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Gamification with Moodle in higher education

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Today, although teachers continuously seek novel pedagogical approaches, it is largely agreed that schools face major problems around student motivation and engagement. In this context, gamification can have good effects, since the gamification, when used as a teaching strategy, favors learning and the motivation. Though the gamification is a subject that is very discussed in the educational field, still's little implemented, especially in higher education. In this work we present one gamification experience with first year and first semester students in a mathematical curricular unit. The goal was reduced school dropouts, which have a traditionally very high rate in these curricular units and increase the motivation to empower students for 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 lower, and the approval rate was good.

Keywords: Gamification, higher education, pedagogy.

Introduction

Traditional schooling is perceived as ineffective and tedious by many students and in a special way a large group of students in the first year of engineering courses, does not like math classes which leads to high dropout and failure rates. At a time when most of the young audience plays computer and video games, the gamification can be a good help, because gamification tries to harness the motivational power of games and apply them to real-world problems, in our case, students' motivational problems.

A lot of papers reporting experiences with gamification have appeared in the last years, but the idea of using thought and game mechanics to solve problems is old (Viamonte, 2018). According to Zichermann and Cunningham (2011), was the Scottish philosopher David Hume who first laid the groundwork for understanding the player's motivations at three hundred years ago. But Gamification is not only about introducing game elements, such as the distribution of rewards and medals for a given product, but it requires an in-depth approach to decide which elements will be incorporated and their conformity with the context of the goal. According Gurjanow and Ludwig (2017), prior to implementing game elements, recommend analyzing the projects target group, the conditions and the inherent activities. The result of the analysis is the definition of goals that gamification should achieve. The next step is to design and implement game elements based on the defined goals. Finally, evaluation and monitoring are useful to make further improvements (Gurjanow & Ludwig, 2017).

There is no consensus about gamification, for example, while some authors highlight the following elements of games to be observed in gamification: objective, rules and voluntary participation, Werbach and Hunter define the PBL Triad: Points, Badges, Leaderboards (Franco et al., 2015). But we can see that when we use the 'gamification' in the classroom, some transformations always
occur, such as, students who become players, more challenging classes, students working autonomously and/or in groups and working to earn points, receive medals, achieve the highest scores and enter the leaderboard...

In this work we pretended study the question: Is gamification effective in reducing dropout?

Gamification

According to Iosup and Epema (2014), gamification may have originated in the early-Communist thought and matured in the Soviet era, as a substitute for monetary incentives to perform at work and saw a reemergence in the U.S. in the early 1980s. More recently, in the 2000s gamification received various definitions, and was used with promising results in various curricular and organizational settings. For 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.

According to Kapp (2015) 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.

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 three categories, dynamics: constraints (imposed limitations), emotions, narrative, progression and social relation; mechanical - elements that stimulate actions and involve the player: challenges, competition, feedback (performance), randomness, cooperation (teamwork), rewards and victory and 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. (Viamonte, 2018)

Methodology

In this work we present one gamification experience that we did in a Linear Algebra course. Gamification was used in the students evaluation, and for this the classification were replaced by points that were attributed to the students as they went doing the tasks in the classes or online. The students could have earned points for completing a lesson or for doing extra research about the lesson. At the beginning of the semester, all students had a hundred starting points, and after classes started, all they did or did not, was giving them or taking them points. Each hundred points corresponded to one level and there were twenty levels corresponding to grades from zero to twenty. During the semester there were several evaluation moments, such as Moodle’s tests, challenges and individual tests, that corresponded to tasks that the students had to do and there were also some medals or bombs. The medals were rewards attributed to the students for doing certain
tasks, such as 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 required tasks such as homework, Moodle tests, among others. Bombs penalized students by taking a predetermined amount of points from them. One task that was proposed to each student at the end of each topic was the resolution of a problem related with his course and where he needed the concepts he had just learned for his solution. These problems were often suggested by the professors of engineering disciplines. Other component of the evaluation were the Moodle's tests. The students took these tests biweekly and on the weekend. During the semester, the student had to do six tests in Moodle. When he opened the test, the student chose the level he wanted to do, easy or difficult, knowing that the difficult level allowed him to get double the points he could reach with the easy level. But each student had to do at least one test of each 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, so he goes 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.

