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Jump to the Next Level: A Four-Year Gamification Experiment in Information Technology Engineering

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ABSTRACT Higher education in Spain has to deal with constant troubles and uncertainties due to the economic crisis, high rates of unemployment in young people, lack for study habits in secondary school and legal fluctuations. This uncertain environment does not foster student effort and it is behind the important rates of abandon in higher education. The Bologna Process was thought to create a new paradigm in higher education in the European Union. However, the changes came from the top (governments) to the bottom (lectures and students) so they were not properly supported by specialized training oriented to lecturers. It did not include the appropriate changes in lower education stages (secondary education) to prepare student when facing University. Therefore, in the past decade several new teaching methodologies have appeared to deal with student demotivation and to fight against dropouts. Those methodologies try to keep the students engaged during the whole course paying more attention to their learning process, attitudes, motivations and expectations. Consequently, in this paper, we present a four-year experiment whose main objective is to keep students engaged during the whole year and to foster their motivation in order to increase their learning outcomes. The experiment is based on the application of gamification to the assessment process emulating a traditional platform video-game, like Super Mario. The results show that this experiment was positive for most students who achieved good marks and good rates of task completion.

INDEX TERMS Education, engineering education, engineering students, gamification.

I. INTRODUCTION

Higher Education in Spain has suffered from a deep transformation from the past ten years. The implementation of the EHEA (European Higher Education Area) changed the Spanish degrees in a competence guided assessment system that should also be combined with more traditional theoretical and practical lessons. Since 2010, all the engineering degrees have been adapted to the requirements imposed by EHEA, popularly known as the Bologne process [1]. These changes have supposed an important challenge for students but also for lecturers [2] that should change their way to teach, creating new study materials and supporting media, and what is even more difficult, their assessment methods. Particularly, the assessment should focus on a continuous evaluation of the student rather than on an assessment based on only a final exam as it was done previously.

Nevertheless, those changes, which were thought to improve student motivation and performance, are not producing the expected outcomes. As described in [3], 60% of the professors from 37 Spanish Universities participating in a survey about the Bologna process in 2017 declared that the continuous assessment was like micro-exams throughout the course with a great shortcoming: students forget about the evaluated concepts after the tests so that a deep learning is not achieved. Although the goal of the EHEA was to create a student-oriented framework, the work in [4] remarks that the students feel themselves as put aside from the whole process.

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Another relevant drawback is revealed in the works in [5] and [6]. They identified that the workload for both lecturers and students is increased in comparison with the traditional approach. According to the students, there is an excess of workload, which was a negative contribution.

In our more than fifteen years of teaching experience, we have also observed this perception on students. Engineering students feel overburdened with the assessment tasks that subjects require in addition to the study of the theoretical concepts. That situation produces a high degree of demotivation in the students. This is partially derived from the lack of good study habits in their High School years, that eventually involves that they prefer old assessment methods based only on final exams. Additionally, most students do not make efforts to get good marks because the deep knowledge of the assessment methods allow them to select which tasks to accomplish to just pass the subject. Consequently, it is not uncommon that students avoid doing some tasks by the end of the semester if they have reached the minimum mark to pass a subject. This undesirable effect is widely extended throughout engineering degrees [7] and supposes a serious threat for the whole learning process in higher education, mostly when students in this area are, eventually, aimed to achieve important degree of knowledge and expertise in difficult skills.

Moreover, the number of dropouts observed since the Bolonia Process show alarming results in our degrees. For the course 2015/2016, the last year that the Government of Spain has published official records (Data available at [8]), the dropout percentage for University students in their first years reached 25%, while in engineering degrees it increased to a 36,4%. This means that one in three students that start studying our degrees abandon in their first year. Taking into account those rates, it is evident that changing only the assessment method is not sufficient to improve the learning process but new methodologies are needed to complement traditional ones in order to improve learning outcomes and reduce dropouts. Thus, some lectures try to complement those methodologies with new ones. Nevertheless, there are some colleagues who are reluctant to participate in these new methodologies because of the workload that this would imply [3].

