A Gamification Experience in a Class of a Degree in Engineering

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ABSTRACT

The Gamification is a subject that is increasingly discussed in the educational field, but still little implemented, especially in higher education. The Gamification, as a teaching strategy, favors learning and motivation and combats student abandonment.

In the first year of engineering courses, traditionally a large group of students does not attend math classes which leads to high failure rates. This work presents a study that was done in a curricular unit of first year mathematics of an engineering course, where a gamification strategy was used. The goal was to reduce school dropout and increase motivation to achieve better learning and a higher passing rate.

Although this experience does not allow for conclusions, it can be verified that the students were more motivated, the dropout rate was low, and the approval rate was quite satisfactory.

Keywords: Gamification; Pedagogic Experiences; Higher Education.

Introduction

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 Gamification, when used as a teaching strategy, favors learning and combats student abandonment. According to Espíndola (2014) the gamification is the use of game mechanics and dynamics to engage people, solve problems and improve learning, motivating actions and behaviors in environments outside the context of games.

The idea of using thought and game mechanics to solve problems is old. Three hundred years ago, the Scottish philosopher David Hume laid the groundwork for

understanding the player's motivations. From the 1960s, several authors wrote books on game psychology (Zichermann and Cunningham, 2011).

Gamification is not about introducing game elements, such as the distribution of rewards and medals for a given product, as it requires an in-depth approach to decide which elements will be incorporated and their conformity with the context of the goal proposed by the project (Marins, 2013).

McGonigal (2011) highlights the following elements of games to be observed in gamification: objective, rules and voluntary participation. Werbach and Hunter (2012) define the PBL Triad (Points, Badges, Leaderboards) as an initial parameter consisting of the following elements: points, medals and rankings. The authors of this work also divided the main elements into categories:

1. dynamics: constraints (imposed limitations), emotions, narrative, progression and social relation;
2. mechanical - elements that stimulate actions and involve the player: challenges, competition, feedback (performance), randomness, cooperation (teamwork), rewards and victory;
3. components: medals (visual representation), rankings (visual representation of evolution), points (numerical representation), levels of progression, team formation, final challenge, collections and unlocking content after accomplishing the mission.

Students who become players, challenging classes, students working autonomously and / or in groups and working online to earn points, receive medals, achieve the highest scores and enter the leaderboard, receive real-time feedback on the performance... These are some of the transformations that occur when one enters into the 'gamification' of teaching.

> Gamification is a tool with advantages and disadvantages in different situations and environments. ... Gamification only uses a few game elements. Learners don't play an entire game from start to finish; they participate in activities that include video or mobile game elements such as earning points, overcoming a challenge or receiving badges for accomplishing tasks. (Kapp, 2015)

A lot of papers reporting experiences with gamification have appeared in the last years. According Dicheva,

> The majority of the papers report encouraging results from the experiments, including significantly higher engagement of students in forums, projects and other learning activities ((Anderson et al., 2014), (Caton & Greenhill, 2013), (Akpolat & Slany, 2014)), increased attendance, participation, and material downloads (Barata et al, 2013), positive effect on the quantity of students' contributions /answers, without a corresponding reduction in their quality (Denny, 2013)); increased percentage of passing students and participation in voluntary activities and challenging assignments (Iosup & Epema, 2014), and minimizing the gap between the lowest and the top graders (Barata et al, 2013). Hakulinen et al. (2014) conclude that achievement badges can be used to affect the behavior of students even when the badges have no impact on the grading. The papers of this group also report that students considered the gamified instances to be more motivating, interesting and easier to learn as compared to other courses ((Mak, 2013), (Barata et al., 2013), (de Byl & Hooper, 2013), (Mitchell, Danino, & May, 2013), (Leong & Yanjie, 2011)). (Dicheva et al., 2015)

According to Franco (Franco et al. 2015), the games in the educational processes should be promoted with due planning in order to generate student engagement. It is the motivation that instigates a person to perform a given activity, so it is fundamental to know what motivates the students. The school goals to be achieved should be clear, during the use of game strategies that users should have a clear perception of their progress. The interaction between the intrinsic and extrinsic motivations must be balanced, since there is a risk that users, in this particular case, the students, aim only at the rewards and even a reduction of motivation if, for example, the challenges become repetitive.