An easy level test involved only operations with real matrices, and a difficult level test involved operations with matrices of complex numbers and matrix properties. A difficult level test could be, for example, the one presented below.

\[
\begin{bmatrix}
1 & i & 0 \\
1+i & -1 & 1 \\
2i & 2 & 1
\end{bmatrix},
\begin{bmatrix}
-i & 1+i & 0 \\
1 & -i & 2i \\
2 & 1-i & -2i
\end{bmatrix}
\text{ and } \begin{bmatrix}
2 & -2 & 1 \\
0 & 1 & 0 \\
1 & 1 & 0
\end{bmatrix}
\]

then \( \bar{B} + A^T C \)

\[
\begin{bmatrix}
i & 5+2i & 1 \\
2 & -1+i & 2+i \\
-i & 1-i & -1+2i
\end{bmatrix}
\begin{bmatrix}
2+3i & -2i & 1 \\
3+2i & -3-i & -i \\
3 & 1+i & 2i
\end{bmatrix}
\]

\[
\begin{bmatrix}
2+3i & -i & 3 \\
3+i & -3-i & 1+2i \\
1 & -2i & 2i
\end{bmatrix}
\]

None of the others is correct.

2. The statement:

"If A and B are idempotent and permutable matrices, then AB is also an idempotent matrix."

It's          False

Challenges were another component of evaluation. Each challenge had multiple choice questions related to the subjects taught from the beginning of the semester up to that time and had three levels, easy, medium, and difficult. The students started at the easy level and went up the level. To level up, the student needed to correctly solve all questions at that level. If he missed a question, he would lose a life, but he could try a new challenge of the same level again. At each challenge, the student had three lives that he could use. The final number of points depended on the number of
In the easiest level the students needed to do 3 questions that were about the subjects taught in the class. In the medium level the students needed to do 2 questions that were about the subjects taught in this class but related to a subject taught in another class of the same year and the same course. And in the difficult level the students needed to do 2 questions that were related with another subject. As they were students of Electrotechnical Engineering, a question of the medium level was, for example the one presented below.

1. Consider the electrical circuit shown in Figure 1.

![Figure 1: electrical circuit](image)

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 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.

During the semester students performed 2 individual exams, the first in the middle of the semester and the second at the end of the semester, but with the gamification, exams were the biggest misses to perform. The grades were the result of the number of points earned through the accomplishment of the missions, and two types of missions were planned: individual and group. Students could choose to do the challenges individually or in groups. If they chose to do as a group, the group would be chosen by them, would have between 3 and 5 students and all the challenges in the semester would have to be made by the same group. Thus, each student earned points based on their individual performance and the performance of his group, which stimulated the collaborative character of the process. Each group had good and weak students and it was noted that the best students were pulling the weak so that the group performed well. Group tasks generally involved group competitions, which potentiated the competitive side of the games, but interacted with the cooperative aspect because each group functioned as a whole. A list of activities to be carried out was published weekly in Moodle and this list also indicated the medals available this week and what students would have to do to reach them. It was also published weekly in the Moodle the Leadership Chart in the form of a list, arranged in descending order of number of points, indicating the points of each student and the level of each student, and were highlighted the students placed in
the first 15 places. There was a lot of competition and it was also discovered that the students made a great effort to be in the first places of the list.

At the end of the semester, students completed an inquiry into the use of gamification and how they felt in the game. The questionnaire, which was answered anonymously and via Moodle, was developed with open and closed questions and aimed to collect data to identify a brief profile of the participants. It was intended to listen to students’ opinions about the advantages and disadvantages they felt about motivation and learning.

**Results**

We worked with all students enrolled in the first year of the first semester of this engineering course (two hundred and ninety-four). As for sex, as one would expect in an Electrotechnical Engineering course, the majority were men, two hundred and seventy-four (93%) and only twenty (7%) of these students were women.

When gamification was introduced, classes became a more challenging experience due to the new method used. For each class in which the student was present and participated, the student earned a small amount of points until reaching the maximum stipulated, there being a large increase in the number of classes that each student went. Traditionally, in mathematics subjects from the first years of an engineering course, the percentage of students per class is small, principally in theoretical classes, this year there was a considerable increase of student’s number in theoretical and practical classes. We also found that this year the rate of students who dropped out was much lower than in previous years as can be seen in Figure 2.

![Figure 2: percentage of students who dropped out in the last years](image)

As they wanted to “win” the game, winning all possible medals, 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 (17%) compared to usual in previous years (31% to 36%) and the rate of failed students was also lower (33%).

