

A conceptual framework for the application of gamification strategies in higher education

Natanael Bandeira Romão Tomé^{1*} Glaudiney Moreira Mendonça Junior^{1*} Frederico da Rocha Tomé Filho^{2*}

Universidade Federal do Ceará, Instituto UFC Virtual, Brasil¹

University of Ontario Institute of Technology, Faculty of Science, Canada²

ABSTRACT

This study aims to develop a conceptual framework for gamification that can be used in university classrooms. To this end, an exploratory research was conducted about the concept of gamification, its main elements and the advantages and disadvantages of using it, focusing on the university environment. From this research, an early version of the conceptual framework for gamification of classrooms was developed. Semi-structured interviews were conducted with teachers from different areas of research related to digital media and education, in order to obtain comments and suggestions that could be used for the development of a framework adjusted to the needs of students and professors. From the feedback received, it was possible to modify and add new concepts to the framework developed initially, making it more suited to the university environment. It is expected in future work the development of a digital application that could support the conceptual framework developed.

Keywords: higher education, pedagogical approaches, game-driven technologies, playfulness, motivational elements for education, gamification in education, frameworks for gamification, gamified systems.

1 INTRODUCTION

The advance of information and communication technologies significantly affected the current view of pedagogical approaches used in the teaching-learning process, promoting the transformation of repetitive and behavioral approaches to adaptive approaches that includes active participation and collaboration between students [14]. Because of this, the traditional model of teaching, based on a unique approach for all cases, is no longer appropriate to meet the growing needs of students, since the learning process does not follow this linear method [6].

As a way to oppose the problems mentioned, several educational approaches and support tools were developed to increase the engagement of students regarding the process of learning, creating a large field of research dedicated to educational games, which are not often used in classrooms due to obstacles related to the high cost of development, use of resources and the difficulty of balancing pedagogical and entertainment objectives [10]. In this context, gamification, usually defined as the use of game design elements in contexts that are not games [8], enters as a simple low cost alternative [23] to motivate students that are increasingly unmotivated with the current educational system [18].

To contribute to the development of motivational ludic-pedagogical approaches in the higher education, this work aims to develop a conceptual framework, characterized as a non-formal structure with diverse ideas and concepts that culminate in a series

of reasons to adopt the points presented [11], grounded in concepts used in different frameworks, models and case studies to guide the use of gamification for education in the higher education.

The present work has as specific objectives:

1. Define gamification in a general context, specifying its vantages and disadvantages;
2. Demonstrate the use of gamification in education (classroom or in a digital context) aimed to the higher education;
3. Develop an initial conceptual framework;
4. Develop a framework adjusted based on the feedback of university professors from different areas.

The “Literature review” section presents the different definitions of gamification, the most common game elements used, rewards and motivations associated with gamified applications, examples of the utilization of gamification in an educational context, developed frameworks that aim to give a theoretical support for gamification applications and exposes the advantages and disadvantages of the use of gamification concepts. Next, the “Material and methods” section begins the development of a basic conceptual framework for gamification, while the “Results” section shows the subsequent modification of the framework based on the feedback of several professors. The final section concludes with suggestions of improvement that can be implemented in future versions of the framework of this research.

2 LITERATURE REVIEW

Game-driven technologies have been continuously transcending the boundaries of their environment [9], one of the most highlighted concepts among ludic approaches being the gamification. It has gained popularity in 2010, being primarily used to evidence the idea of raising users’ motivation related to products and to shape their behavior by the use of “game elements” [10]. The most widely used definition of gamification is that given by Deterding *et al.* [8], that refer to gamification as the utilization of game design elements in contexts that aren’t games, to motivate and increase users’ motivation and retention, where these elements were supported by the idea of extrinsic motivators, a concept created by Deci, Koestner and Ryan [7] that refers to the use of elements that provides an external control of the behavior of a determined person. González and Carreño [13] add that gamification is not directly related to game design, but rather to the addictive components of games, applied in different environments and with the goal of encouraging users to perform actions satisfactorily, depending on the context that users are inserted. For this work, gamification is understood as the junction between game elements and the experiences provided by games (be it interactions, narrative and linear and non-linear processes) in contexts outside the scope of games.