Gamification tries to harness the motivational power of games and apply it to real-world problems, in our case, students' motivational problems. Mathematics disciplines in the early years of engineering degrees usually face a very high drop-out rate so motivation and engagement of the students are important challenges

for the teachers. But what is the gamification of education? According to Lee and Hammer,

> What do we mean by the gamification of education? After all, schools already have several game-like elements. Students get points for completing assignments correctly. These points translate to "badges," more commonly known as grades. Students are rewarded for desired behaviors and punished for undesirable behaviors using this common currency as a reward system. If they perform well, students "level up" at the end of every academic year. Given these features, it would seem that school should already be the ultimate gamified experience. However, something about this environment fails to engage students. In contrast, video games and virtual worlds excel at engagement (McGonigal, 2011). As evidence of this, 28 million people harvest their crops in Farmville on a daily basis (Mashable, 2010), and over five million people play World of Warcraft for more than 40 hours per week (Blizzard, 2010). On the other hand, the default environment of school often results in undesirable outcomes such as disengagement, cheating, learned helplessness, and dropping out. Most students would not describe classroom-based activities in school as playful experiences. Clearly, the existence of game-like elements does not translate directly to engagement. Understanding the role of gamification in education, therefore, means (Lee & Hammer, 2011).

The goal in the use of the Gamification is always the same, motivate students for learning.

The aim of this study was to use gamification were a motivation factor and to combat high school drop-out rates in the first years of higher education in curricular units of mathematics. Thus, we present here an experience where gamification was used in a mathematics class of the first year of an engineering course. Although this work does not allow to draw conclusions, it's yet another contribution on the positive effects of the use of gamification in teaching.

The Gamification

According gamification as well as active learning methodologies and educational coaching come as alternatives to promote learning by means pedagogical and interactive practices with proven effective results. The gaming experience goes beyond the entertainment factor and goes through other points such as the need for competition, instant feedback, the possibility of rapid evolution, and the pursuit of tangible rewards and rewards, which are inherent characteristics of human beings.

In addition, community building for work in games are also actions that encourage the participant to continue playing until their goals are achieved. Investing in gamification it is a way of engaging people, the gamification offers incentives for participants to feel excited to take action or to progress with a task. By promoting experiences that involve students emotionally and cognitively, gamification helps to achieve greater engagement compared to traditional teaching models.

The neurosciences have already confirmed that "when there is an emotion, one learns," then can the introduction of video games bring this about. One of the incessant searches of our brain is by reward. Games are important for education because our brain develops from the method of observation, trial and error. The endocrine system, together with the nervous system, releases dopamine, noradrenaline and serotonin, rewarding us with euphoria and a sense of happiness when we experience and learn in this way.

Another important factor is that games can develop social-emotional skills as well as being a way of engaging people, games provide incentives for participants to feel excited to take action or progress with a task. And with this, some socio-emotional competences can be perceived: interactivity; creativity; own thinking; persistence; sense of urgency; healthy competition; discipline, among others.

Traditional schooling will make less and less sense. For we live in a conflict, between two realities that makes the school a boring environment, outside technology and interactivity - horizontal learning and from the inside the learning process vertically. The learning environment is not very motivating, since most of the teachers went through this school with a content environment and today people do not have that profile anymore. Today:

- 97% of the young audience plays computer and video games;
- 69% of heads of households play video games;
- Most gamers want to play the rest of their lives;
- Collectively, more than 3 million hours of game-related weekly activity are spent.

Methodology

When introducing gamification, the evaluation was replaced by points that were assigned to the students for completing the evaluation components and for their participation in classes and online.

