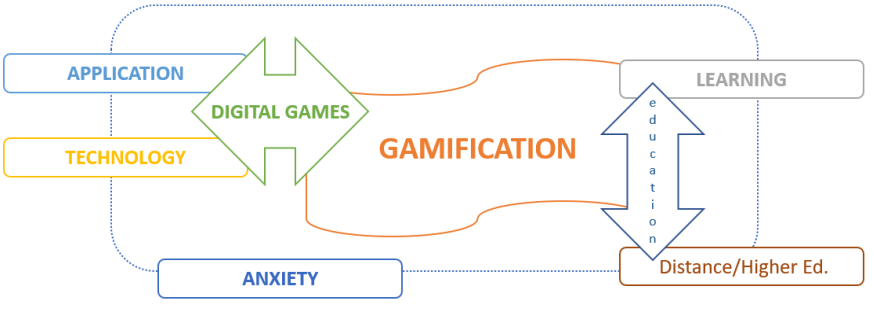



**Figure 4. Conceptual map drawn upon the prevailing terms of the analysed documents' words metadata.**
[The data was collected for this study.]

It is worth noting that in Figure 4 it was meant to weave a hierarchical network of possible relations between the meta-analysed concepts, from the central and fundamental term "gamification". Although this visual representation may seem elementary, the content from which it was drawn, because it is complex, admits other interpretations that can be intertwined in a later study. This could be in a new (re)design of the conceptual map on games and gamification from the perspective of the adult learners. Such a design may apply different tools to present it (e.g., by using CmapTools, LucidChart, Mindomo, or similar resources).

Although not all of the categories of the MAECC® were considered in this exploratory study, there is no doubt that the analysis of the conceptual contributions of the documents of the corpus alone can still

be further explored. On the one hand, this can be explained by the richness of such literature reviews and knowledge systematisations: on the other hand, it could be by the demanding efforts they entail. Another argument is the diversity of the metadata included in each of the repositories aggregated by the OASISBR, as well as the diversity of the norms of presenting institutional/scientific works (i.e., the metadata description), even within a single main repository. In any case, the stimuli they provide for imminent research is indisputably clear; some of these possible future directions will be pointed out together with the concluding remarks provided in the final section of the text.

## Final remarks and further research

As recognised in the previous paragraph, not all of the dimensions of the MAECC® were dealt with in this text. However, the research question defined for this study – Games and gamification in education: what does Portuguese research tell us from the perspective of the adult learners? – led us to some conclusions, which we intend to further inform and complement in a follow-up study of our preliminary and exploratory research.

Indeed, it revealed topics that need an in-depth analysis; in other words, we ended up with extra questions that can motivate future research. For example, the perspective of the adult learner is not explicitly evidenced, as it was initially anticipated and expected. But again, this could have been predicted already from the moment when it was realised that the word "adults" was just mentioned once, if we only bear in mind the documents' title and keywords (cf. Domingos Filho & Vale, 2017).

So, with regard to the adult learner, how can/should we define it? Which layers and how many of them does this concept actually include/exclude? We can read that "[d]uring past years, gamification has become a major trend in technology, and promising results of its effectiveness have been reported. However, prior research has predominantly focused on examining the effects of gamification among

young adults, while other demographic groups such as older adults have received less attention". (cf. Koivisto & Malik, 2020).

From our exploratory analysis and mapping of the concept of gamification, as presented before, it can be highlighted that it emerges mainly as a very recent research trend, with a strong link to technology, corroborating the previous quote. This can also resonate with the account of Pinto & Cardoso (2019), when they conclude that "the gamification of learning is a trend, […] an inevitable and irreversible path, especially if we consider the potential of the application of artificial intelligence to digital games."

And, as such, it is important to continue to explore the knowledge mapping on games and gamification in education, approaching its contributions to educational theory and practice from the perspective of the adult learner (young and older). In short, due to its many potentialities, it is hoped to further contribute to the knowledge on this subject. The hope is that it can be useful for the different educational actors who are using, or who are willing to use, games and gamification. This particularly applies to teachers who want to improve their pedagogical practices, grounded on evidence-based recommendations.

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# Konnecting: a Mobile Game to Introduce Undergraduates to the Evolution of Communication

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## Introduction

First year undergraduate students are dependent on their mobile devices and are constantly using them. These students belong to a generation called the "thumb generation" (Rheingold, 2002), digital natives (Prensky, 2010), homo zappiens (Veen & Vrakking, 2006), amongst other designations. They like to play games and they are used to being online, to participating actively in social networks, to multitasking, to sending SMS and MMS, to be connected all the time, and so on. They need challenging digital interactive activities to learn through their mobile devices as they are used to, particularly with online games (Douch, Attewell, & Dawson, 2010; Gee, 2003; Hamari et al., 2016; Orr & McGuiness, 2014; Laurillard, 2011; Squire, 2011).

Different skills can be learned with video games, for example: persistence; cognitive and motor skills, as games improve attention, focus, and reaction time; problem solving; decision making; dealing with success and failure, among others (Connolly et al., 2012; Gee, 2003; Hamari et al., 2016; Orr & McGuiness, 2014; Squire, 2011, Zimmerman, 2008). The different type of skills to be learned also depends on the type of game and gameplay characteristics.

Many lecturers realised that students are changing. It is getting more difficult to get them engaged in learning. Due to the increased

popularity of games among students and the use of mobile devices, a research project called "From Games to Mobile-Learning Interactive Activities" (PTDC/CPE-CED/118337/2010) was developed. This project intends to (i) characterise students' game preferences and habits, (ii) to identify the most played games by students in articulation with the learning principles, proposed by Gee (2003), and the game mechanics, (iii) to create a mobile game and to evaluate its effect on learning as well as on students' engagement (Carvalho & Araújo, 2016; Carvalho et al., 2014a). This paper focuses on the reactions of undergraduate students about learning the course content using a mobile game. A game called Konnecting, about the evolution of human communication, was designed as a course introduction for freshmen enrolled in an undergraduate program on Education Sciences.

For a better understanding on this research, data collected about students' game preferences and game habits will be presented. The game developed – Konnecting: The evolution of human communication – will be described in detail. Finally, findings based on students' reactions to the use of the mobile game *Konnecting* as well as the learning results achieved by them will also be analyzed.

## Game Preferences and Habits of Portuguese Higher Education Students

To develop a mobile game for higher education students, the following research question was addressed: Which are higher education students' mobile game preferences and habits? The study involved a survey (Babbie, 1997) conducted in Portugal in 2013. Data was collected with a questionnaire, available online, that included four dimensions: (i) students' characterization, (ii) game habits, (iii) game preferences, and (iv) learning course content through games.

From 1101 respondents to the online questionnaire, 626 (56.9%) were mobile game players, 263 male (42%) and 363 female (58%). The results indicated that the games most played by Higher Education students are essentially casual and puzzle games, with existing differences

between female and male students' preferences (Carvalho et al., 2014b), as represented in Table 1.

**Table 1. The most played games by gender**

| Ranking | Female | Male | Total |
|---|---|---|---|
| 1 st | Candy Crush | Angry Birds | Candy Crush |
| 2 nd | Angry Birds | League of Legends | Angry Birds |
| 3rd | The Sims | Football Manager | The Sims |
| 4th | Bubbles | Pro Evolution Soccer | Bubbles |
| 5th | Fruit Ninja | Flow, Hill Climb Racing | Flow, Fruit Ninja, Solitaire |

From a total of 177 games indicated, the top five games played are *Candy Crush*, *Angry Birds*, *The Sims*, *Bubbles*, and ranking in 5th place are *Flow*, *Fruit Ninja* and *Solitaire*. *Candy Crush* was the game with more downloads in 2013, according to iOS App Store and Google Play. Moreover, four of the games most played by Portuguese students belong to the world ranking, namely: *Candy Crush*, *Angry Birds*, *Fruit Ninja* and *Hill Climb Racing*. Male students prefer sports games, particularly football (*Pro Evolution Soccer* and *Football Manager*). These are long games, with clear goals and they demand effort (*League of Legends*, *Pro Evolution Soccer* and *Football Manager*). They like behaviours and interactions with limited time and space. Female players prefer short game matches and good rewards. They like to be recognised by the system and by other players (*Candy Crush*, *Angry Birds*, *Bubbles* and *Fruit Ninja*).

Students spend an average of 4.2 hours per week playing, but male students play more time (5.4 hours) than female students (3.4 hours). They were asked about the game characteristics that kept them playing and results are shown in Table 2 and commented afterwards.