*e-mail: natanaelbandeira@gmail.com
 glaudiney@virtual.ufc.br
 fredericofilho@gmail.com

2.1 Game Elements

For a successful use of gamification, it is necessary to be aware of the game elements that will be used and how best to combine these elements [5]. Despite the lack of a formal list of game elements used in gamification, Barata, Gama, Jorge, and Gonçalves [1] indicate that the most commonly used are:

- Experience points, levels and progress bars, which serve to transmit progress and feedback;
- Challenges and quests, which provide activities with well-defined objectives;
- Badges, visual representations that incite users' behavior of collecting achievements;
- Leaderboard, an element that fosters competitiveness and encourages users to try to reach higher rankings.

Pirker *et al.* [23] believe that the elements mentioned above are essential for the use of gamified systems. However, a successful gamification strategy is not one that uses as many game elements as possible, but rather uses them more efficiently [10].

2.2 Gamification in Education

There are already universities that use or have used gamification in some of its disciplines [18]. De Sousa Borges, Reis, Durelli and Isotani [3] report, in their systematic mapping of work related to gamification in education, that the great majority of studies carried out have as target audience students of higher education, where most of those studies have as main objective to evaluate the degree of engagement of academics through activities built according to gamification concepts.

Becker *et al.* [2] believe that the freedom to choose which contents, activities, and ways of problem solving in educational contexts is one of the factors that best defines gamification applied correctly. In the experience that the researchers conducted in a classroom with masters' students, a great majority of them praised the myriad of available choices, although it should be noted that, due to the huge amount of activities, a combination of individualized activities with automated marking is required. Another aspect considered as a key element for a gamified system is to allow repetition of activities with low performance and provide a variety of paths that students can take to reach the end of the course.

2.3 Frameworks for Gamification

In the literature, frameworks for gamification derive mainly from studies on games and psychology [31]. Nicholson [22] observed in his studies developing frameworks for gamification that there is no single system that will benefit all users, and that in order to reach as many people as possible they need users to feel in control in order to facilitate learning and increase the sense of mastery over the system. The author argues that gamified system designers should not start developing a system based only on external rewards.

Although not developed with gamified systems in mind, the game design framework called Mechanics, Dynamics and Aesthetics (MDA) is commonly used to understand and describe particular elements of a game based on its user visibility [23]. Developed as a tool to help designers, researchers and scholars better understand aspects of a game, the MDA framework seeks to narrow the gap between the design, development, study, and criticism of a game [16], being also used as a base for gamified applications.

3 METHODOLOGY

In order to choose the frameworks that would be used as reference for this study, an exploratory research was carried out, consisting of the study of material already elaborated so as to have a greater

familiarity with the problem, with a view to the improvement of ideas or the discovery of intuitions [12]. The databases used for this research were the Science Direct, IEEE Xplore, and Springer, using as keywords the terms "Gamification Education" and "Gamification Framework", with a total of 612 articles being found. From these articles, the title, abstract and keywords were analyzed and, after that, a screening was done using as a reference an adaptation of the systematic mapping process used by de Sousa Borges *et al.* [3], applying some inclusion and exclusion criteria taken from their work and others elaborated by the authors. The inclusion criteria applied were as follows:

- Presents definitions and frameworks on gamification that can be used in any context (commercial or non-commercial), or only focused on an educational context;
- Have a major focus on the use of gamification in higher education;
- Have a main focus on the use of gamification in the study of cognition in adults;
- Analyze web-based or mobile tools for learning.

And the following exclusion criteria:

- Aimed at the use of gamification in elementary and/or middle school students;
- Aimed at the study of gamification in the cognition of children;
- With frameworks aimed at the corporate environment;
- On game-based learning that did not focus on the use of gamification;
- In another language other than English and Portuguese.