> Students who have become players, work to earn points, level up, receive medals and other prizes, avoid bombs, get the highest scores and join the leaderboard.
>
> Students earned Experience Points for completing a lesson or for doing extra research about the lesson. And they gained access to special powers by fulfilling all the tasks proposed for a week. These special powers allowed them to eliminate an incorrect alternative from a math test or give them extra lives. If they have enough XP they could buy a help on a test.
>
> The gamification in education implies bringing features and elements of the games to the contexts of teaching and learning, to engage students in their activities and learning processes, also leveraging creativity, critical thinking, teamwork and independence in problem solving.
>
> The students barely registered in the UC had a hundred of starting points and everything they did, or not did, was giving them or taking more points. Each hundred points corresponded to one level and there were twenty levels corresponding to grades from zero to twenty. A student with a thousand of points was at level ten, which means that his grade at that time would be ten values.
>
> The medals or badges were rewards attributed to the students by performing certain tasks, such as going to class, participating in forums, solving challenges, among others. Obtaining a medal rewarded the student with a predetermined amount of points.

The Bombs were penalties attributed to the students for not doing certain tasks such as TPC, Moodle tests, among others. Bombs penalized students by taking a predetermined amount of points from them.

One of the components of the evaluation was the testing of Moodle. The students took these tests biweekly and during the weekend. All Moodle tests had three difficulty levels, Easy, Medium Difficult, and it was the student who chose the level he was doing.

During the semester, the student had to do six tests in Moodle, and had to do at least one test of each level. When he opened the test, the student chose the level he wanted to do, knowing that the average level allowed him to get double the points he could reach with the easy level and that the difficult level allowed him to get double the points he could reach with the average level.

In each test to perform in Moodle the student always had the possibility to make two attempts, but he knew that his classification in this test was the one obtained in the last attempt. The purpose of allowing two attempts was, when the first attempt had gone wrong, lead the student to reflect on what had not gone well on the first try and go to study or look for information to solve correctly this test. So, when he tried the second time, he would be better prepared to do the test. To force this reflection, between the first and second attempts the student had to wait at least sixty minutes between the two attempts. The second attempt was optional, but if the student chose to do it, it had to be of the same level as the first.

Consider, for example, the matrices' test;

- An easy level test involved only operations with complex numbers and operations with real matrices.
- Thus, an easy level test could be, for example,

1. If i is the imaginary unit, the value of $i^{30} + i^{-60}$ is

   □ 0

   □ -1

   □ 1

   □ i

   □ None of the others is correct.

2. If $A = \begin{bmatrix} 1 & 1 & 0 \\ 0 & -1 & 1 \\ 1 & 2 & 1 \end{bmatrix}$, $B = \begin{bmatrix} 0 & 1 & 0 \\ 1 & -1 & 2 \\ 2 & 1 & 2 \end{bmatrix}$ e $C = \begin{bmatrix} 2 & -2 & 1 \\ 0 & 1 & 0 \\ 1 & -1 & 0 \end{bmatrix}$, then $A^2 + B^t C$ is

   □ $\begin{bmatrix} -1 & 2 & -1 \\ 6 & 0 & 3 \\ 5 & 5 & 2 \end{bmatrix}$

   □ $\begin{bmatrix} -1 & 1 & 0 \\ 7 & 2 & 2 \\ 6 & 2 & 4 \end{bmatrix}$

   □ $\begin{bmatrix} 3 & -1 & 1 \\ 4 & -1 & 1 \\ 4 & 1 & 4 \end{bmatrix}$

   □ $\begin{bmatrix} 3 & 0 & 0 \\ 3 & -3 & 2 \\ 3 & 4 & 1 \end{bmatrix}$

   □ None of the others is correct.

- A medium level test involved operations with matrices of complex numbers and matrices proprieties, but only the easiest proprieties and without demonstrations.

1. If $A = \begin{bmatrix} 1 & i & 0 \\ 1+i & -1 & 1 \\ 2i & 2 & 1 \end{bmatrix}, B = \begin{bmatrix} -i & 1+i & 0 \\ 1 & -i & 2i \\ 2 & 1-i & -2i \end{bmatrix}$ e $C = \begin{bmatrix} 2 & -2 & 1 \\ 0 & 1 & 0 \\ 1 & -1 & 0 \end{bmatrix}$, then $\bar{B} + A^t$C

- $\begin{bmatrix} i & 5+2i & 1 \\ 2 & -1+i & 2+i \\ -i & 1-i & -1+2i \end{bmatrix}$
- $\begin{bmatrix} 2+3i & -i & 3 \\ 3+i & -3-i & 1+2i \\ 1 & -2i & 2i \end{bmatrix}$
- $\begin{bmatrix} 2+3i & -2i & 1 \\ 3+2i & -3-i & -i \\ 3 & 1+i & 2i \end{bmatrix}$
- None of the others is correct.