**Table 2. Game characteristics that keep players engaged**

| Characteristics | Important/ Very important (%) | Less important (%) | I don't know (%) |
|---|---|---|---|
| Gameplay | **94.4** | 2.6 | 2.9 |
| Scenarios | **71.9** | 27.0 | 1.1 |
| Graphic effects and animations | **67.6** | 31.3 | 1.1 |
| Sounds | 39.9 | **58.6** | 1.4 |
| Music | 37.7 | **61.0** | 1.3 |
| Story | **64.5** | 33.9 | 1.6 |
| Characters | **65.8** | 32.7 | 1.4 |
| Long game | **62.6** | 34.3 | 3.0 |
| A game with several levels | **71.6** | 26.0 | 2.4 |
| Improving scores | 49.4 | 47.9 | 2.7 |
| Playing with others | 47.8 | 48.6 | 3.7 |
| Playing with others online | 37.1 | **58.0** | 5.0 |
| My friends play this game | 37.5 | **56.5** | 5.9 |

Players like to play or keep playing a game due to its gameplay[1] (94.4%), scenarios (71.9%), the existence of several levels (71.6%), and graphic effects and animations (67.6%). Other attracting features include game characters (65.8%) and their story (64.5%). With similar percentage they give preference to long games (62.6%). The players considered the music (61.0%) and the sounds (58.6%) not to be as important. Playing with others online (58.0%) and the fact that friends play the game (56.5%) is also not as important in keeping them playing. Finally, with a similar distribution (with less than 50%) between important/very important and less important, are the characteristics "improving game scores" and

[1] Gameplay is the specific way in which a player interacts with the game. It is based on the game rules, challenges, plot, etc.

"playing the game with others". Social variables seem to be of little relevance to higher education students. Most of the students prefer to play a game alone (71.6%), 82.1% female and 57.0% male. Those who prefer to play with others online (28.4%) prefer to play in teams (18.2%) and most of them are male.

Finally, students were also asked if they would like to use games to learn course contents and most of them answered positively (78.12%), 78.5% female and 77.6% male.

After the analysis of the favorite games and the identification of the learning principles (Gee, 2003) and game mechanics (Adams & Dormans, 2012), the following components were identified to be included in mobile games for higher education: the *context* (has to be related to the course content), the tasks or *missions* to be solved, the *levels* (game progression), the *feedback*, the *leaderboard*, and the "affinity group"[2] (Carvalho et al., 2014b; Carvalho et al., 2015). The research team designed and developed the game *Konnecting* for mobile devices aimed at undergraduate students, which is described on the following section.

## The Mobile Game Konnecting

The mobile game *Konnecting: the evolution of human communication* was developed at the Faculty of Psychology and Education Sciences at the University of Coimbra, in 2015 (Carvalho et al., 2015). Komuniket, an extraterrestrial character, has to collect information about communication behaviour and practices of Earth inhabitants (Figure 1) (the *context*). On Earth, he travelled in time. He took pictures from prehistoric times up to the selfie stick, but he needs help to understand them (*mission*). He invites the student to help him. The game has two levels: Kronos and Themating Zapping (Figures 2 & 3). The latter is available once the player finishes the 82 Kronos tasks.

[2] The expression "affinity group" is described by Paul Gee [5]: "Learners constitute an 'affinity group', that is, a group that is bonded primarily through shared endeavors, goals, and practices and not shared race, gender, nation, ethnicity, or culture." (p. 212).


Figure 1. Konnecting


Figure 2. Kronos menu

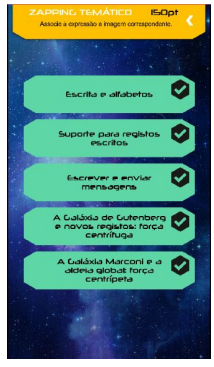


Figure 3. Thematic Zapping menu

The Kronos menu is divided into seven stages (Figure 2) and each stage has several images to be identified, which are organised chronologically. When facing an image, the player has to decide in three seconds (counted by Komuniket's fingers - Figure 4) if he/she wants to read a short explanatory text about it or go to playing straightway. The task consists of selecting three keywords out of six to characterise the image (Figure 6). The student has a minute to solve the task.

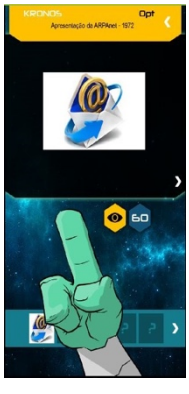


Figure 4. Example of a task in Kronos


Figure 5. Explanatory text about the image in Kronos


Figure 6. Task in Kronos: select three appropriate keywords

When reading the information available (short explanatory text) the time is not counting (Fig. 5). As the time for completing the task runs out or considering the player finishes it in time, he/she gets the feedback about each keyword selected, with visual effect and sound.

The Thematic Zapping (Figure 3) is only unlocked when the player finishes Kronos. This second level has five thematic crossings, inspired in the principles of the cognitive flexibility theory (Spiro et al., 2003). For example: "Writing and alphabets" or "The Marconi Galaxy and the Global Village". The player has access to a small theme contextualization text (Figure 7), then, according to an expression or term presented, the player should select the appropriate image from four available (Figure 8).

*Feedback* is presented through graphic effects as well as whenever the player performs a task. In Kronos, according to each image, the three selected words are validated and points will be added; in the Thematic Zapping the selected image is validated, also scoring points.


**Figure 7. Contextualizing the Thematic Zapping**


**Figure 8. Example of task in the Thematic Zapping**

The game has several *Leaderboards*: total, only Kronos, only Thematic Zapping and every stage of Kronos and each thematic crossing in Zapping (Figure 9). Thus, players in the class where they are registered know the position of the top five in each type of leaderboard as well as their related position, if not part of the top five. This information is intended to be stimulating for the players, challenging them to improve their scores in this affinity group.


**Figure 9. Leaderboard (Total)**

## Methodology

The study based on the serious game *Konnecting* considers two research questions: (i) Will undergraduate students be engaged in learning an introductory module course through a mobile game? and (ii) Do they learn through the mobile game "Konnecting"?

A quasi-experimental study was conducted [19] with a single group. Two questionnaires were developed, one for the sample characterization and the other about users' reactions to the mobile game. The questionnaires were filled in online. A knowledge test was applied before playing the game (pretest) and after the game (posttest). The study was conducted in October 2015.

The sample included 26 undergraduate students (1st year) of an Education Sciences degree program, enrolled in the course Communication Processes and Education. All participants were female, with ages between 18 and 21 years old. The mode was 18 years old. The participants (84.6%) like to play games on their mobile devices and are used to downloading games onto their mobile devices (80.8%). However, only 15% have ever learned new curricular concepts by using a digital game. Most of the participants (69%) have an Android mobile device, which is the system needed to play the game. After the students filled the sample characterization questionnaire and the knowledge test (pretest), they downloaded the game and signed up.

Once students finished playing the game, a Knowledge test (posttest) was applied. Finally, they filled in the questionnaire about users' reactions to the mobile game.

## Student Learning and Reactions to the Mobile Game *Konnecting*

The knowledge test results achieved show evidence of learning from pretest to posttest (Table 3). The knowledge test has 29 questions and 26 students took both tests.

**Table 3. Knowledge tests results – descriptive statistics**

| Tests | Mean | Standard deviation | Minimum | Maximum |
|---|---|---|---|---|
| Pretest | 16.42 | 3.870 | 10 | 22 |
| Posttest | 25.00 | 3.533 | 16 | 29 |

Through the non-parametric Wilcoxon ranked test, the results are statistically significant (Table 4). Students learned with the game Konnecting. Most of the students (69.2%) found it easy to install the game. They had no problem in registering in the game. All the students (n=26) liked the game. They also liked the story and the invitation to help Komuniket (the avatar) (92%).

All students indicated that they learned with Kronos. The game provided curiosity for 71% of the students who wanted to know more about the game subjects.

**Table 4. Wilcoxon ranked results**

| Tests | | N | Mean Rank | Sum of Ranks | Z | Asymmetrical Significance |
|---|---|---|---|---|---|---|
| Posttest-Pretest | Negative ranks | 0 | .00 | .00 | -4.467 | .000 |
| | Positive ranks | 26 | 13.50 | 351.00 | | |
| | Ties | 0 | | | | |
| | Total | 26 | | | | |

In the game, the hand of the Komuniket appears to show the discount of 3 seconds so that the player can decide if he/she wants to read the informative text about the image. Most students (88%) enjoyed this feature as it was a way to interact with the game and to decide what to do. One student mentioned that she did not like it because it caused her stress and two students selected the option 'Others', saying that "*It was fun, but we were always afraid to not click on time*" (ID15) and "*We should have a bit more time to decide*" (ID25).

All the students agreed that only after playing Kronos should students play the Thematic Zapping, in order to first understand the importance of human communication. Checking the leaderboard was stimulating for 73% of the students.

They liked the game dynamics, the graphic design, the sounds used, the explanatory texts related to each image in the Kronos, and learning in a fun way. Most of the students considered that the game is interesting, and it is a good way to study the contents of the course. One student stated: "*it is a great teaching and learning method*" (ID12). Two students considered the game fun and pedagogical. One student wrote:

> *At first, when the game was presented in class and as it was a mandatory element of the assessment method used in the course, my first impression was not the best, because I thought that the game would not provide us with great knowledge and that it would be a waste of time (…) However, after downloading it (...) my enthusiasm changed. It became a competition and a nice way to learn"*
>
> (ID14).

Students got engaged in the learning process. The game provided curiosity for 71% of the students who wanted to know more about the subjects in the game. "Learning through Konnecting was somewhat curious and fun! I learned a new subject in such an "informal" way which is much more pleasurable than having extensive lectures that sometimes only get us tired and bored" (ID12). Another student stated: "I liked the motivation that the game creates. It is a simple way to catch the attention, considering each student's learning needs" (ID24).