Therefore, from our experience, we have verified that efforts aimed to analyze and to initiate and test new methodologies have to fight on two different pedagogical fronts: against the demotivation of students and against the objection of some lecturers to change their habits. Consequently, new methodologies should be attractive for both groups. Carefully designed methods and long periods of testing are required to achieve this objective. In particular, we have set three requirements for the techniques to apply. First, the new methodologies must be aware of the competence system and the approved assessment methods to avoid claims from students or academic institutions. Second, those methodologies should demand low or no effort from students because in this way they would not see their new tasks as part of assessment. And third, for lecturers, those new methodologies should require little or affordable effort because the additional work that they need would probably not be easily rewarded by the students and even by the university. This could derive in conflicting emotions as stated in [9]. According to Lagoa-Varela et al. [2] only lecturers between 10 to 20 years of experience have incorporated more changes in teaching skills, while those with less experience usually can't devote enough time because they are overburdened with research because it is mandatory for their promotion. In order to not have an excessive workload at the beginning of the experience, it is desirable a soft deployment of the methodology in the subjects.

Taking into account those requirements, most methodologies applied in the past decade in higher education are based in giving more prominence to the students instead of more traditional approaches that focused only in lecturers work [10]. As a result, some lecturers have adapted their methodologies to focus on students, e.g. new classroom dynamics like role playing [11]–[13], evaluation between pairs [14] or new ways of presenting theoretical contents to students like audio-visual media and interactive learning applications on Learning Management Systems (LMSs) [15] and online course [16]. Additionally, other kinds of methodologies which focus on complementary ways of assessment have been proposed. This is the case with the competition based assessment [17]. Among those new methodologies, gamification has been proved that to improve student engagement for different studies, even online ones [18], [19]. Although gamification has been widely applied during the past years, empirical examples are still scarce and the difficulties of its application go beyond its apparently simple concept [20].

From our experience [17], competition based assessment is well accepted among students. We detected that when students have feasible objectives and a clear reward (e.g. correctly finishing in first place a laboratory experiment to get one extra point in their final mark), they are more motivated and more autonomous in their work. Even working in groups, they organize themselves more efficiently. However, some students disengage from the competition after few tasks because they did not win any challenge and the efforts to get them failed. For that reason, we proposed a gamification framework based on game-guided tasks for a continuous assessment. This game lasts during all the semester with rewards that can be achieved by any student who shows a good performance in the course tasks. However, we combine intrinsic and extrinsic motivation by means of two types of rewards. Emulating the Super Mario saga video-games, students can get points and gold coins when the tasks are performed correctly. We have set a progressive degree of difficulty to obtain these items by defining three levels. The gold coins are used to acquire new tools/gadgets to use during the game, but they do not imply a direct impact on the students' final marks. Alternatively, the number of points got during the

game determines the Level to which the participant gets. If a student achieves Level 3, then it will increase their final mark. In addition, if she is the participant with the greatest number of points in her class, she will also receive an extrinsic reward with an extra increment in her mark. The combination of the extrinsic and intrinsic rewards supposes a very desirable tool to foster competition. The exact design is detailed in Section II.

The remainder of the paper is organized as follows. The next section presents the proposed gamification method. Section II-C shows the results obtained with the experiments conducted for three different subjects. The paper concludes with a discussion of the results, conclusions and future work in Section III.

II. METHOD

Engineering subjects usually combine theoretical concepts and their application. For this last competence, Engineering curricula combine theoretical concepts taught in a classroom with the practical work in laboratories [21]. Aiming at developing the autonomy of the students when facing a laboratory task, one of the common approach is to explain the basics and the objectives of the work to the students at the beginning of the course. Our previous experience with this approach showed that it is close to the end of term when the students deal with their final laboratory tasks, theoretical exercises and presentations. As a consequence, overburdened students give up doing the more demanding and less rewarding tasks. As a consequence, a deep learning is not achieved.

Our proposed experiment tries to keep students engaged with the course assessment throughout the semester. Consequently, the gamification-based assessment tries to show the student the benefits of a continuous effort during the semester, which can avoid last minute rushing for different work deadlines. Therefore, with a continuous work, students can achieve 'deep learning' [22], [23] and eventually better marks, avoiding demotivation and drop-outs.