After the screening, 145 articles were selected, which went through a new screening involving the reading of the abstracts, introduction and conclusion, to again apply the previous inclusion and exclusion criteria, resulting in a subset of 110 primary studies. From these papers, concepts and case studies related to gamification were analyzed, including the application of frameworks and models for the educational field in higher education.

3.1 Developing a Conceptual Framework

In addition to the frameworks already mentioned, several others were considered for the development of the conceptual framework for the gamification of higher education (e.g. [4][5][10][15][19][27][29][31]). Frameworks from platforms such as Open Badge, BadgeOS and Open Badge Passport, which are based primarily on the use of digital badges to validate skills and competences [17] were disregarded in the development of the framework presented in this paper, due to the high dependence on a single element of extrinsic motivation.

3.2 Conceptual Framework for Gamification

After analyzing case studies, concepts, models and frameworks for gamification aimed at use in higher education, a conceptual framework was developed, divided into five layers, containing elements and concepts used in the researched papers. These layers are shown below.

3.2.1 Feedback Layer

It involves components that support the gamified system, providing rewards for students (extrinsic rewards) and feedback, such as individual assessment and frequency. These elements will be better explained below:

- Avatar: Digital representation of the student, which can be customized through items;
- Items: Accessories used on a student's avatar that can be donated by positively reputed students to promote a cooperative environment in the classroom. Students may also decide to exchange items among themselves,

through prior negotiation between the parties involved. Some of the accessories available for avatars should enable the acquisition of powers, or be required to perform specific activities;

- Powers: Single-use advantages that students can use to facilitate their progress in a determined subject. These powers can be acquired by means of coins, badges or items;
- Coins: An element that relates to the amount of experience and reputation points acquired. When you earn experience points, a percentage of the value you earn is accrued as coins. By increasing his reputation, the student gradually increases the percentage of coins that can be acquired, and vice versa;
- Experience points: Element that can be used as substitute for marks and can also serve as a metric for unlocking powers or for obtaining coins;
- Badges: Elements that allow the student to visualize their achievements and be recognized by them. It is expected that they will be made available to students who perform extracurricular tasks, not to indicate how many experience points they have. It is also important that they be associated with the powers that students can obtain, avoiding to be only an aesthetic resource;
- Reputation: An element used to increase the amount of coins a student can acquire and to allow the exchange of gifts. Students who acquire badges, or contribute in some positive way to the progress of classes, increase their reputations;
- Hall of fame: Students who excelled in classroom gain the chance to have their achievements published in some digital medium, so that these students can use this recognition in their curricula;
- Levels: Element that relate to the points of experience and used to refer to a student's grade by designating different categories depending on the number of experience points acquired;
- Progress bar: Visual representation of experience points;
- Leaderboard: Visual representation of the progress of all players, in order to compare their progress;
- Health: Element used as a substitute for frequency [19]. When a student does not attend a class, a health unit is reduced from their total amount. When it reaches zero, the student is unable to successfully complete the discipline, even if it has the minimum amount of experience points required. But it is possible to recover lives through special activities, or through the use of coins to acquire it.

3.2.2 Activities Layer

It includes the learning material and activities that will be developed, containing short and long term goals.

3.2.3 Pedagogical Layer

Based on approaches used in association with gamification, such as:

- Adaptive learning: Adaptive learning proposes to flexibilize the learning environment, either implicitly (automatic) or explicit (according to the individual's desire), so that the content can be presented in a personalized way [20];
- Flipped classroom: A form of teaching where participants study prior to going to the classroom, and there the content is deepened through practical exercises or case studies [28];

- Information and communication technologies (ICTs): Technologies that can be used for distance and face-to-face teaching [25].

3.2.4 Narrative Layer

Layer inspired by the framework developed by Nicholson [21]. It involves two types of strategies:

- Use of fictional narratives that deal with content related to the real world;
- Development of scenarios that begin in the real world, but have fictional elements and can culminate in a fantasy development.