Students referred that the game was fun (65%), they learned a lot in a short period of time (58%). However, two students mentioned that they would have preferred to do a project or have lectures instead of the game.

Besides the 26 participants, 8 students had positive results but did not sign up for playing the game. They were inquired. They had studied

the content of the game through printscreens made by a colleague who was playing the game. That was a surprise. They preferred, due to several reasons, to read printscreens of the game rather than to play the game. Some had difficulty in installing the game or they did not have an Android device, but guidelines about how to install an emulator were provided. Further research is needed to understand this generation of students.

## Conclusion

A mobile game, *Konnecting*, was developed to present course content in a more engaging way, due to the interest of students on digital games. However, some students were not interested in playing or they did not take both tests (pretest and posttest), which was important for the research.

The two research questions had positive answers. Students learned through playing the game and the knowledge test results were statistically significant. All of them liked the game and they reported that it is a good way to study the contents of the course. They got engaged in the learning process.

Due to the fact that eight students did not play the game but had positive results (between 60% and 80%) they were inquired about this result. Surprisingly they had access to the game printscreens, instead of playing. This was unexpected. New questions emerge after this study: Will students who like to play games like learning with the mobile game *Konnecting*? Will the students who usually do not play games prefer traditional methods of studying instead of a game-based learning? How much of game-based learning do students find interesting/beneficial, before they prefer direct exposition to the content or other learning approaches?

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# Milage Learn+: a gamified Learning Platform for the digital transformation of adults

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## Introduction

This chapter shows the uses of MILAGE LEARN+ platform that were developed for smartphones, tablets and computers to provide activities that students can do in the classroom, online, anytime, anywhere. It is explored with the INCOLLAB "Industry 4.0" course that is used for CLIL and interdisciplinary learning in Higher Education.

The MILAGE LEARN+ learning platform enables teachers to become authors of resources that are made available to their students, who solve activities that were made by their teachers. Students are helped by the presentation of educational videos with the activity's solutions. Students can use the platform in the classroom or outside the classroom in a blended learning model to learn. When students have difficulty in solving a task, they can watch its solution.

The MILAGE LEARN+ platform uses gamification to motivate students and implements self- and peer-assessment that aims to stimulate students' autonomous work.

## Gamification

Gamification contemplates a technology transformation so that it becomes more "game-like", involving "similar positive experiences and motivations that games do (the 'gameful' experience)" and promote behavioural change (Högberg, Hamari, & Wästlund, 2019, p. 620). This strategy seems more effective with contemporary students or so-called "digital-natives", and they have more sensibility to react accordingly, even in a non-game context. The 'nowadays society' is facing a "cultural shift powered by the technological development of more 'gameful' experiences in people's lives and society" (*ibidem)*. Gamification has been one of the bets made in education of the 21st century. The theory is that it can influence directly the changing process of learning and also affect indirectly the motivation (Wouters & Van Oostendorp, 2017). In general, gamification is based on three objectives: to motivate, commit and reward (Lee and Hammer, 2011). In education, gamification has great potential to motivate students to learn. Gamification may be able to motivate

students to learn in a deeper, more engaged way, revealing an internalised, self-regulatory motivational style (i.e., intrinsic motivation).

Schools already have several gamification elements, where students get points for completing assignments correctly. These points translate into "badges", more commonly known as grades. Students are rewarded for desired behaviours and punished for undesirable behaviours using this common currency as a reward system. If they perform well, students "level up" at the end of every academic year. However, something about this environment fails to engage students, especially when the received feedbacks (i.e., grades) are not positive or satisfying for the students.

The gamification component is also present in the MILAGE LEARN+ app. It implements a scoring scheme that relates to solving tasks and assessments. There are four rankings: course, school, country and world. The student wins points when solving tasks. The student also wins points when self-assessing or when the student assesses their peers. This motivates students to do more tasks, to win more points.

Gamification can provide social credibility and recognition for academic achievements, which might otherwise remain invisible or even be denigrated by other students. We found out that students get motivated by the immediacy of real-time competition, which is not possible in traditional school grading, where the grades are available at the end of the month, quarter or semester. In the MILAGE LEARN+ platform there is real-time grading and the rankings are always available. The student sees the 10 best students in the four available rankings; this motivates students to perform better in order to integrate the ranking listing.

The scoring scheme implemented in the MILAGE LEARN+ platform directs students' energy, motivation and the sheer potential of their game-play toward learning. When students become higher scorers, this translates into learning achievements and better grades in school.

Figure 1 shows the national scores for school years 2016-2017, 2017-2018, 2018-2019 and 2019-2020, which shows a sustained increase, meaning that students are working more each year. This is what teachers want – that students work, enhance their intrinsic motivation and, in the end, gain better school grades.

2016/17

Top 10 Ranking — Global

| Rank | Nickname | Points |
|---|---|---|
| 1 | Ines | 3807 |
| 2 | João C. | 2634 |
| 3 | João Lopes | 2529 |
| 4 | Araujo | 2357 |
| 5 | GoncaloJ | 2333 |
| 6 | JoaoF | 2184 |
| 7 | PedroAzevedo | 2105 |
| 8 | bernardoquinteiro | 2102 |
| 9 | Bia g. | 2076 |
| 10 | miltonrosa | 2004 |

2017/18

Top 10 Ranking — Global

| Rank | Nickname | Points |
|---|---|---|
| 1 | Ema Sakamoto | 7649 |
| 2 | Megui | 7521 |
| 3 | Madalena | 6614 |
| 4 | Henrique | 6076 |
| 5 | ASM | 5846 |
| 6 | Ines | 5330 |
| 7 | Joana | 5256 |
| 8 | danielzinho | 5215 |
| 9 | Andreia Horta | 5158 |
| 10 | vitoria araujo | 4686 |

2018/19

10 Melhores — Matemática

| Classificação | Nickname | Pontos |
|---|---|---|
| 1 | Rafael Pereira | 18859 |
| 2 | Jose | 17004 |
| 3 | Ines | 14885 |
| 4 | ines afonso | 13041 |
| 5 | Vitoria Araujo | 10328 |
| 6 | Mafalda Jesus | 10034 |
| 7 | Clara | 8541 |
| 8 | PedroAzevedo | 7206 |
| 9 | Marta S. | 6235 |
| 10 | Joana | 6044 |

2019/20

Top 10 Ranking — Matemática

| Rank | Nickname | Points |
|---|---|---|
| 1 | Taveira | 23546 |
| 2 | joaoalves30 | 22966 |
| 3 | guizadodosptes | 19875 |
| 4 | Inês Barras | 18936 |
| 5 | Diogo Silva | 18570 |
| 6 | Frida | 14657 |
| 7 | zeluis | 14160 |
| 8 | eric | 13854 |
| 9 | Matilde G | 13774 |
| 10 | Rodrigo 2 | 13639 |

**Figure 1. National scores for school years 2016–2017, 20172018, 20182019 and 20192020.**

## Milage Learn+ Learning Platform

The MILAGE LEARN+ learning platform implements a pedagogical model developed to motivate students and promote active, student-centred learning: it provides greater autonomy and different learning styles in a gamified environment, with educational videos that aim to reach all students (Figueiredo *et al.* 2016). Therefore, the App offers a gamified structure designed to promote students' engagement and learning, with self-assessment and peer-assessment strategies that induce an immediate feedback, increasing a more internal self-regulatory approach. With the purpose of reaching students with different learning-profiles, i.e., low achievers as well as high performance students, the App makes available activities and tasks that have various degrees of difficulty. The platform provides both the MILAGE LEARN+ app and the MILAGE LEARN+ TEACHERS application.

The MILAGE LEARN+ app is the student application. It is available for Android, iOS, Windows, OSX and Ubuntu. With this app the student access course contents. The application MILAGE LEARN+ TEACHERS allows the teachers to follow the work of students and promotes the development of a sharing community of teachers and student authors. In this way, it enhances the development of personalised resources and soft skills that translate into new pedagogical practices. The MILAGE LEARN+ TEACHERS application is available for Windows, OSX and Ubuntu. Both are available for free.

## Teachers as Authors

The MILAGE LEARN+ learning platform enables teachers to become authors of resources that are made available to their students. The teacher becomes a producer of contents that they create using the application MILAGE LEARN+ TEACHERS. This chapter shows the example of a Higher Education course about "Industry 4.0". The teacher author organises the course activities in chapters and sections. The teacher creates worksheets of activities With this application that include tutorials or activities to be solved by students (Figure 2). Each worksheet includes a set of tutorials or activities that relates to a section and chapter of the course. Activities can be exercises, problems or project tasks: for each activity the teacher provides criteria for classification for self- and peer-assessment, together with an educational video that provides the solution for the activity. Teachers can upload multiple choice, true or false, or open questions for students in any order; there is no limitation on this.