Since the experiment is designed for higher education students, it should not modify the general assessment aspects. These aspects must be previously approved by the different teaching departments. As an illustrative example, the assessment aspects approved by the Department of Telecommunication Engineering at the University of Jaén (Spain) are four: (i) attendance and participation (S1); (ii) theoretical concepts (S2), (iii) problems and exercises solving (S3); and (iv) practical work (S4). All of them have also fixed percentages for the final course grade which are 10% for the first one and 30% for the other three. There is also a final exam that represents the half of the theoretical concepts (15%) and problems and exercises solving (15%). Thus, the final course mark is the contribution of each aspects throughout the semester (70%) and the final exam (30%). As a consequence, the gamification has to deal with the aspects evaluated during the semester, with no interference in the final exam (See Table 1 for summary). These aspects rule all the subjects that took part in the present experiment.

TABLE 1. Distribution of assessment aspects for a subject.

Assessment aspect	Semester	Final exam	Total
Attendance and participation (S1)	10%	-	10%
Theoretical concepts (S2)	15%	15%	30%
Problems and exercises solving (S3)	15%	15%	30%
Practical work (S4)	30%	-	30%
Subject total	70%	30%	100%

A. THE GAME

The engagement to the continuous assessment is achieved through the use of a gamification practice. In the designed gamification framework, there are three levels associated to a progressive degree of difficulty for obtaining rewards. These levels are:

- Level 1. It is the initial level in which all the students start.
- Level 2 or intermediate level.
- Level 3 or the final level.

Independently of the level the student is, all the participants have to deal with the same tasks. Particularly, we have designed 12 tasks in this framework (four for each aspect under evaluation in the S2, S3 and S4 assessment topics). Each task has a deadline, so students must submit their result before that time for its evaluation.

Considering the mark of the task and the level of the participant, she can obtain a number of points. The result from the evaluation of a task is codified with the term 'jump' in order to involve the students with the gamification world [24]. The jump is one of the most common element in the mechanics of some platform-based video games. The most popular example of a video-game based on this kind of movement is the Super Mario saga, where Mario, the main character, has to avoid obstacles and enemies jumping over or jumping on them to get gold coins and other kind of rewards.

In an analogous way to the Super Mario games, in our gamification procedure each successful jump, which means that the task is successfully accomplished in a certain degree, gives the student a different amount of points and an amount of gold coins depending of the evaluation of the task. The gold coins can be spent in buying different gadgets to improve, for instance, their scoring in the next tasks. The points, as the score in a video game, allow the progression of the student over the three different levels of difficulty. The number of points and gold coins obtained for each task are the same but they depend on two parameters. First, the degree of correctness of the submitted solution is related to the number of points. Second, the demanded degree to start accumulating points depends on the level so there is a progressive degree of difficulty from Level 1 to Level 3. So, in the starting level, or level 1, participants are rewarded just for their participation. In Level 2, only a passed task provides points to the participant. Finally, the demanding Level 3 only allows scoring with marks of 7 out of 10, or higher. The details for points and gold coins rewards are showed in Table 2.

TABLE 2. Score in points and gold coins rewarded for marks in the assessment tasks.

Mark of a task	Type of jump	Level 1	Level 2	Level 3
Just do the task	just walking	1*	0	0
$5 \leq$ mark < 7	normal jump	1 + 1*	1	0
$7 \leq$ mark < 9	big jump	2 + 1*	3	4
$9 \leq$ mark < 10	great leap	3 + 1*	4	5
mark = 10	incredible leap	4 + 1*	5	6

*: This point is rewarded for the students who do the task (even for those who failed) and for all the jumps in Level 1. For instance a student who score a big jump would receive 2 + 1 = 3 points.

The points needed to get a new level is based on the amount of assessment tasks that are set up for our subjects for courses without gamification to allow a better comparison with gamification ones. Therefore, in our implementation, we have 11 or 12 assessment tasks, that are divided among the three aspect under evaluation (S2, S3 and S4). As a result, with 12 jumps (evaluation tasks) a student with good marks should get level 2 by the middle of the semester and 3 by the end of the semester. Besides, the amount of points rewarded should be kept easy to manage, so that we set a scale from 0 to 6 to reward any jump (see Table 2 for details).