It's important that, regardless of the strategy used, students have the power to modify the story presented, depending on their actions and allowing them to create their own stories.

3.2.5 Motivational Layer

Layer based on the work of Suh, Wagner and Liu [26]. It involves concepts that serve as triggers for the development of intrinsic motivation in students, such as:

- Collaboration;
- Competition;
- Progression;
- Creativity;
- Personalization;
- Exploration;
- Discovery;
- Relationships;
- Altruism;
- Freedom of choice;
- Freedom to fail.

3.3 Feedback

After delimiting the layers of the initial version of the conceptual framework for the gamification, interviews were conducted with professors from different areas of research (as presented in table 1) of the Digital Systems and Media program at the Federal University of Ceará, in order to have their opinion on the structure of the framework, as well as suggestions for improving it.

Table 1: Number of professors interviewed from different areas of knowledge

Number of professors	Area
6	Multimedia systems
2	Interactive digital design
2	Digital games
2	Education
1	Audiovisual
1	Business management

Altogether, 14 teachers were interviewed through semi structured interviews, discussing six topics:

- Gamification concept;
- Analysis of the feedback layer;
- Analysis of the activities layer;
- Analysis of the pedagogical layer;
- Analysis of the narrative layer;
- Analysis of the motivational layer.

The duration of the interviews ranged from 20 minutes to 1 hour, totaling 6 hours. To preserve the anonymity of the participants, they will be referred as "I1" through "I14".

3.3.1 Gamification Concept

In this topic, the interviewees were asked about their knowledge of gamification. In case of unfamiliarity, a brief explanation of the

concepts most used to define gamification was made and, in case of previous knowledge about the term, it was asked which definition the interviewee knew. 79% of the professors had some kind of prior knowledge about what gamification is.

Regarding the definitions presented, seven interviewees used the definition proposed by Deterding *et al.* [8] where gamification is seen as the use of game design elements in contexts other than games. Three interviewees defined it as the development or use of a game with a more serious tone, a definition that is more related to serious games, which, in a digital context, can be characterized as games developed to be more than entertainment [24].

After the initial questioning, the layers of the conceptual framework developed were presented.

3.3.2 Analysis of the Feedback Layer

After explaining the elements of the feedback layer, the interviewees were asked about the possibility of using these elements in the classroom, more specifically about some type of impediment that could exist for their use, whether for reasons of infrastructure, university rules, or disinterest to apply them.

Two interviewees said that at first glance they saw no problem in the above mentioned elements, but would need to do further research to confirm it accurately. I3 acknowledged that it would need to see a practical application of the elements before making a decision, questioning how these elements would be used, while I4 asked how these elements would be visualized by both participants and external people.

The biggest obstacle reported in the interviews was the use of confidential information from the students, where six interviewees showed great concern about the use of this information (notes and names of the students) in the framework developed, and the element mentioned by four interviewees that relates to this problem is the leaderboard.

Other issues mentioned regarding this layer include:

- University bureaucracy;
- How to provide automated feedback to students;
- Prejudice by university and students of not perceiving the idea as something serious;
- University not accepting a modification of their frequency system;
- Need for many resources and people to develop a virtual environment based on the framework;
- Extra dedication to the development of the aesthetic part of the system;
- Dependence on extrinsic motivators.

At the end of this topic, the interviewees were asked to suggest new elements to be inserted in this layer. Guilds, quests and challenges were mentioned by two of the interviewees. I5 thought about the same idea of the challenges but calling it Player vs. Player (PVP), yet admits that it would be difficult to deploy this idea of direct competition in an academic setting, even if it was made available on an optional basis. I2 suggested the addition of a mentoring element, in which high-performing students could choose to tutor classmates who requested support related to the discipline. In this case, the tutor would earn a gratification. I9 thought about creating a channel for sharing experiences, such as strategies and materials used to progress the discipline, and even reports of strategies that did not work out to prevent other students from making the same mistakes. As a bonus, participating students could receive coins or powers.