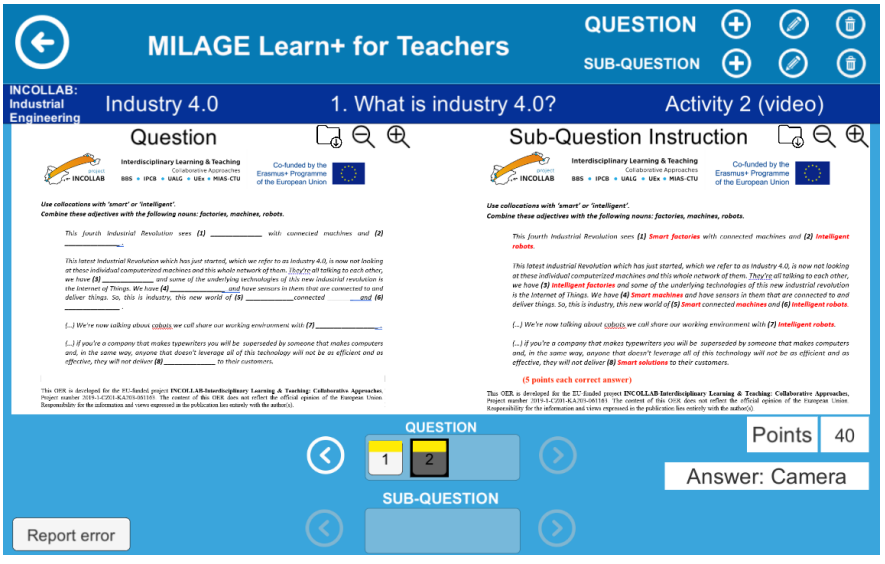


**Figure 2. national scores for school years 20162017, 20172018, 20182019 and 20192020.**

## Milage Learn+ App

Students use the MILAGE LEARN+ app on a smartphone, a tablet or a computer to solve worksheets of activities that were made available by the teacher. After the login screen, the student has the option to choose either the worksheet of activities to do or assess a peer (Figure 3). In this way, the student can study either by solving activities, including a self-assessment step, or by revisiting the contents when the student is assessing the work of another student.

Self-assessment allows students to take the initiative in learning, develop awareness of how they learn, evaluate their learning needs and undergo an inclusion process (Bransford, Brown, and Cocking 2000; Bourke and Mentis 2013). Inclusion of peer assessment contributes to the promotion of formative learning, fosters learners' independence, and promotes autonomous work and responsibility for the learning process (Badea and Popescu 2020).


**Figure 3. The student solves a worksheet of activities or assesses a peer.**

Each worksheet of activities relates to the course, chapter and section. After selecting the worksheet of activities, the student starts solving an activity (Figure 4). At this point, one task is shown at a time: in this case, the first activity is to watch an educational video tutorial, which is available when the student presses the button "concise video" (Figure 4).

The second activity is an open task. The student writes the solution with a pen and a paper and takes a picture by clicking the camera icon to turn on the camera of the mobile device to take a photo and upload it to the server for the student activity (Figure 5 and Figure 6).

This app combines analogue with digital. The student writes the solution with traditional tools, pen and paper, and later it is converted to a digital format and stored in the server. It is also possible for the student to solve the exercise by using the keyboard or uploading a pdf file, thus allowing the submission of project activities done by the student.

It is also possible to have multiple choice or true/false activities where the student selects the right answer in a very straightforward way and the app can automatically identify if the answer is correct or wrong.

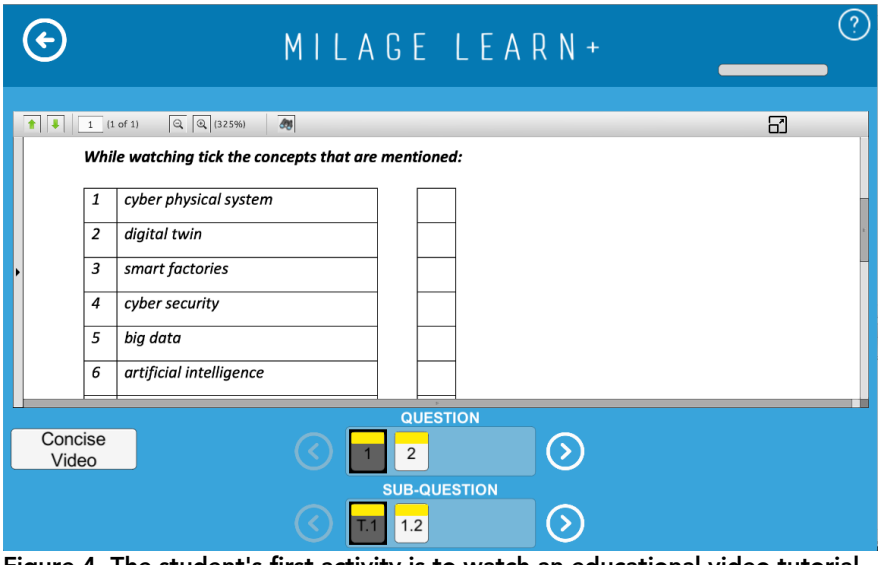


**Figure 4. The student's first activity is to watch an educational video tutorial.**

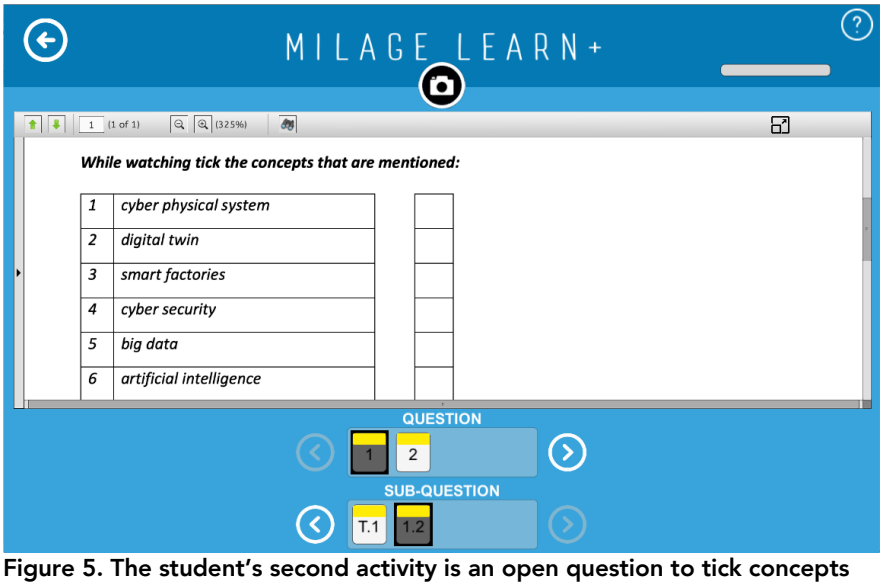


**Figure 5. The student's second activity is an open question to tick concepts presented in the educational video.**

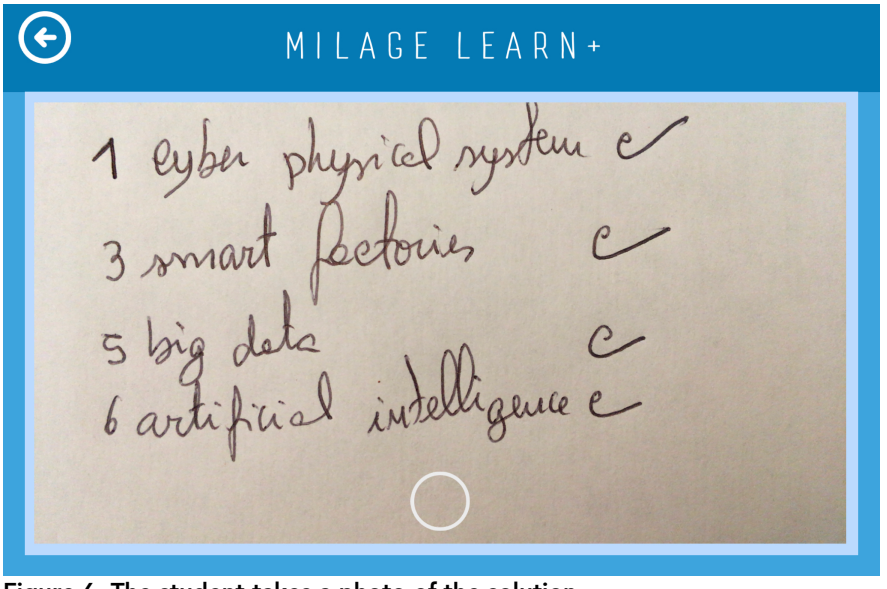


**Figure 6. The student takes a photo of the solution.**

Next, the student gets immediate feedback (Figure 7). The task solution is shown together with the instructions for self-assessment. When the student finds it difficult to solve the task, the student can watch the educational video with the solution explained by the teacher.

When the student finishes solving the worksheet and another student also completes the same worksheet, they are both ready to do peer assessment. Peer-assessing or peer review is anonymous: the student sees the solution of another student on the left side, as well as the instructions for assessment, and the student gives points to the peer as if in a game (Figure 8). In this way, the student is revising content that helps them to store knowledge in long-term memory.