Consequently, if there are about 12 assessment tasks, and the students with a good performance should be able to reach Level 2 and 3 during the semester, they have to score at least normal jumps at the beginning of the semester and big jumps at least, by the remainder period. Thus, to achieve Level 2, is required a good performance at the beginning of the semester, which should imply to accomplish 4 to 6 evaluation tasks with big jumps (see Table 2). Taking into account that for the first level all evaluation tasks are rewarded with one point plus the jump for 4 big jumps the score achieved will be 12 and for 6 big jumps 18, being the average value 15. However 16 points were chosen to make Level 2 slightly challenging. With the same assumptions, Level 3 is also set in 32 (16 extra points) because it should be reached with 4 or 6 new big jumps that will score again for 12 to 18 points. As a consequence, getting Level 3 represents an outstanding student performance.

As can be observed, the difficulty of the design can be easily modulated to adapt the scoring to different type of subjects. This allows a soft deployment of the gamification experiment supervised by reluctant lecturers.

Next section describes the reward program which represents the interaction of the students with the gamification experiment. By the end of the experiment, the student gets a final reward/prize depending on their score and on their achievement in comparison with other participants. A dashboard is used in the game in order to show the students' rankings. The ranking of a student results from the sum of the points accumulated during the game.

B. "IN GAME" REWARD PROGRAM

The "in-game" reward program has been designed to keep students interested on the subject until the end of the semester through two main kind of reward: point and gold coin. With the points, students can access to a new level and improve their personal ranking in the dashboard referred to as "High scores". Alternatively, gold coins allow the student to buy gadgets to get help, to increase the number of points obtained from the following tasks or make the competition more interesting with effects that can even be applied to other participants.

The gadgets that a student can get are associated with the level on which she is. Consequently, only students in a higher or in the same level that the level restriction of the gadget can buy it at that instant of the gamification experience. The gadgets were designed to engage students in the competition and study through a set of rewards that encourages improving previous results. Each gadget has a cost in terms of gold coins. The use of a gadget is called "activation". All the gadgets are detailed in Table 3.

The management of the items bought and the gold spent by the students have been controlled by the lecturer through ILIAS [25], the Learning Management System (LMS) of the University of Jaén. This procedure relies on the concept of forums, which are implemented in almost all the LMS. Specifically, two different forums are used: the bazaar and the activation forum. In the bazaar, shown in Fig. 1, posts inserted by the students are used to buy gadgets. In the activation forum the student must post her intention to use a gadget previously bought. This statement must be posted in the forum before the task deadline. Fig. 2 shows an example of the activation forum.

As can been seen in Table 3, the rewards are designed with three main goals: motivation, work improvement and gaming. Motivating students is one of the main purposes of these kinds of educational techniques. In this experiment, as in video games, we have set special items and potions, which are usually difficult to buy. This makes the game more addictive because obtaining those items of gadgets gives status to the player and foster competition. Thus, due to the fact that not everyone is able to collect them, students compete not only in marks but for gadgets.

In this approach, gadgets are not automatically won but they have to be bought. This step implies that the student has to collect enough gold coins, which usually implies having obtained good marks, specially in the early stages of the gamification experience.

One of the gadget type is the jumping potion. With jumping potions the students are motivated throughout the competition. First, they are showing to the others that they have won enough gold coins to get that gadget, which could increase their self-confidence. Besides, with this gadget they "sign a contract" with the assessment system because the effects of potions are not always applicable: students have to beat their previous score or maintain an outstanding mark without