2. The statement:

"If A is a square matrix of order three and with a null row and B is a square matrix of order three and with no null elements, then AB is a square matrix of order three and with a null row."

It's

- True
- False

- A difficult level test involved matrices proprieties. Thus, an medium level test could for example be

1. The statement:
"If A and B are idempotent and permutable matrices, then AB is also an idempotent matrix."
It's
☐ True
☐ False

2. Consider the matrix $A = \begin{bmatrix} 1 & 2 & 3 \\ 0 & \propto & 0 \\ 0 & 0 & \propto \beta \end{bmatrix}$. Rank(A) = 2, if and only if
☐ $\propto \neq 0 \ \wedge \beta \neq 0$
☐ $\propto = 0 \ \vee \beta = 0$
☐ $\propto \neq 0 \ \wedge \beta = 0$.
☐ None of the others is correct.

Another evaluation components were the challenges. Each challenge had three multiple-choice questions related to the subjects being taught. Each challenge also had three levels. In the easiest level the questions are only about the subjects taught in the class. In the medium level the questions are about the subjects taught in this class, but related with a subject taught in a other class of the same year and the same course. In the most difficult level the questions were related with real problems. The student started at the easiest level and was going up the level. To level up he had to be able to solve all the issues at that level. If he missed any question he lost a life, but he could try a challenge of the same level again. In each challenge the student had three lives he could use. The number of points depended on the number of lives used and the level at which the student arrived. During the semester the student performed three challenges.

For example, one question of the easiest level is

1. Consider the matrix $A = \begin{bmatrix} a & 0 & b \\ c & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$, where a, b and c are real parameters.

a) Indicate the values of the parameters a, b and c for which A is an idempotent matrix.

b) Indicate the values of the parameters a, b and c for which A is a matrix nilpotent of order 3.

One question of the medium level is, for example

1. Consider the electrical circuit shown in figure

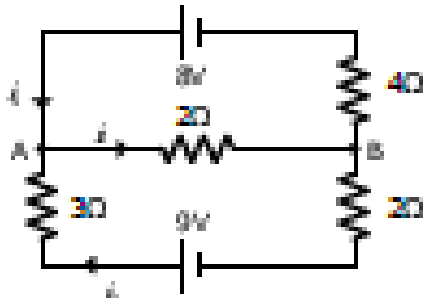

Figure 1. Electrical Circuit

The potential difference between the battery terminals, measured in volts (V), produces a current that leaves the positive pole of the battery (indicated by the side containing the longest vertical line). The capital letters represent the nodes of the electric circuit. The letter i (not to be confused with imaginary unit which in this context is represented by letter j) represents the current between the nodes and the arrows indicate the direction of flow, but if i is negative then the current flows in the opposite direction to the indicated one. The currents are measured in amperes and the resistors in ohms.

Based on Kirchhoff's laws for electrical circuits, determine the currents in the meshes

One question of the difficult level is, for example

1. Consider the image

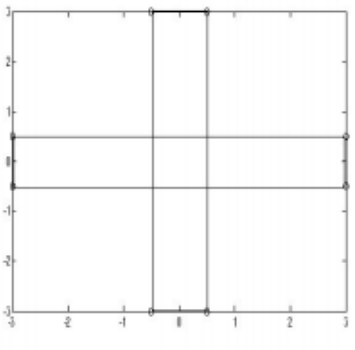

Figure 2 . Cross

and the matrix D that represents it.

$$D = \begin{bmatrix} -0.5 & 0.5 & 3 & 3 & 0.5 & -0.5 & -3 & -3 \\ 3 & 3 & 0.5 & -0.5 & -3 & -3 & -0.5 & 0.5 \end{bmatrix}$$

a) What is the effect of pre-multiplying D by matrix $A = \begin{bmatrix} 20 & 0.5 \\ 0.5 & 2 \end{bmatrix}$?

b) Give a matrix B such that BD represents a reduction of the initial figure, i.e., a similar but smaller figure.