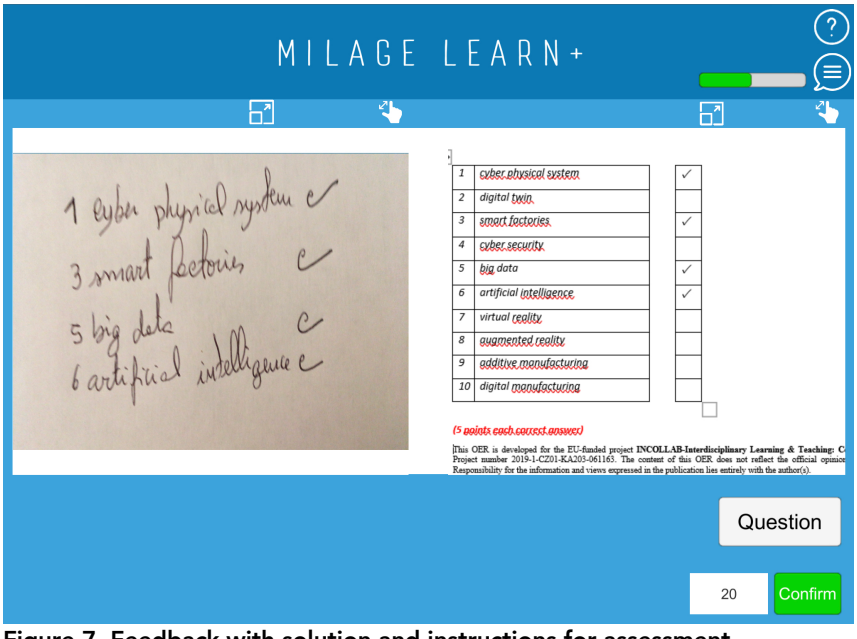


**Figure 7. Feedback with solution and instructions for assessment.**

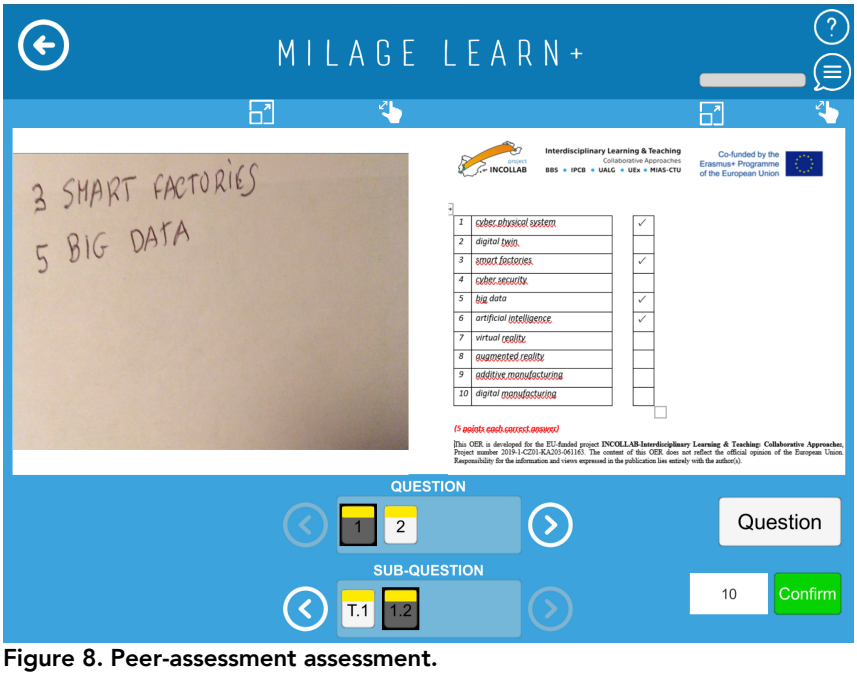


**Figure 8. Peer-assessment assessment.**

## Student e-Portfolio

The MILAGE LEARN+ platform automatically builds the student's digital portfolio. Student work is saved in the platform and a learning record is saved providing actual evidence of student achievement.

MILAGE LEARN+ TEACHER application offers the possibility to export an e-book that is a pdf file with the e-portfolio of the student, which is a way to generate learning as well as document learning, as both are important in the learning process (Basken, 2008).

The MILAGE LEARN+ TEACHER application also allows the teacher to follow student work in real time (Figure 9). The teacher can immediately see the work done by the student, which is particularly useful for synchronous online learning. The teacher can see in real time the student's answer to the activity and give additional feedback to the student. The teacher can also change self- and peer-assessment guidelines. The teacher application also provides graphical information about the class and student progress. It automatically compiles Excel files that teachers can use for formative assessment, in order to help students identify their strengths and weaknesses and to target areas that need work, thus addressing learning problems immediately.

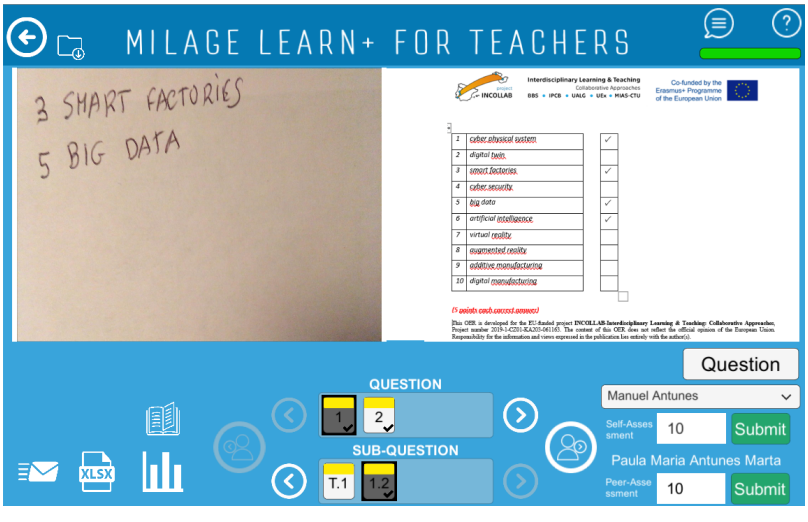


**Figure 9. The teacher can see the student work in real-time.**

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# Deal Me In: an inclusive lens on digital storytelling and game-based learning with young people and adults

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## Introduction

Technological development has caused a gradual but constant set of changes in the educational scenario over the past 20 years. According to Demartini and Benussi (2017) these changes can be related to four configurations of education: Education 1.0. in which the teacher is the main knowledge source, the learning process values lessons, essays, papers and tests, while technological mediation is done through an institutional learning management system (LMS); Education 2.0 is where the teacher is a guide or a consultant, learning is facilitated by the development of classroom projects, the student has an active role and collaboration is encouraged, but the institution's boundaries are maintained; Education 3.0 promotes the collaborative construction of knowledge through open activities developed in networks that value creativity, and innovation, while digital mediation is done through Web technologies that integrate a set of applications for different purposes. Finally, Education 4.0 is an emerging profile that provides for a greater symbiosis between people and technologies in flexible, customisable, adaptive, integrated environments without national, regional and institutional borders.

In these environments, skills such as creativity and innovation are mobilised and, according to the World Economic Forum (2020, p. 4): "Include content that fosters skills required for innovation, including complex problem-solving, analytical thinking, creativity and systems analysis". In this sense and, according to Almeida and Simões (2019, p. 122), "the Education 4.0 paradigm empowers students to define their model and pace of learning (…) technology is used to propel learning according to the specific needs of each student".

The World Economic Forum (2020, p.10) defined the four main characteristics of Education 4.0's innovative pedagogies: (1) playful includes free play, guided play, and games; (2) experiential integrates content into real-world applications; (3) computational supports problem-solving; while (4) embodied incorporates the physical body into learning through movement. These go together with a multiliteracy approach that focuses on diversity and the multiple ways in which language is used and shared and connects learning to cultural awareness.

The innovative pedagogies learning meets the principles of game-based learning, as will be discussed later. We believe that self-paced learning, flexibility and adaptability can contribute to remove barriers and increase the opportunity for access, inclusion and participation for all. Based on these assumptions, digital storytelling and game-based learning practices – developed for educational purposes with young people and adults in vulnerable situations – were analysed through an inclusive lens.

The inclusive and equity lens has been used by public entities, non-profit organizations and community associations to guide actions and decision-making, while one engages in:

- *Reflecting the needs of people with a range of experiences;*
- *Applying knowledge of [local]history (…);*
- *Finding a diversity of ways for people to participate (no one-size-fits-all),*
- *Understanding how and why exclusion happens, resulting in action steps.*

Simmonds, 2019, p. 4

According to the same author, the equity lens's main components: "Identify barriers where they occur; eliminate barriers by making adaptations that reflect the life experiences of those affected; create new ways of working by considering inclusion at the earliest stages rather than at the end" (idem, p. 4).

This chapter, after establishing preliminary considerations about the concepts of equity, diversity, inclusion and game-based learning, presents and analyses two projects that involve digital storytelling and game-based learning through the principles of an inclusive lens, followed by final considerations.