3.3.3 Analysis of the Activities Layer

The interviewees were asked about the types of activities they used to support their teaching methods. The activities mentioned were:

- Collaborative assignments involving the whole classroom;

- Tasks with responses shared by the class, through online platforms;
- Written assignments;
- Practical assignments;
- Exams;
- Oral presentations;
- Seminars;
- Classroom activities;
- Homework;
- Debates;
- Elaboration of scientific papers.

3.3.4 Analysis of the Pedagogical Layer

The interviewees were asked about innovative pedagogical approaches that could be used in a gamified classroom. In this case, approaches that are not limited to lectures are considered innovative. If the interviewee had no idea of any specific approach, they were asked to explain how their teaching method was.

The pedagogical approaches cited by the interviewees were:

- Flipped classroom;
- Adaptive learning;
- Problem-based learning (PBL);
- Role-playing;
- Collaborative learning.

Three interviewees stress the importance of always using a mix of different approaches, since different students react in different ways. I8 emphasizes that innovation in today's education should be directed to the methodology and not to the use of technology, as the technologies currently used become obsolete quickly.

3.3.5 Analysis of the Narrative Layer

The interviewees were asked their opinions about the inclusion of interactive narratives in the classroom. Twelve interviewees see the use of narratives in the classroom as positive and interesting, and four interviewees have never seen an example of using interactive narratives in an educational context. After the answers to the first question, the interviewees were asked about what would positively or negatively influence the use of interactive narratives in their teaching methods.

Positive aspects mentioned include:

- Make the class more attractive;
- Promotion of student interaction with the developed narrative;
- Improvement of the relationship between teachers and students;
- Contextualization of a subject.

Regarding the negative aspects, three interviewees see as difficult the balance of the play aspect of the narrative (fun) with the serious aspect (learning), in addition to the high demand of time. I14 points out as a problem the impossibility of student autonomy in predefined scenarios, where professors could not accept divergent opinions.

3.3.6 Analysis of the Motivational Layer

The interviewees were asked if some of the concepts presented in the motivational layer were not adequate for their pedagogical approaches and if they would add other concepts. Eight interviewees stated that all concepts are appropriate, while three stressed the importance of freedom to make mistakes without being heavily punished.

Two interviewees saw as problematic the inclusion of competition and collaboration concomitantly, because they could not visualize these two antagonistic concepts working in the framework. I9 suggested that these two concepts could work in a context where teams compete with each other.

At the end of this topic, participants were asked to suggest new concepts that could enter the motivation layer. The concepts cited were:

- Privacy;
- Sharing;
- Responsibility;
- Autonomy;
- Recognition.

I3 thinks it would be positive to include some concept related to the pursuit of a long-term goal. I11 suggested that some of the concepts mentioned would enter as mobilizing elements rather than motivating elements.

4 RESULTS

After the feedback from the participating professors, all proposed suggestions were taken into account in the development of a conceptual framework for gamification adjusted for the university environment. Some points that deserve attention are:

- The conceptual framework developed aims the development of a virtual environment that supports the established layers;
- Prior agreement is required of students who agree to participate in a gamified classroom based on the conceptual framework developed;
- Professors can choose which layers or elements of the framework they wish to use.

4.1 Adjusted Framework

The elements and concepts added or modified from the initial conceptual framework for gamification developed will be presented as follow.

4.1.1 Modification of the Feedback Layer

The following elements were modified:

- Powers: The acquisition of powers by obtaining points of experience (which relates to obtaining a specific level) could be done in a fixed or random way. In addition to single use powers, students can develop powers of limited duration. It is important that there is a limitation on the use of powers in certain situations;
- Achievements: Can be taken into consideration for a future master's degree and used as a prerequisite for entering the Hall of Fame;
- Leaderboard: It is important that students have the choice to participate or not in the competition, having their names removed from the public ranking if they wish;
- Reputation: It is important to mention that there is a limit on the amount of reputation that can be lost or acquired, in which all students start with 3 reputation and can increase to 6 or decrease to 0;
- Items: It would be interesting to make it possible to donate to random students. It is also necessary to set limits on the sending of items among students, to avoid abuses;