With gamification, the tests and exams turned into fighting against enemies and the proposed exercises for classes and group work turned into missions. The grades were the result of the number of points earned through accomplishing the missions and combats with the enemies, which allowed the students to increase the number of points and level up until reaching the maximum. Two types of missions were planned: individual and group. Thus, each player earned points based on their individual performance and also on the performance of the group as a whole, which stimulated the collaborative character of the process. Some tasks involved competitions between groups, which potentiated the competitive side of the games, but in interaction with the cooperative aspect, because the disputes happened between these groups.

The fact that grades were the result of the points obtained implied making available and evaluating a much larger number of tasks than in the previous curriculum. In games, the player has opportunities to evolve his character all the time accomplishing missions or defeating enemies to gain points. To provide that look in the classes, it was necessary to think of a larger number of punctuated tasks, so players could perform various missions to get those points.

A list of activities to be carried out each week was published weekly in Moodle. On that list was also the indication of the medals available this week and what the students would have to do to reach them. It was also published weekly in the Moodle the Leadership Framework in the form of a list, sorted in descending order of number of points, indicating the points of each student and the level in each student was. There was a lot of competition and it was also found that the students made a great effort to be in the first places of the list.

Results

In this study, the sample was the set of all two hundred and ninety-four students enrolled in the first year and first semester of this engineering course. As for sex, as would be expected in an electrotechnical engineering course, the majority were men, only twenty (7%) of these students were women and two hundred and seventy-four (93%) were men, see figure 3.

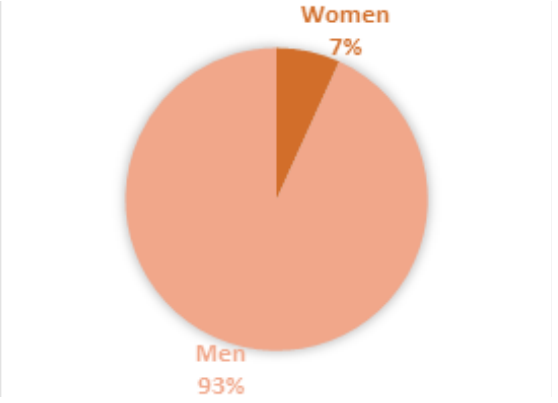

Figure 3. Gender distribution

With the introduction of gamification, classes have become a more challenging experience due to the new method used. As in each class where the student was

present and participated, the student earned a small amount of points until reaching the stipulated maximum, there was a very large increase in the number of classes each student went to. Traditionally, in mathematics subjects from the first years of an engineering degree, the percentage of students per class is small, this year has seen a considerable increase in both theoretical and practical classes, see figure 4 and figure 5.

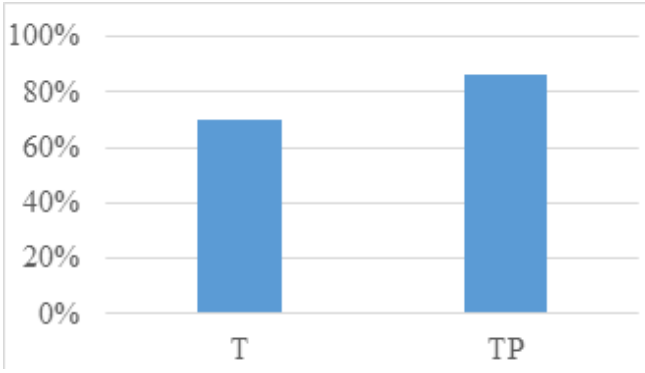

Figure 4. Average attendance with gamification

As can be seen this year the rate of students who dropped out was much lower than in previous years.