## Equity, diversity, inclusion and game-based learning

The universal right to Education and the principles of lifelong learning enable access for an increasingly diverse audience of young people and adults to learning in different contexts, with different objectives and at different stages of life. The Learning by Design framework (Cope & Kalantziz, 2015) recognises that learner-identities are diverse, complex and multi-layered, and that their differences should be taken into account. The authors also classify these differences as demographics ((1) material – social status, resources, relationship; corporeal – age, race, sex, abilities; symbolic – language, ethnos, gender) and as attributions from a life well-lived (life experiences, belonging, identity, dispositions, sensibilities, networks, interests, values, etc.).

In the diversity of these students' equity, conditions must be guaranteed (Kyriakides, L. et al., 2019) that materialise inclusion principles to promote social justice (Vincent, 2003; Santomé 2013; Sampaio & Leite, 2018). To accomplish this, it is important to create conditions that foster student involvement, based on their characteristics and different starting points, where interaction with their peers, reflection focused on the contents, and situations that are being worked on will be possible.

To provide equity, according to the City of Ottawa and City for All Women Initiative (2018, p.10), means that "they are given different

supports to make it possible for them to have equal access to the game" or even removing systemic barriers to participation.

There are several elements associated with the integration of games in education that favour inclusion and consider diversity. Hawkins at al. (2019) argue that digital learning games are interactive and customisable, and can contribute to provide access to a more diverse group of individuals. Games in Education also involves hands-on, immersive activities (Bartlett & Anderson, 2019); "goal-oriented tasks that target both real-world and non-real-world scenarios, players feel responsible for success (…) turning errors into learning elements" (Almeida & Simões, 2019, p.124); "potential social benefits in terms of creating a sense of closeness, friendship and belonging, especially when linking online and offline relationships" (Hanghøj, Lieberoth & Misfeldt, 2018); "a sense of autonomy and creativity, challenge, and purpose, safe opportunities to "fail", and incremental information about how much progress they were making towards achieving in-game goals" (Bolstat & McDowell, 2019, p.).

All of the above characteristics are in line with the concept of inclusion. Having this reference in mind, two projects involving games and digital storytelling with young people and adults in situations of social vulnerability were analysed. Game-based learning and digital storytelling: analysing projects and practices through an inclusive lens

## ReGap project

ReGap is an Erasmus+ project with the main goal of reducing the educational gap for migrants and refugees in EU countries through the development of open-access learning resources, and enhancing social belonging and inclusion. This intends to improve the terms of participation in the hosting society by promoting opportunities, the access to resources, and respect for rights (United Nations, 2016) – namely through knowledge and skills necessary to take part in employment, health, social security and schooling on an equal footing with EU citizens.

The project rationale is inspired in findings from a previous Erasmus+ project (Advenus) on the barriers to engagement in e-Learning, namely when resources are not deemed relevant and fail to engage with the learners' need for knowledge about vitally important life-sustaining areas. The project considered how language skills can impact on learning engagement, and the research about the role social belonging in massive open online courses (MOOCs), where it was found that the completion rate in online courses increases when learners experience some kind of social identity (Kizilcec et al., 2017).

Moreover, refugees and migrants are not a homogenous group, and ReGap wants to reach as many as possible. This requires e-Learning activities that are culturally and gender sensitive, that at the same time offer the opportunity to be delivered fully online (delivered through Moodle platform), but also face-to-face in blended mode for those who have lower ICT skills. It also requires cooperation with social and educational professionals that work within the scope of hosting institutions, programs and projects. Finally, ReGap actively supports learning by additionally utilising visual media such as digital narratives and visual signs as an integral part of the resources to overcome language barriers as much as possible.

Six online courses have been developed, covering Employment, Education, Health, Social Security and Welfare, Justice and Citizenship, and Gender as topics. The courses were trialled and evaluated by 300 refugees and migrants and 50 educators in 4 European countries (Norway, (North) Macedonia, Italy and Portugal).

A key concept in the project is (digital) storytelling, considering the importance to include the "voice" of adult migrants and refugees in all stages of the project: it argues that digital stories – featuring refugees and migrants, when used wisely and in context – may contribute to generating a feeling of social belonging and inclusion and foster the personal meaning of educational resources.

Digital storytelling can be defined in a broad sense, and embrace all stories – fiction and nonfiction – told with digital technologies

(Alexander, 2017). Still, a digital story is often personal, using the storyteller's own voice and "combines the art of telling stories with a mixture of digital media, including text, pictures, recorded audio narration, music and video" (Robin, 2016, p. 18).

According to Robin (2016), sharing stories with others "can promote gains in emotional intelligence, collaboration and social learning" (Robin, B. R., 201, p. 19). Also, Svoen, Dobson & Bjørge argue that "digital storytelling has several decades of tradition, and is also being used as a way of calling attention to migrants and refugees and bring forth their stories" (2019, p. 5). Moreover, digital storytelling can help to better deal with "episodes of conflict related to cultural, sociological and historical differences between diverse groups" (Rutta et al., 2019, p. 509).

In this regard, digital storytelling was used as a key concept and a pedagogical tool to create a feeling of social belonging in migrants and refugees. On one side, the research team has included in each of the educational resources a storytelling component, namely through short videos that link training content with daily life situations that migrants and refugees usually have to deal with in the hosting countries. These may contribute to their social inclusion, making the courses more relevant and promoting identification with these as well as a sense of social belonging (ReGap, 2019).

On the other side, all ReGap partners have conducted country-based workshops on digital storytelling; including refugees, migrants, and educators where all were given the opportunity to make their own digital stories. These digital stories are personal and visualised narratives and testimonials, where the storyteller's own voice is a driving force. As a result of the workshops, many stories have been produced as part of the ReGap project, including some by the project partners themselves, and with the author's consent, integrated/connected in the learning resources portfolio.

In conclusion, Education is at the centre of the challenges for the hosting countries of migrants and refugees to ensure their long-term social inclusion. Frequently, those groups struggle with a lack of language skills

as well as knowledge on everyday issues in the hosting society. Developing migrants and refugees' skills and competences, especially for those with low levels of education, is paramount for social inclusion: when wisely considered, namely by avoiding any ethical pitfalls, e-Learning resources and (digital) storytelling may be driving forces for it.

## MINDtheGaps project

Established in 2015 by the United Nations, Sustainable Development Goal 4 targets both the elimination of all discrimination in education (especially those in vulnerable situations) and the provision of affordable, reliable and context-sensitive digital education as a guarantee of equal opportunities for young people.

MINDTheGaps (Media Literacy Towards Youth Social Inclusion) is an Erasmus+ project that aims to promote equal opportunities through media literacy development with socially vulnerable young people (aged 15 to 18 years old). Vulnerability is a broad concept, but this project identified those with economic and educational difficulties, cultural differences, and discrimination based on gender, race, religion, family and citizenship status.

The project uses a participatory intervention based on a training programme and multimedia open-educational resources development. In this sense, young people are involved in all steps of the open-educational resource's creation, including digital games. At schools, teachers identify vulnerable students and stimulate them to participate in the project: a workshop involving three students from each participant country (Portugal, Bulgaria and Turkey) is planned. In addition to promoting a discussion about data literacy and the risks and opportunities of the internet and social media, the experience of creating digital games will offer other chances to develop digital contents, creativity, critical thinking, problem-solving, safety issues communication, collaboration and citizenship. These students will organise local workshops based on peer-tutoring, in their own countries, for vulnerable young people from 12 to 16 years old.

As a snowball methodology, the project aims to reach at least 100 youngsters, as well as involving the entire educational community and reinforce a transnational collaboration. MINDTheGaps also predicts a multiplier event – "Media Literacy - raise awareness, spread ideas and play" – to disseminate the results to Portuguese teachers, and students from 12 to 16 years old. In this, they can play and evaluate the resources produced collaboratively by young people from participating countries).

Beyond digital games creation, the project will produce knowledge reflected on a Handbook publication and assessment/testing materials, including digital resource evaluation grids for this target audience.

## Final Considerations

Given all the above, we conclude that digital storytelling and game-based learning can trigger inclusive, flexible, customisable, adaptive, integrated learning scenarios, in line with Education 4.0 innovative pedagogies.

Digital storytelling, as developed in ReGap, impacts on who tells the story, providing an opportunity to share with others ideas and feelings in a safe context. This also provides a sense of togetherness and the comfort of knowing someone is listening, while at the same time creating knowledge, empathy and sensitivity on who listens to the story, thus building social belonging (Konstantopoulou et al., 2019).

Inclusion through game-based learning, as addressed in MINDtheGaps, implicates young people in:

- analysing the context, resources and learning objectives;
- planning;
- developing and/or choosing games;
- playing and evaluating the process and
- the final result.

During all stages, the interaction between different actors and technologies provided real word experiences that promote digital inclusion. However, admitting that technology can also become another social exclusion element, in order to be able to provide young people and

adults facing socially vulnerable situations more opportunities to "stay on the game", it is important to identify and remove systemic barriers so that everyone can:

- Know, discuss and co-create the rules of the learning activity/game;
- Interact with digital technologies and produce contents under fair conditions, taking into account different paces and starting points;
- Have an immersive, pleasant and amusing experience that allows the development of skills and self-awareness, construct relevant knowledge and interact with the group;
- Try it out, make mistakes, start over and receive support, feedback and contextual help whenever needed.