The following elements were added:

- Mentoring: High-performing students may become available to tutor students struggling to learn a subject, serving as an extracurricular activity;
- Tavern: Channel for sharing experiences among students. As an example, students could share strategies and materials used to progress in a determined subject, and even reports of things that did not work so well, to prevent other students from making the same mistakes;
- Skills tree: An element that works in association with the experience points, which can be distributed in branches of a skill tree, allowing the acquisition of powers of a

specific category. Students can divide their points into the various branches available in order to obtain powers of different categories, or they can focus on a single branch to achieve all the powers that exist in it;

- Guild: Representation of teams formed in a discipline, who may cooperate or compete with others, having their own leaderboard;
- Quest book: An interface where students can check which quests have already been performed, their performances, which optional quests are available and which compulsory quests are not yet completed.

4.1.2 Modification of the Activities Layer

The following elements were added:

- Quests: Compulsory or optional activities that students must take to progress in the discipline;
- Challenges: Classroom activities where a guild should respond to some kind of challenge by an opposing guild, all through professor mediation;
- Missions: Optional collaborative activities that relate to the interactive narrative used in the discipline, and necessary for the advancement of the story.

4.1.3 Modification of the Pedagogical Layer

The PBL approach was included, where one or several students are presented with a real problem that must be solved using previous knowledge, as well as the acquisition and integration of knowledge acquired during the problem solving process [30].

4.1.4 Modification of the Narrative Layer

The following observations were added:

- Students must decide in advance whether they wish to participate in the interactive narrative, with the possibility of completely ignoring this factor in the subject without any kind of loss;
- It is important that students are not passive spectators, but there must also be a limit to the freedom given to participants so that the narrative does not become a distraction.

4.1.5 Modification of the Motivational Layer

The title of the layer was changed to "Layer of Motivation and Mobilization", including both concepts related to intrinsic motivation and mobilization. The added concepts were:

- Privacy;
- Sharing;
- Responsibility;
- Autonomy;
- Recognition;
- Persistence.

4.1.6 Visual Representation of the Conceptual Framework

In order to facilitate the understanding of the conceptual framework and the way the layers are related, a graphical representation of the framework was developed. Figure 1 shows that the layers placed at the sides of the framework are influenced by the principles of the layer of motivation and mobilization.

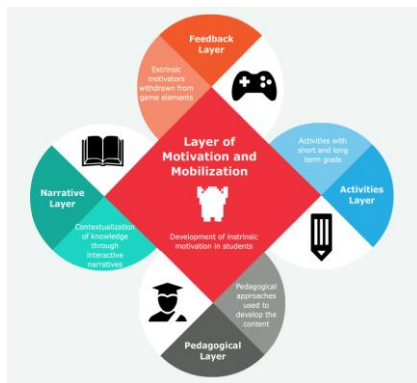


Figure 1: Conceptual framework developed.

5 CONCLUSION

As a way to create more engaging and motivating environments, gamification comes as a strategy that can be used in a variety of contexts, whether in business, training, or education. In the educational environment, this strategy comes as a way to improve students' motivation and their learning process, in order to balance pedagogical goals with entertainment. Through the use of mechanisms commonly found in games such as experience points, badges and leaderboard, it is expected the creation of an environment conducive to the active participation of students. It is essential that these elements be used to provide the same experience that motivates a player to solve problems on his own.

But a careful approach is necessary with how rewards (extrinsic motivators) will be addressed in a gamified system, especially in the educational environment, which, applied indiscriminately, can have a negative effect on learning. Ethical issues, such as the use of sensitive student data and the possibility of encouraging inappropriate behavior, must also be taken into account. From the papers analyzed and the variety of results, it is possible to observe that strategies of gamification in education can be influenced by several factors, such as tools used, support offered by the university, profile of students, and therefore a same strategy used in two different classrooms can have completely opposite results.