The survey to listen to students' opinions about the advantages and disadvantages was answered by most students (97%) and 95% said they were more motivated and worked harder, which was reflected in the average frequency and passing rate. Of the students who answered, 38% considered the experience of using gamification excellent, 42% very good and 20% good. Although some students said that the gamification experience was very laborious, none of them rated it as bad or very bad, see Figure 3.
In the questionnaire that was placed in Moodle at the end of the semester, the last question asked each student to identify which were in their opinion the positive and negative aspects of the gamification experience that they had done. The positive points more presented were

- motivation and stimulation of learning;
- playful and dynamic way of learning;
- self-improvement and persistence.

And negative points more presented were

- harder than in previous years;
- over-competitiveness;
- mechanization: the student plays for playing and not for learning.

In this questionnaire they were placed other following questions:

Q2 - Which type of evaluation do you prefer
Q3 - Gamification was useful for my learning
Q4 - The gamification didn’t help me anything
Q5 - The gamification helped me in studying
Q6 - The gamification didn’t promote my self-motivation

According their opinion the students filled for Q2 (only assessment, assessment with gamification) and for remain questions they filled (Strongly agree, Agree, Neither agree nor disagree, Disagree, Strongly disagree).

In order to verify the effect of type of evaluation, we performed a Chi-square test who revealed significant difference between two categories from question 2, as shown in table below by p-values results (<0.05* and 0.01**)

<table>
<thead>
<tr>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
<th>Q5</th>
<th>Q6</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.010*</td>
<td>0.016*</td>
<td>0.002**</td>
<td>0.008**</td>
<td></td>
</tr>
</tbody>
</table>

Table 1: The effect of type of evaluation

The gamification had a significant contribution in motivation for doing the assessment. We detail in below the process. We assigned 100 points to each student at the beginning of the gamification process. The students had been subjected at 7 moments of evaluation corresponding to 6 moments
to Moodle actions and the other one, on the first assessment. The scores obtained by students had also a significant performance along the process of gamification.

We observed a great enthusiasm between at the beginning of the process, showed by graph, figure 4. Until the 3rd moment (before the first assessment) these good results went on, but the remains didn’t give the previous impression. We observed some outliers in some moments, explained by the penalties according to the rules of the game. The outlier’s presence caused a negative impact in general results which provoked the existence of significant mean differences as we can observe in Table 2.

![Scores Game](image)

**Figure 4: Scores Game**

<table>
<thead>
<tr>
<th></th>
<th>M1</th>
<th>M2</th>
<th>M3</th>
<th>M4</th>
<th>M5</th>
<th>M6</th>
<th>Final</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>17.21</td>
<td>16.43</td>
<td>15.69</td>
<td>14.20</td>
<td>13.90</td>
<td>12.54</td>
<td>13.45</td>
</tr>
<tr>
<td>S.d.</td>
<td>0.30</td>
<td>0.33</td>
<td>0.33</td>
<td>0.33</td>
<td>0.34</td>
<td>0.33</td>
<td>0.31</td>
</tr>
</tbody>
</table>

The table above show difference significant between all moment’s means (t-test, p<0.001). We observed higher results at the first three moments followed by a significant break in four last moments. However, the variability has not suffered a significant changing along the gamification process.

**Conclusion**

During this semester, we realized that the elements of the game are valuable tools, but we need to use them with care and knowledge to get the expected results. Nowadays, most people play electronic games, so games have a strong psychological effect on people's behavior. Gamification becomes then a valid alternative to arouse emotions and, particularly in education, the gamification contributes to the student's motivation during the execution of tasks. In the learning scenario, this proposal allows a more active and practical participation of the students. But to obtain its potential benefits and reduce the risk of the student to be interested only extrinsically by the approach, aiming only rewards, fun and entertainment. It is necessary to plan the educational objectives, discuss the strategies to be used and analyze the experiences already promoted. In this work we did not do a quantitative approach because it is not possible to compare the results of this year's educational success with those of previous years because the students are different, and it is also difficult to compare with the results of other curricular units of same year because the degree
difficulty is also different. To use a quantitative approach, we would have to have a test group to make comparisons and this was not possible. However, in this semester the dropout rate was low, and the students were very involved in the classes and in the activities of the curricular unit. These facts may indicate that the impact of gamification on learning has been successful.

The positive and negative points pointed out by the students at the end of the semester were very interesting, presenting diverse and yet very coherent opinions. The listed positive points outweighed the negative ones, with motivation being a very prominent aspect. They found too the applying problems difficult but interesting as they helped them to better understand the usefulness of learning mathematics in an engineering course. The main negative point presented by the students was the fact that the curricular unit this semester was more work, which in our opinion is not negative, and was reflected in the good approval rate. Although evaluating activities as laborious, students reported feeling more motivated and interested and it may be noted that no student considered this experience to be bad or very bad.

References