## Acknowledgments

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# New Teaching Methods with Gamification Techniques in Developing a Website

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## Introduction

Higher education, with all its structures, its internal processes and influences from the outside, goes through a process of conceptual and organizational transformation, promoting a new paradigm of academic education, able to respond to the needs of a dynamic society which is constantly being reformed.

The graduation rate of tertiary education in Romania is one of the lowest in the EU (25.6% in 2015, compared to 38.7% in the EU). This is caused by a number of factors that reduce young people's access to tertiary education, such as the relatively low promotion of the *baccalaureate* exam, and the high rate of early school-leaving (European Semester Country Report - Romania).

In May 2017, a report published by the Institute European Agency for Gender Equality ranks Romania third in The European Union regarding university dropout. The Median reported at European Union level is 11%, while Romania has an average of 18% (Babeș – Bolyai University).

Traditional schooling is perceived as ineffective and boring by many students. Although teachers continuously seek novel instructional approaches, it is largely agreed that today's schools face major problems around student motivation and engagement (Lee & Hammer, 2011). The use of educational games as learning tools is a promising approach due to the abilities of games to teach and reinforce not only knowledge but also important skills such as problem-solving, collaboration and communication. According to Dicheva et al. (2015), games have remarkable motivational power; they utilise several mechanisms to encourage people to engage with them, often without any reward, just for the joy of playing and possibility of winning.

The gaming industry is generating revenues in the billions (VGSales). Today's young learners gain skills and a method to learn by using games [3] in their everyday lives but must use other methods to be successful in school or at university. This situation needs to be remedied: over the past five years, an increasing number of teachers and researchers have recognised this and coined the term 'gamification'.

Gamification, defined by Deterding et al. (2011) as the use of game-design elements in non-game contexts, is a fairly new and rapidly growing field. The 'gamification' approach suggests using game thinking and game design elements to improve learners' engagement and motivation. According to Kapp, gamification is "using game-based mechanics, aesthetics and game thinking to engage people, motivate action, promote learning, and solve problems." (Kapp, 2012). Gamification is the use of game-thinking – approaches and elements in a context different from the games. Using game mechanics improves motivation and learning in formal and informal conditions (GamifyingEducation.org).

Gamification is still rising in popularity. According to Gartner's Hype Cycle (Gartner, 2013), a research methodology that outlines an emerging technology's viability for commercial success, it is at the peak of the Hype Cycle in 2013 with an expectation for reaching the Productivity Plateau in 5 to 10 years. This position however reflects mainly its use in

business contexts. The penetration of the gamification trend in educational settings seems to be still climbing up to the top as indicated by the amount and annual distribution of the reviewed works.

This paper presents the results of a study of the concept-course ''Creating a web site using Wix'', implemented with gamification elements on a learning management system (Talent LMS).

## Methods and Materials

A learning management system (LMS) is a software application for the administration, documentation, tracking, reporting, automation and delivery of educational courses, training programs, or learning and development programs. The learning management system concept (Levensaler, Leighann; Laurano, Madeline, 2010) emerged directly from e-Learning. Learning management systems were designed to identify training and learning gaps, utilising analytical data and reporting. LMSs are focused on online learning delivery but support a range of uses, acting as a platform for online content, including both synchronous and asynchronous courses. Modern LMSs include intelligent algorithms to make automated recommendations for courses based on a user's skill profile as well as extract metadata from learning materials in order to make such recommendations even more accurate.

### *Talent LMS platform*

TalentLMS is used by thousands of organisations and businesses worldwide, including ones in education, retail, construction, public sector as well as the non-profit sector (Talent LMS platform and features).


**Figure 1. Talent LMS specification**

Currently the gamification engine implements the following game mechanics:

### Points

Points can be collected through various activities; for example, whenever the user completes a test or a course, or for each time the person logs in. When someone gets points, a non-intrusive message is displayed (e.g. +3 points for logging in).

### Levels

Levels can unlock Courses. Users will be able to upgrade levels by collecting points or badges (depending on the Gamification settings). By default, users start on Level 1. When levels are turned-on, the course editing screen will have a new Level option where the minimum required level for unlocking the course can be set up.

### Badges

The badging system consists of eight categories of badges, with each category consisting of eight badges, so 64 badges in total can be unlocked. It is easy to start getting badges by completing simple tasks like a few

logins or one course completion, but it is becoming increasingly difficult to get additional badges. Domain administrators may select to work with a subset of badge categories if they want to do that.

Leaderboards

Leaderboards offer a visual presentation of a user's relative position under various metrics (Points, Badges, Certifications, etc.) compared to fellow learners. The leaderboards always present the best in their category and a few people around the reference user.

Assignment

Teachers can also develop pop quizzes, or tests, or even exams for students after finishing a course. The test can be made from simple questions with or without pictures. The answer can be: Multiple choice, Fill the gap, Ordering, Drag-and-drop, or Free text.

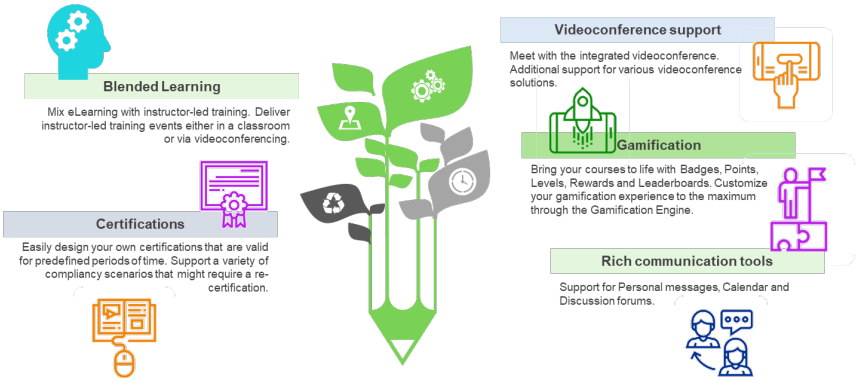


**Figure 2. Talent LMS learning delivery**

## *Creating a web page course*

Wix can represent a great solution in developing a website, with only very basic knowledge. An important advantage is that no specific knowledge of a programming language is required. The development of the website is free and can come with many design patterns. The platform, Wix, has

also developed its own A.I., nicknamed 'ADI', which stands for 'Artificial Design Intelligence'.

Wix's Adi is a very useful toolkit, mainly to its user-friendly features, making a more interactive course within the TalentLMS platform, rather than one of the many usual, conventional courses.

First of all, a 'concept-course' was developed and then introduced on chapters within the platform.

The first chapter is created within TalentLMS platform; it is an introduction, where students can discover that there are other solutions when creating a website, a personal blog or an online shop.

To help students to understand better the purpose of the course, the platform offers a wide variety of ways to share information, such as other websites within 'buttons' and videos from websites. In the picture from above, YouTube videos were inserted to explain the benefits of developing a website.

An informal tutoring method was chosen for a better connection with students. Moreover, small jokes with GIFs were made so that the teaching process takes place in a relaxed atmosphere.

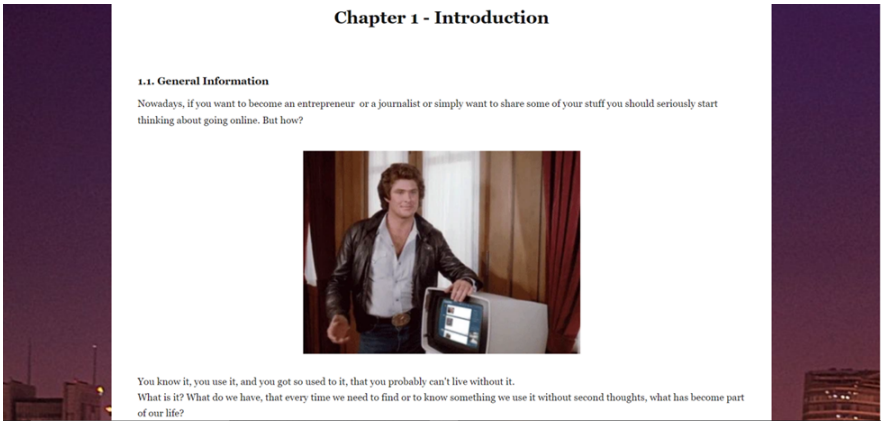


**Figure 3. Concept course-Developing a website with Wix, on TalentLMS**

Within the second chapter, students will discover what Wix and Adi represents, how to create an account and how to insert their first

information. The model website within the course was developed as an example of a retail website for a start-up company.

Following up, students are advised how to choose the optimal option for a fast and easy development of their first website. Thus, students can see throughout elements from which to choose in order to complete the course. After choosing an ADI feature, the website will ask general information regarding the website's purpose, such as the nature of the website they want to develop, what cosmetic theme they prefer, and what combination of colours.

Within the third chapter, students will fill specific 'pages' of their freshly developed website. Information on the pages could be:

- how a visitor can make contact (containing e-mail address, location, phone number, information about the team or company),
- products (where they can add and edit prices and pictures of product, insert specific options for a product such as retail prices, sales prices, available colours of products, available sizes of products, etc.),
- an introduction of the company on the home page, with a short presentation of their services and products or a blog on the site's shop, any logos, the company's mission, or even a motto.