In order to approach the concepts established in the conceptual framework developed and the limitations of the professors (infrastructure and general rules of universities), semi-structured interviews were conducted with professors from the different areas of research, in order to obtain suggestions for improvements, culminating in the development of a framework adapted to the university environment.

As future work, it would be interesting to have a more detailed study to include other layers relevant to the framework. A layer of student's profiles would be important and would aim to provide a more personalized experience according to the profile of a particular student. Existing researches use profiles developed for videogame players to refer participants to a gamified system, (e.g. [5]), but often the profiles specified are not enough to compose the rich range of personalities in a classroom. Another layer suggested would be the social layer, which would serve to identify elements used to promote sociability and interactivity among students. From the interviews, it was considered the development of a layer of conflict resolution, both between professors and students as well as between the students themselves. Finally, the creation of a virtual environment that supports the presented ideas is very important to facilitate, encourage and make accessible the application of the developed framework.

REFERENCES

- [1] G. Barata, S. Gama, J. Jorge and Gonçalves, D. Early Prediction of Student Profiles Based on Performance and Gaming Preferences. In *IEEE Transactions on Learning Technologies*, volume 9(3), pages 272-284, 2016.
- [2] K. Becker, D. Gunson, H. Blair, L. Cheng, M. Hayden-Isaak and C. Miller. Gamifying an M. Ed. Course: A Post-Mortem. In *Games Entertainment Media Conference (GEM)*, 2015.
- [3] S. de Sousa Borges, V. H. S. Durelli, H. M. Reis and S. Isotani. A systematic mapping on gamification applied to education. In *Proceedings of the 29th Annual ACM Symposium on Applied Computing*, pages 216-222, 2014.
- [4] L. Butgereit. Gamifying a PhD taught module: A Journey to Phobos and Deimos. In *IEEE IST-Africa Conference*, pages 1-9, 2015.
- [5] G. C. Chalco, D. A. Moreira, I. I. Bittencourt, R. Mizoguchi and S. Isotani. Personalization of gamification in collaborative learning contexts using ontologies. In *IEEE Latin America Transactions*, volume 13(6), pages 1995-2002, 2015.
- [6] J. Chauhan, S. Taneja and A. Goel. Enhancing MOOC with Augmented Reality, Adaptive Learning and Gamification. In *IEEE 3rd International Conference on MOOCs, Innovation and Technology in Education (MITE)*, pages 348-353, 2015.
- [7] E. L. Deci, R. Koestner and R. M. Ryan. Extrinsic rewards and intrinsic motivation in education: Reconsidered once again. Review of educational research, volume 71(1), pages 1-27, 2001.
- [8] S. Deterding, D. Dixon, R. Khaled and L. Nacke. From game design elements to gamefulness: defining gamification. In *Proceedings of the 15th international academic MindTrek conference: Envisioning future media environments*, pages 9-15, 2011.
- [9] S. Deterding, M. Sicart, L. Nacke, K. O'Hara and D. Dixon. Gamification: using game-design elements in non-gaming contexts. In *CHI'11 Extended Abstracts on Human Factors in Computing Systems*, pages 2425-2428, 2011.
- [10] D. Dicheva, K. Irwin, C. Dichev and S. Talasila. A course gamification platform supporting student motivation and engagement. In *IEEE International Conference on Web and Open Access to Learning (ICWOAL)*, pages 1-4, 2014.
- [11] M. Eisenhart. Conceptual Frameworks for Research Circa 1991: Ideas from a Cultural Anthropologist; Implications for Mathematics Education Rese, 1991. Available at: <<https://goo.gl/5NvObU>>. Last Access: May 11, 2017.
- [12] A. C. Gil. Como elaborar projetos de pesquisa. São Paulo, BR: Editora Atlas, 2002.
- [13] C. S. G. González and A. M. Carreño. Methodological proposal for gamification in the computer engineering teaching. In *IEEE International Symposium on Computers in Education (SIIE)*, pages 29-34, 2014.
- [14] C. Gütl, C. Cheong, F. Cheong, V. Chang, S. Z. Nau and J. Pirker. Expectations of the generation NeXt in higher education: Learning engagement approaches in information sciences subjects. In *IEEE International Conference on Interactive Collaborative Learning (ICL)*, pages 205-214, 2015.
- [15] O. Hanraths, A. Wintermeyer and K. Knautz. Questlab: A Web-Framework for Gamification of Seminars. In *IEEE 49th Hawaii International Conference on System Sciences (HICSS)*, pages 847-856, 2016.
- [16] R. Hunnicke, M. LeBlanc and R. Zubek. A formal approach to game design and game research. In *Proceedings of AAAI Workshop on Challenges in Game AI*, 2004. Available at: <<https://goo.gl/nEICQS>>. Last Access: May 11, 2017.
- [17] J. Jovanovic and V. Devedzic. Open badges: Novel means to motivate, scaffold and recognize learning. *Technology, Knowledge and Learning*, volume 20(1), pages 115-122, 2015.
- [18] B. B. Lambruschini and W. G. Pizarro. Tech—Gamification in university engineering education: Captivating students, generating