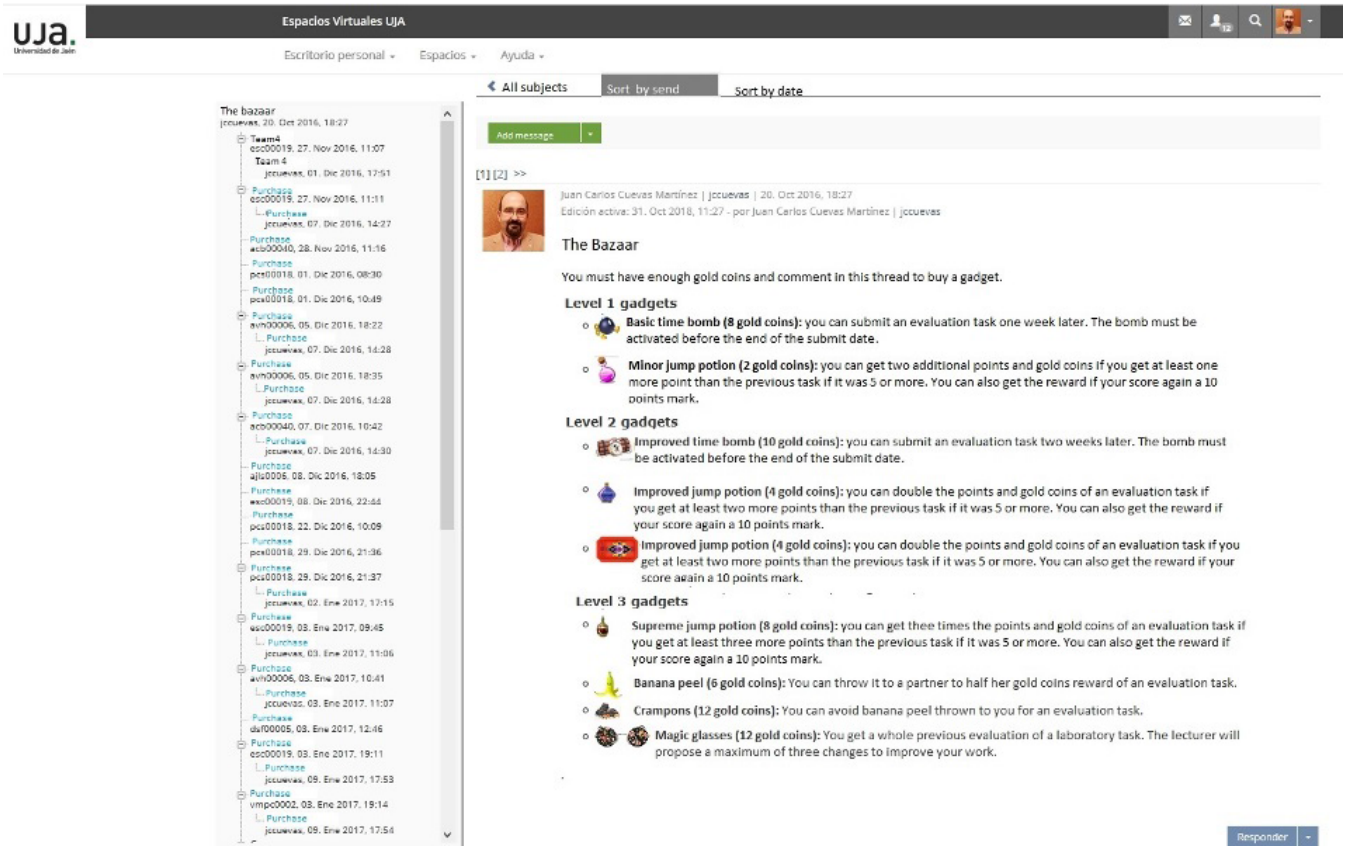

FIGURE 1. Gadgets forum.

any teacher's intervention. Thus, student who buy jumping potions are challenging themselves to improve their own previous work. Jumping potions can be foreseen as intrinsic motivation tools.

The other category of gadget is the one that helps student with an extension of the deadline or a special coaching (auction ticket and magic glasses). It is obvious that the lecturer helps students during practical lessons or tutorial hours, but these gadgets give the opportunity to add the teacher to the group as a partner or gives the opportunity of getting a review that could improve the work to present. With this type of reward the student can avoid failing and being worried about the correctness of her work. Those effects also foster motivation and confidence with the teacher while strengthening their relationship.

The third kind of reward, the banana peel and the crampons, are just for fun, to allow students to relax by the end of the semester and to test their engagement. Those gadgets try to emulate some kind of items in multi-player video games. Their use is planned for the students who are tracking close the scores and are absolutely engaged into the competition.

In the next section, we describe the final reward, which is set as an increment in the students final mark. In this sense, extrinsic motivation is included in the gamification experience.

The experiment presented in this paper, apart from the "in game" rewards, defines two final rewards. One final reward could be achieved by any student who reaches Level 3 whereas the other final reward can only be won by the student with the highest score. The winner student will be published as "the Winner" in the dashboard published in the LMS. The prize for students who reach Level 3 was set to an additional 0.25 points in the final subject mark. The winner of the competition gets 0.75 points more, that actually means one extra point in the final evaluation of the subject.