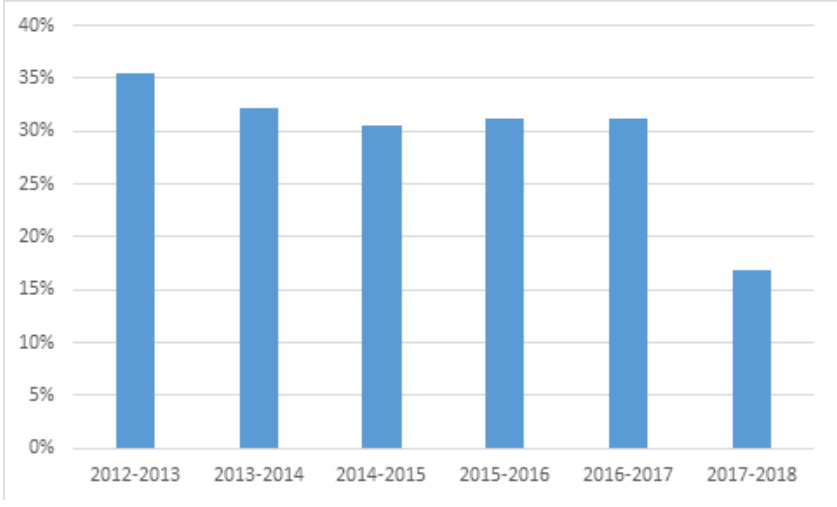

Figure 5. Percentage of students who dropped out in the last years

As they wanted to "win" the game, earning all the medals possible, overcoming all the challenges to reach the last level, they worked harder during the semester and this was reflected in the learning and consequently the Final Approval Rate. The percentage of students leaving the course was very low (6%) compared to usual in previous years (15% to 30%) and the rate of failed students was also lower (33%), see figure 6.

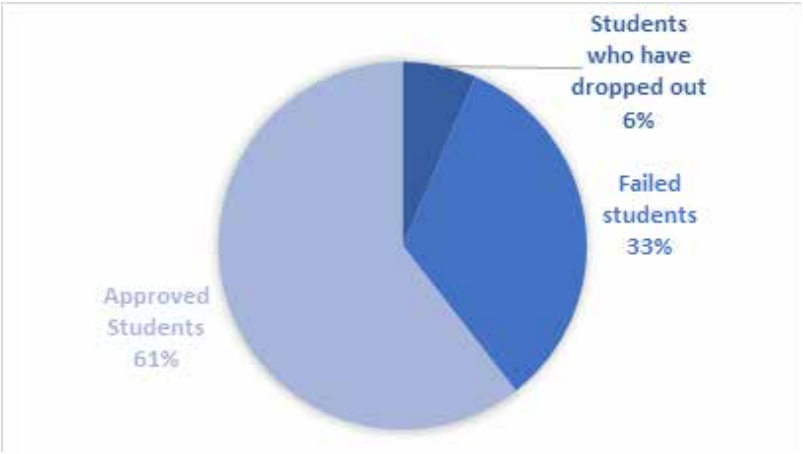

Figure 6. Approval rate

At the end of the semester, the students were asked to fill out an inquiry where they gauged how they had felt in the game. The questionnaire was elaborated with closed and open questions and aimed to collect data to identify a brief profile of the participants and to listen to their opinion about the proposal to use gamification.

The students answered the questionnaire in an anonymous way and via Moodle. It was intended to listen to the students' opinions regarding the advantages and disadvantages they had felt regarding motivation and learning.

Most of the students (97%) responded to the survey and 95% said they had been more motivated and they work harder, and this had been reflected in the average attendance and in the approval rate. Of the students who answered, 38% considered the experiment to be optimal, 42% that was very good and 20% that was good.

Students were asked to identify the positives and negatives related to the topic. In general, the positive points presented were

- motivation and stimulation of learning;
- development of logical reasoning and problem-solving strategies and challenges;
- competitiveness;
- self-improvement and persistence;
- playful and dynamic way of learning;

And the negatives points presented were

- harder than in previous years
- over-competitiveness
- distractions, with loss of focus on content;
- increased gambling addiction;
- mechanization: the student plays for playing and not for learning.

Of the students who answered, 38% considered the experiment to be excellent, 42% that was very good and 20% that was good. Although some students said that this experience was very laborious, none of them rated it as bad or very bad, see figure 7.