- knowledge. In *IEEE 10th International Conference on Computer Science & Education (ICCSE)*, pages 295-299, 2015.
- [19] M. Mochocki. Gamedec. UKW: A case of edu-gamification for game designers. In *IEEE International Conference on Interactive Mobile Communication Technologies and Learning (IMCL)*, pages 323-326, 2015.
 - [20] V. Naik and V. Kamat. Adaptive and Gamified Learning Environment (AGLE). In *IEEE Seventh International Conference on Technology for Education (T4E)*, pages 7-14, 2015.
 - [21] S. Nicholson. A recipe for meaningful gamification. Gamification in education and business, pages 1-20. Springer International Publishing, 2015.
 - [22] S. Nicholson. A user-centered theoretical framework for meaningful gamification. Games+ Learning+ Society, pages 223-230, 2012. Available at <<https://goo.gl/Uva4Ut>>. Last Access: May 11, 2017.
 - [23] J. Pirker, C. Gutl and Y. Astatke. Enhancing online and mobile experimentations using gamification strategies. In *IEEE 3rd Experiment@ International Conference (exp. at'15)*, pages 224-229, 2015.
 - [24] U. Ritterfeld, M. Cody and P. Vorderer. Serious games: Mechanisms and effects. Routledge, 2009.
 - [25] R. Schulz, G. M. Isabwe and F. Reichert. Investigating teachers motivation to use ICT tools in higher education. In *IEEE Internet Technologies and Applications (ITA)*, pages 62-67, 2015.
 - [26] A. Suh, C. Wagner and L. Liu. The effects of game dynamics on user engagement in gamified systems. In *IEEE 48th Hawaii International Conference on System Sciences (HICSS)*, pages 672-681, 2015.
 - [27] L. Szegletes, M. Koles and B. Forstner. Socio-cognitive gamification: general framework for educational games. In *Journal on Multimodal User Interfaces*, volume 9(4), pages 395-401, 2015.
 - [28] M. F. Tretnjak, A. Bednjanec and M. Tretnjak. Application of modern teaching techniques in the educational process. In *IEEE 37th International Convention on Information and Communication Technology, Electronics and Microelectronics (MIPRO)*, pages 628-632, 2014.
 - [29] M. Urh, G. Vukovic and E. Jereb. The model for introduction of gamification into e-learning in higher education. In *Procedia-Social and Behavioral Sciences*, volume 197, pages 388-397, 2015.
 - [30] M. D. L. V. Rodrigues and J. F. de Castro Figueiredo. Aprendizado centrado em problemas. *Medicina (Ribeirao Preto. Online)*, volume 29(4), pages 396-402, 1996.
 - [31] H. Vermeulen, J. Gain, P. Marais and S. ODonovan. Reimagining gamification through the lens of Activity Theory. In *IEEE 49th Hawaii International Conference on System Sciences (HICSS)*, pages 1328-1337, 2016.