These rewards represent a plus over the final mark. As described in Table 1, the final mark includes the impact of the final exam. For our subjects, it is compulsory to pass the final exam (with a rank at least 4 out of 10). It is also compulsory to obtain a final mark over 5 to get any reward from the gamification experience. The experimental results show that only students with an average mark over 5 reached Level 3 and obtained a reward, which is one of the objectives of the method.

C. EXPERIMENT MANAGEMENT

To cope with all the information derived from the execution of the designed game, as was previously commented, we have opted for a LMS in order to organize test and practical work results in an accessible way. The LMS implements forums,

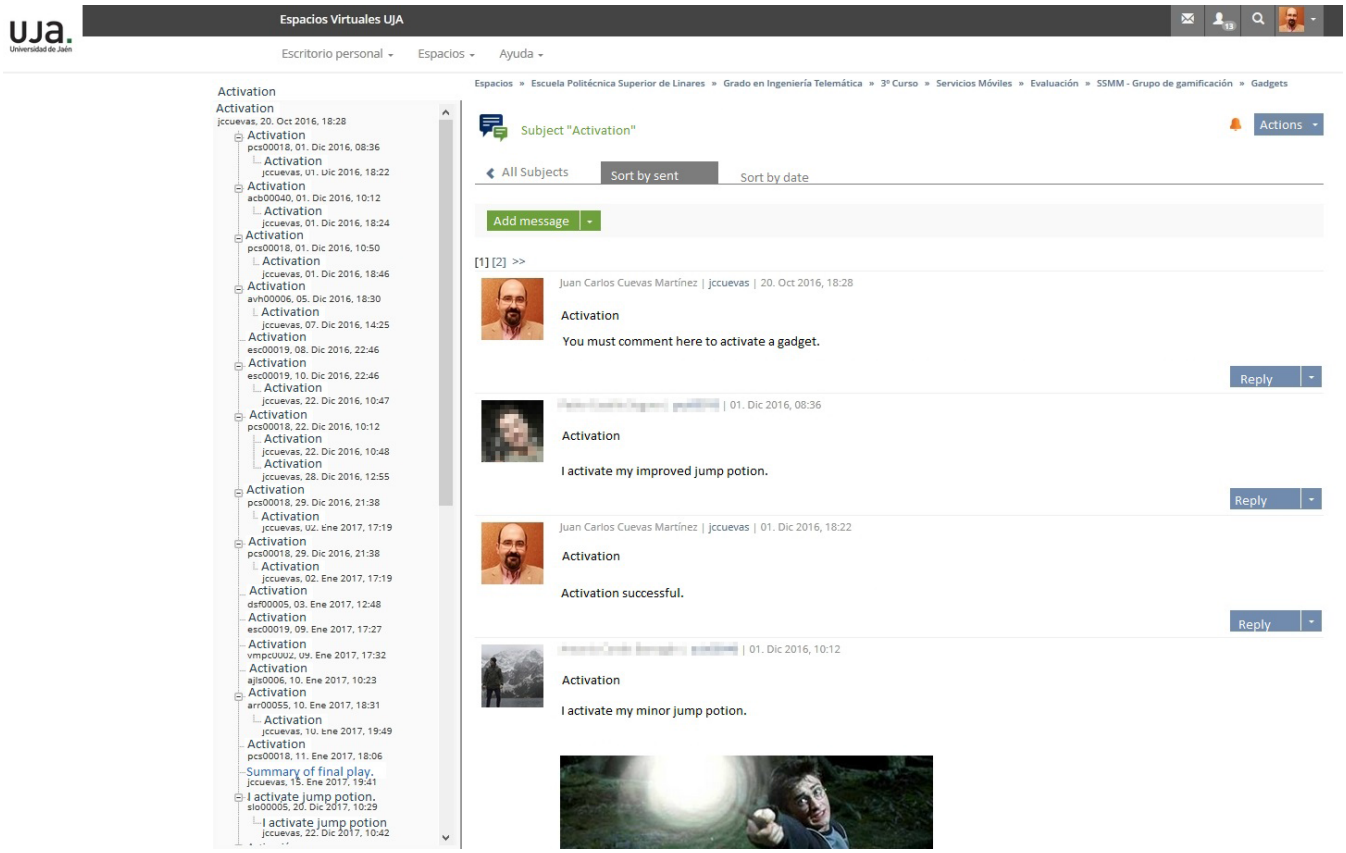

FIGURE 2. Activation forum.

exercise submission and deadline control, etc. In addition to the above commented forums, the scoring was published after every task and the ranking dashboard was updated accordingly.

