

Gamification in Higher Education: Gamifying an Engineering Course

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Abstract: *Research has shown that games have the potential to improve motivation, encouraging players to fulfill their quests. The process of adopting game elements in non-gaming contexts is known as gamification and has been successfully used in a variety of settings. Leveraging on this, we gamified an engineering course, including classical game elements such as leaderboard, experience points and levels. Results were very encouraging, showing increased involvement, participation, fun, motivation and satisfaction.*

Keywords: *Gamification, Gamification in Education, Gamified Learning, Student Engagement.*

I. Introduction

Recent years have witnessed a dramatic increase in the use of Games in a multitude of purposes. In a great part, this phenomenon is due to the capacity of games to motivate and encourage users to successfully complete the quests they are presented with. If effectively designed, games provide a sense of flow, in which players reach a state of immersion and energized focus without feeling either bored or frustrated [1,2].

Researchers have studied games over the years, aiming at understanding how their inherent mechanisms may be used to enhance learning processes. Research has, in fact, shown that games, due to their nature and ability to captivate users and enable them to strive for quest completion, can increase the engagement of students, motivating them to learn [3,4].

Gamification consists of taking advantage of the potential of games by adopting game

elements in non-game contexts [5]. Gamification has been favorably used to keep users motivated to perform a set of tasks to improve their productivity [6], eco-friendliness [7] and health [8], among others.

Gamification in educational settings has been an active field of study over the recent years, yielding very promising results. Research has shown the potential of gamified processes in education. In particular, student activity [9] and performance [10] seem to highly benefit from gamification. In fact, games have been relevant in education, with documented improvements in learning outcomes. Research has replicated overall iterations of the same gamified course over the years [11], with a considerable number of students, achieving good results in terms of performance and engagement.

In this work, we added a set of game elements (leaderboard, levels and experience points (XP)) to an instance of a Multimedia Engineering Course – Graphical Animation Techniques I – at Instituto Superior de Tecnologias Avançadas (ISTEC), aiming to understand the effect of gamification in a more restrict group of students. Even with a small sample, results were favorable, showing increased engagement, satisfaction, involvement, fun, participation and creativity.

The remainder of this paper is organized as follows: section II presents Related Work, and section III describes the adopted game mechanisms and how they were embedded in learning processes. While in section IV we present and discuss our results, in section V we finalize with our conclusions.

II. Related Work

The fact that traditional learning processes have become ineffective over the decades, failing at properly motivating students to participate in curricular activities, has motivated a wide corpus of research.

Several studies have shown that the most effective gamified processes are the ones in which a coherent, immersive learning experience is created. Lee Sheldon [12] describes the approach to follow when converting a course into a game, allowing users to upgrade their grades from an F to an A+ through challenges and experience points. This has been the starting point to promising research such as the works conducted by Holman and Aguilar [13,14].

In their research, Cheong et al. [15] evaluated IT students through a gamified quiz in which they were granted points for each correct answer. A leaderboard was part of this experience, in which students reported improved enjoyment and engagement.

Barata et al., [11] performed a long-term study in which a higher education Engineering course was gamified for ten years, using different game elements (leaderboards, experience points, levels, badges, challenges, quests, etc.), having shown a positive impact in student engagement and participation.

More recently, Legaki et al. [16] studied the impact of gamification in statistics education. Their game “Horses for Courses” took advantage of points, levels, challenges and a leaderboard, having shown a positive impact in learning. Also very recently, Putz et al. [17] ran a study with a large number of students over two years, concluding that gamification plays a major role in knowledge retention and, consequently, learning performance. Interestingly, this study found that the effect of gamification is independent of age.

All these studies prove the potential of gamification in learning, specifically targeted at learning outcomes and engagement. However, with our work we want to focus on studying the

results in smaller groups and look at other facets as well, such as fun and overall satisfaction.

III. Creating a Gamified Course

Considering the importance of using familiar gameplay mechanisms, we adopted a Leaderboard, Experience Points (XP) and levels to our instance of the course.

The Leaderboard (Figure 1), depicts, for each player, their rank, picture/avatar, current XP and current level. It was updated right after each course activity (in the same day), providing students with timely feedback on their progress.