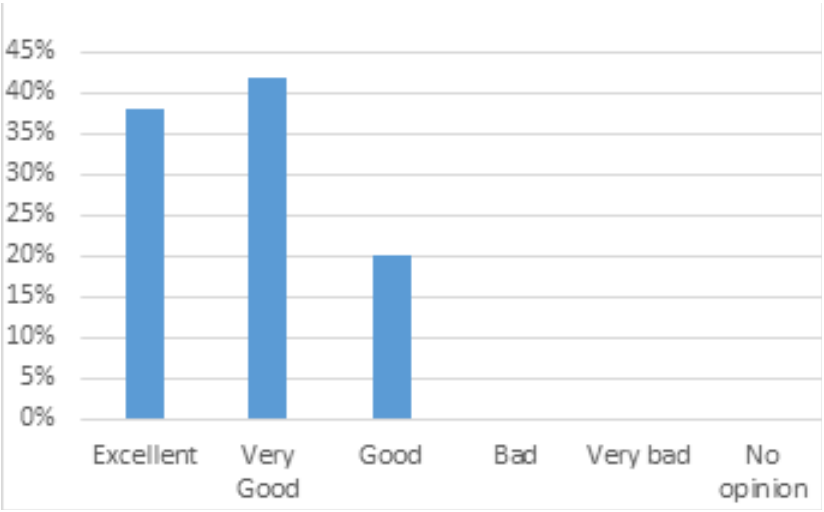

Figure 7. The feeling about gamification experience

Conclusion

During this semester I realized that the true potential of gamification is not easy to obtain. Game elements are valuable tools, and using them requires discernment, care, and knowledge. As with gambling, misuse of gamification may result in an unattractive and insignificant entertainment experience.

In this case it seems to us that a quantitative approach is not appropriate, since it is not possible to compare the results of the educational success this year with those of the previous years, because the students are different. It is also difficult to compare with the results of other curricular units, because the degree of difficulty is different. However, it can be observed that the impact of learning through gamification has proved to be very successful, with very low dropout rates and high student involvement in classes and in UC activities.

Gaming has a strong psychological effect on people's behavior, so gamification becomes a valid alternative to arouse emotions and contribute to student motivation while performing tasks. Games, which have always been seen as a form of distraction, can merge with contemporary needs in various aspects and environments. In particular, in education, gamification can motivate the study and promote the student's cognitive development. In the learning scenario, this proposal allows a more active and practical participation of the students. However, to obtain its potential benefits it is necessary to plan the educational objectives, discuss the strategies to be used to apply the concepts and mechanics of the games, as well as to analyze already promoted experiences.

In this way, it is possible to reduce the risk of the student to be interested only extrinsically by the approach, aiming only rewards, fun and entertainment.

The positive and negative points pointed out by the students in the final of the semester were very interesting, showing diverse opinions and, nevertheless, very coherent. The positive points listed outweighed the negatives, with motivation being a very prominent aspect. Despite evaluating activities as laborious, students reported feeling more motivated and interested.

References

Akpolat, B.S., & Slany, W. (2014). Enhancing software engineering student team engagement in a high-intensity extreme programming course using gamification. 149-153. 10.1109/CSEET.2014.6816792.

Anderson, A., Huttenlocher, D., Kleinberg, J., & Leskovec, J. (2014). Engaging with massive online courses. In C. W. Chung et al. (Ed.), 23rd International Conference on World Wide Web, 687–698 https://cs.stanford.edu/people/ashton/pubs/mooc-engagement-www2014.pdf

Barata, G., Gama, S., Jorge, J., & Gonçalves, D. (2013). Improving Participation and Learning with Gamification. In L. Nacke et al. (Ed.), International Conference on Gameful Design, Research, and Applications 10– 17 file:///C:/Users/Utilizador/Downloads/barata2013c.pdf

Caton, H & Greenhill, D. (2013). The effects of gamification on student attendance and team performance in a third-year undergraduate game production module. 7th European Conference on Games Based Learning, ECGBL 2013. 1. 88-96.

de Byl, Penny & Hooper, James. (2013). Key Attributes of Engagement in a Gamified Learning Environment. 30th Annual conference on Australian Society for Computers in Learning in Tertiary Education, ASCILITE 2013. file:///C:/Users/Utilizador/Downloads/paper_171232.pdf

Denny, P. (2013). The effect of virtual achievements on student engagement. In W. E. Mackay et al. (Ed.), Conference on Human Factors in Computing Systems (CHI 2013), (pp. 763–772). Paris, France.