Within the fourth chapter, students will discover, develop and edit the product page. Chapter 4 is focusing mainly on product and service insertion. Each step represents a specific command, where students can choose if it is necessary or not for them.

The only different task is that students must ultimately make their own website with the help of this course. They must insert their own products and information. The steps within the course must NOT be copied by students. This method helps them to develop their own website by making their own choices and using their imagination for the design.

The sixth chapter's focus is on developing a 'service-product' page, where students will learn how to develop such a product with booking features and assign members to specific services.

After the services area is completed, students will 'publish' the website. Hence, the website being public and online, they can view their work and edit it if they want further developments or features.

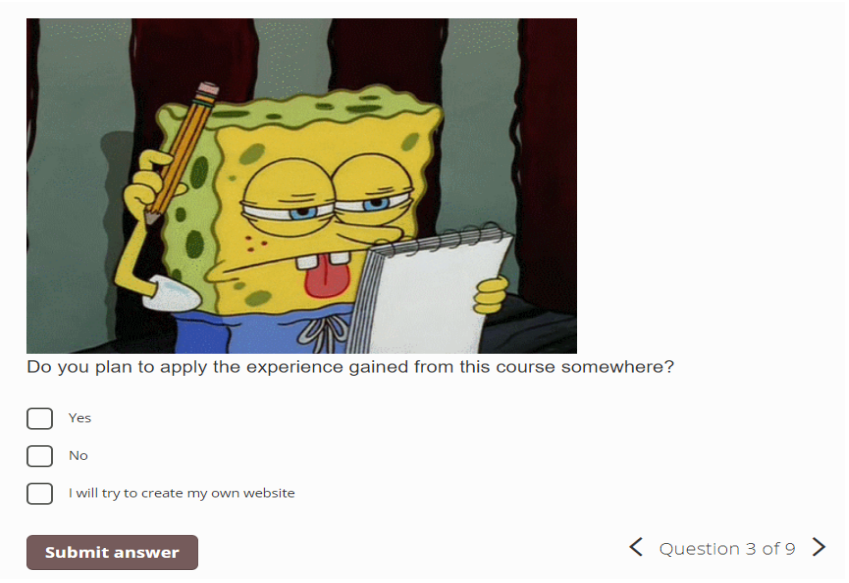


**Figure 4. Feedback form for the concept course**

### *Target group*

The target audience for the current study is a group of eight students from the second year of studies (Applied Informatics in Engineering). All students from the target group had no prior knowledge in creating a website from scratch.

## Statistics

The Talent LMS platform allows the administrator to download the statistics (Excel, infographics etc) for every student and for the entire group. For a systematic presentation of the review results, we classify and interpret them in accordance with a framework.

Most of the educational gamification studies and applications are driven by the presumption that gamification in education consists chiefly of incorporating a suitable combination of game elements within learning activities. However, the current study shows that the empirical studies on

understanding what kind of game elements under what circumstances can drive desired behaviour are not quite systematic.

In Figure 5, it is presented as a statistic for one of the students from the target group, with the elements of gamification: levelling up, acquiring badges, completion of assignments, submitting feedback on the form, and adding the new website address.

| Event | User | Description | Date |
|---|---|---|---|
| Level | User 1 | User 1 upgraded to level 2 | 14.05.2020 19:26 |
| Badge | User 1 | User 1 unlocked the Certification Newbie badge | 14.05.2020 19:26 |
| Certification | User 1 | User 1 was awarded a certification for the course Web Development for 3D Printing Start-Ups | 14.05.2020 19:26 |
| Badge | User 1 | User 1 unlocked the Learning Newbie badge | 14.05.2020 19:26 |
| Completion | User 1 | User 1 completed the course Web Development for 3D Printing Start-Ups | 14.05.2020 19:26 |
| Badge | User 1 | User 1 unlocked the Survey Newbie badge | 14.05.2020 19:26 |
| Completion | User 1 | User 1 completed the survey Feedback | 14.05.2020 19:26 |
| Badge | User 1 | User 1 unlocked the Perfectionism Newbie badge | 14.05.2020 18:58 |
| Passed | User 1 | User 1 passed the test POP QUIZ (score: 100%) | 14.05.2020 18:58 |
| Badge | User 1 | User 1 unlocked the Assignment Newbie badge | 14.05.2020 18:55 |
| Reply | User 1 | User 1 uploaded a reply for assignment Assignment 1 | 14.05.2020 18:55 |
| Add | User 1 | User 1 was added to the course Web Development for 3D Printing Start-Ups | 14.05.2020 16:54 |
| Login | User 1 | User 1 signed in | 14.05.2020 16:54 |
| Login | User 1 | User 1 signed in | 13.05.2020 10:51 |
| Add | User 1 | User 1 was added to the course Web Development for 3D Printing Start-Ups | 13.05.2020 00:16 |
| Registration | User 1 | User 1 was registered from Bejenaru Alexandru | 13.05.2020 00:16 |

**Figure 5. Gamification elements statistics for a participant**

The infographic from Figure 6 shows an overview progress rate of test and training time. Moreover, it shows the log-ins on different days/weeks/months. Thus, the 'instructor' can verify how many students and which students logged in for course completion and/or any test completions.

The platform offers a wide variety of information regarding the group's progress and also an analysis of individual progress analysis for a great overview. The information given is very detailed, from completion time of each course or all courses, to the test pass rate. Each set of information is structured on specific 'topics', from general ones (Insights) to the Gamification area which shows the top-3 in ranking order. The ranking is made through an analysis made from the test score, progression rate, most badges earned, etc.

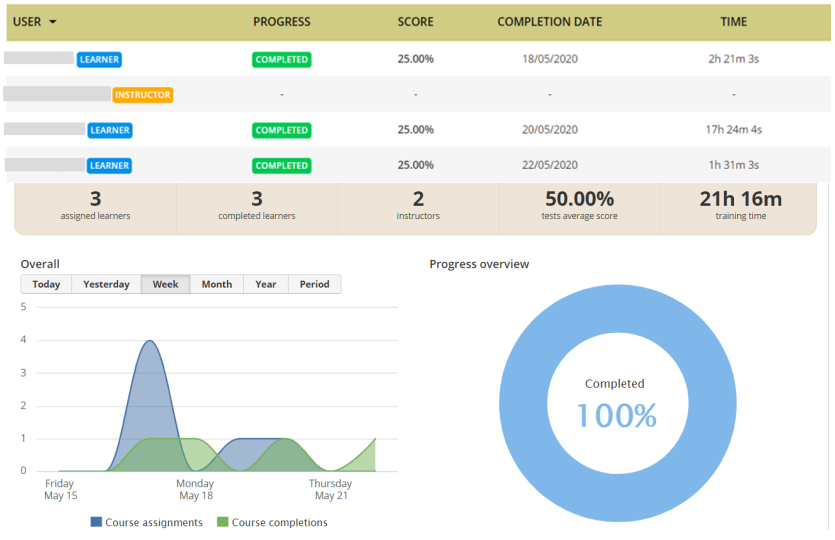


**Figure 6. Infographics for the first group of participants**


**Figure 7. a) Group Infographic from Talent LMS Statistics**


**Figure 7. b) Individual infographic for User 4, from Talent LMS paltform**

Hence, a "trainer" (which represents the teacher), will have an overview on its course and quiz efficiency. Theoretically, if most students fail the quiz/exam, either the information is too ambiguous or complicated, or the exam's requirements were not explained precisely. Nevertheless, the possibility of superficial completion by the students can be taken into consideration; however, the information in this case was not interesting enough. Thus, the focus of the 'new method of teaching' is to make learning attractive, through a relaxing atmosphere and using the newest technology available.

A common pattern observed in this study is to design and develop a gamified course/activity/environment, test it in a pilot and assess users' approvals and gains in performance. The reported outcome often concludes that the gamification produced the pursued learning gains and that the users appreciated the added gamification features.

## Conclusions

Gamification in education is an approach for encouraging learners' motivation and engagement by incorporating game design principles in the learning environment. The importance of sustaining students' motivation has been a long-standing challenge to education. This explains the significant attention that gamification has gained in an educational context – its potential to motivate students. However, the process of integrating game design principles within varying educational experiences appears challenging and there are currently no practical guidelines for how to do so in a coherent and efficient manner.

The discussion in the present review has been structured based on the combinations of the game elements used, the gamified subjects, the type of learning activities, and the statistics on the platform. The review confirmed that the research on gamification is very diverse with respect to the focus of the studies, the reported outcomes and methodological approaches. It also indicates that the research focus at present is mainly on empirical studies with less attention on the theoretical considerations.

While the effort to understand the effects of gamification on learning is expanding, there is a need for exploring the effect of game design elements in a broad sense, including both game mechanics and game dynamics across learning contexts. The observed emphasis on points, badges, and leaderboards is too narrow to address the relevant motivational factors. It is also crucial to understand the target population of a gamified system in order to gamify a learning activity successfully. Specifically, the unique needs and preferences of each group of learners, along with the learning objectives relevant to that group must inform the choice of game elements.

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