Leaderboard			
Rank	Player	XP	Level
1	 [Player Name]	37375	19 Unlocking the next level!
2	 [Player Name]	36250	19 Unlocking the next level!
3	 [Player Name]	34250	18 Slaying bosses
4	 [Player Name]	33875	17 Slaying enemies
5	 [Player Name]	30500	16 Expanding inner strenght
6	 [Player Name]	30000	15 Acquiring secret scrolls
7	 [Player Name]	25375	13 Measuring strengths
8	 [Player Name]	1000	1 Let the games begin!

Figure 1: Leaderboard

Levels ranged from 0 to 20 and were directly mapped to the current grade of the student. This means that XP were converted to the corresponding level, allowing students to understand which grade they had attained so far (and manage their effort).

Our proposed gamified course consisted of a total of 40.000 Experience Points (XP). Participation in course activities throughout the semester granted students a corresponding amount of XP, as we will shortly detail.

To create an engaging narrative [18], graded activities were created with a connection to the Hero’s Journey [19], in which: (a) Smaller

challenges (“*Hands-on*”) were thrown (practical course assignments); (b) A more significant challenge (“*Quest*”) was presented (course project); (c) The course theoretical quizzes (“*Scrolls*”) were unlocked, allowing game completion (passing the course).

Since the theoretical contents of the course consisted of two distinct parts, two smaller challenges were presented throughout the semester, corresponding each to one part of the contents. These, named *Hands-on exercises*, were, in total, worth 10.000XP (25% of the total course XP) and were done in two-student groups. To promote collaboration and social and cognitive presence, if all groups completed the activity, an extra 5% would be granted to all. Otherwise, no points were awarded.

The *Quest* corresponded to the final course project, also done in groups of two elements, and could grant a maximum of 80.000XP (20% of the total course XP).

Lastly, the *Scrolls*, corresponding to written quizzes, were worth 20.000XP (50% of the course grade). Additionally, since the final exam is mandatory at our institution, we defined that students must pass the final exam with a grade higher or equal to 10.000 XP.

An additional amount of 2.000 XP was granted for answering the initial and final questionnaires, which we will further detail.

Our game was deployed in the spring semester of 2018-2019, with a 16-week duration. The course was attended by eight students (N=8). At the beginning, students answered the BrainHex questionnaire [20], so that we could understand their gaming profile, with an additional question “I like to compete for grades”. At the end, they filled in the final questionnaire, comprising eight questions mainly aimed at assessing engagement and fun (Questions 1, 2, 3, 4 and 8) and at understanding each player’s predominant type of motivation (Questions 5, 6 and 7).

IV. Results

Table 1 summarizes the results of the final questionnaire, depicting the absolute frequency of each score (1 to 5) for each question. The average score was computed by multiplying the frequency of each score to its corresponding value.

	1	2	3	4	5	Average score
Q1				5	3	35
Q2					8	40
Q3			2	1	5	35
Q4				2	6	38
Q5			4	2	2	30
Q6			1	3	4	35
Q7	“ <i>I prefer to be challenged</i> ”: 8					
Q8-a				1	7	39
Q8-b		1		5	2	32
Q8-c		2		4	2	30
Q8-d				4	4	36

Table 1: Results of the final questionnaire.

Looking at the questions related to engagement and fun, we can see that participants were highly involved in the course (Q1: *avg*= 35), especially when compared to other courses (Q2: *avg*= 40). The same happens for participation (Q3: *avg*= 35) and creativity (Q4: *avg*= 38). We can also see which course elements generated more fun: XP (Q8-a: *avg*= 39), then assignments (Q8-d: *avg*= 36), followed by the leaderboard (Q8-d: *avg*= 32) and levels (Q8-d: *avg*= 30).

Regarding motivation, students found it more important to be challenged (Q6: *avg*= 35) than to have a higher grade (Q5: *avg*= 30). In fact, all preferred to be challenged over having the highest grade (Q7: *to be challenged* (N=8)).

Looking at these results, we conclude that gamification mechanisms were successful, leading to high scores of involvement and fun. In particular, these students, who want to feel challenged and need to find creative solutions as opposed to competing for grades, found these mechanisms to work well and completed the course with a high satisfaction.

V. Conclusions and Future Work

Gamification has shown promise in many settings, ranging from health to marketing. The use of game elements has proven its potential in academic settings, allowing very interesting results in terms of engagement and participation. This study presents the adoption of game mechanisms in a Higher Education Engineering course with a small number of students, showing promising results in terms of engagement, participation, fun, motivation and satisfaction.

While analyzing the results of future iterations of the course may provide us with interesting insights, we consider that adding further game elements may increase the success of these processes even further in years to come.

VI. References

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