Dicheva, D. Dichev C. Agre, G. & Angelova G. (2015). Gamification in Education: A Systematic Mapping Study. Educational Technology & Society, 18 (3) https://www.researchgate.net/publication/270273830_Gamification_in_Education_A_Systematic_Mapping_Study_

Espíndola, R. (2014). O que é a gamificação e como ela funciona? https://www.edools.com/o-que-e-gamificacao/

Hakulinen, L., & Auvinen, T. (2014). The Effect of Gamification on Students with Different Achievement Goal Orientations. LaTiCE' 14, (pp. 47 - 54). Kuching, Malaysia. doi:10.1109/LaTiCE.2014.10

Iosup, A., & Epema, D. (2014). An experience report on using gamification in technical higher education. In J. Dougherty, & K. Nagel (Ed.), SIGCSE'14 (pp. 27–32). Atlanta, GA: ACM.

Kapp, K. (2015). Gamification: Separating Fact from Fiction. http://ww.w.cedma-europe.org/newsletter%20articles/Clomedia/Gamification%20-%20Separating%20Fact%20from%20Fiction%20(Mar%2014).pdf

Lee, J. J. & Hammer, J. (2011). Gamification in Education: What, How, Why Bother? Academic Exchange Quarterly, 15(2).

Leong, B., & Yanjie, L. (2011). Application of Game Mechanics to Improve Student Engagement. International Conference on Teaching and Learning in Higher Education. Singapore. doi:10.1.1.368.1256

Mak, H. W. (2013). The Gamification of College Lectures at the University of Michigan. http://www.gamification.co/2013/02/08/the-gamification-of-college-lectures-at-the-university-ofmichigan/

Marins, D. R. (2013), Um Processo de Gamificação Baseado na Teoria da Autodeterminação, Dissertação (Mestrado em Engenharia de Sistemas e Computação) – Universidade Federal do Rio de Janeiro/COPPE, Rio de Janeiro.

Franco, P. M., Ferreira, R. K, R, Batista, S. C. F. (2015). Gamificação na Educação: Considerações Sobre o Uso Pedagógico de Estratégias de Games, Congresso Integrado da Tecnologia da Informação file:///C:/Users/ajv/Downloads/6950-18869-1-SM%20(1).pdf

Mitchell, N., Danino, N., & May, L. (2013). Motivation and Manipulation: A Gamification Approach to Influencing Undergraduate Attitudes in Computing. In P. Escudeiro, & C. de Carvalho (Ed.), European Conf. on Games Based Learning (pp. 394–400). Porto, Portugal: ACPI.

Moura, P.C. & Viamonte, A.J. (2010) , Teaching using Mathematics Games, 9th International Conference on Applied Mat. - APLIMAT 2010, Bratislava, 2 a 5 de fevereiro de 2010.

Lopes, R. P. & Mesquita, C. (2015). Gamificação: uma experiência pedagógica no Ensino Superior. CNaPPES 2015: Congresso Nacional de Práticas Pedagógicas no Ensino Superior. Leiria, Portugal. https://bibliotecadigital.ipb.pt/handle/10198/13685

Viamonte, A.J. (2016). Uma experiência de avaliação e aprendizagem com moodle. CNaPPES.16, Proceedings.

Viamonte, A.J. (2017). Uma experiencia de Gamificação numa disciplina do 1º ano de uma licenciatura em Engenharia. CNaPPES.17, Proceedings (pp. 60) http://cnappes.org/files/2014/03/cnappes-2017-booklet.pdf

Zichermann, G. e Cunningham, C. (2011), Gamification by Design: Implementing Game Mechanics in Web and Mobile Apps, O'Reilly Media