In the next section the results obtained with the gamification experiment are shown.

RESULTS

The presented gamification method was employed in students of the third course in the Telematics Engineering degree. We have tested it with three different subjects: one compulsory subject and two optional ones. The three subjects cover different aspects and areas of study of the most important services, applications and protocols of current TCP/IP networks. The experiment was run during courses 2016/2017, 2017/2018 and 2018/2019. Those subjects have an important amount of theoretical concepts and practical exercises to learn how Internet applications work and deal with user information. To acquire this knowledge, students have to develop desktop and mobile applications for well-known or custom Internet services.

To evaluate the effectiveness of the method, the academic results have been compared with the parameters derived from the same subjects but in previous years. We have also compared these results with the ones obtained in the following courses for those experiments driven one year ago. Detailed course scheduling of the experiment are shown in Table 4.

The number of students in the tested subjects was similar for the four evaluated courses (The exact number of participants is shown in Tables 5-7). For almost all the students who attended lectures, this was their first time enrolled in that subject and they had an analogous knowledge background and their ages range from 21 to 29 years old with an average value of 23.9 (variance 7.1).

As can be seen in Tables 5-7, almost all the students participated in the experiment when offered. However, the rate of active students vary from one subject to another: despite all of them know about the experiment and were aware of ''in-game'' rewards, they did not buy any gadget. The possible reasons of that rate of non-active students are analysed in the conclusions section.

The effects of this gamification experiment in the assessment evaluation have been measured employing three parameters for each subject:

- Disengagement: percentage of tasks that were not handed in among all the evaluated tasks.
- Effectiveness: percentage of passed tasks among all the evaluated tasks.
- Performance: mean marks of all the evaluated tasks from 0 to 10.

TABLE 3. Gadget description and cost used in the experiment.

Gadget	Level	Description	Cost
Minor time bomb	1	Add one week of extra time to finish an exercise before its deadline.	8
Minor jumping potion	1	Get 2 extra points for a task if the student obtains more than 5 points and at least one point more than the previous one, or the same mark if the previous mark was 9 or higher.	4
Improved time bomb	2	Add two weeks of extra time to finish an exercise before its deadline.	10
Improved jumping potion	2	Get double points for a task if the student obtains more than 5 points and at least two points more than the previous one, or the same mark if the previous mark was 9 or higher.	4
Auction ticket	2	Ticket to participate in the auction. Students can win the help of the lecturer for a practical session. The auction will be blind, each student or group makes their bet in secret.	6
Supreme jumping potion	3	Get triple points for a task if the student obtains more than 5 points and at least two points more than the previous one, or the same mark if the previous mark was 8 or higher.	8
Banana peel	3	When applied, only one target student obtains half of the points he or she would obtain with the normal procedure for one evaluation task. The effects of banana peels are not cumulative for the same task and the same student.	6
Crampons	3	Students are immune to banana peel for one task.	12
Magic glasses	3	Student gets a provisional pre-evaluation of the practical work from the lecturer that would give up to three improvements that student should add to their work.	12

TABLE 4. Contrast courses for experiment evaluation.

Subject	15/16	16/17	17/18	18/19
Subject 1	normal	normal	**gamification**	normal
Subject 2	normal	**gamification**	normal	**gamification**
Subject 3	normal	**gamification**	normal	normal

The values obtained for this parameters are shown in Tables 8-10.

As can be noticed, the results of the students in the subjects where gamification was applied show a general good performance. However, int the comparison with the other subjects it is difficult to find an improvement pattern, mainly due to the fact that the students are not the same each year. Thus, for Subject 1 and 2, the results in the year when gamification was applied are slightly better, but in Subject 3, the effects of gamification do not represent a remarkable effect. To measure the engagement of the student that participated in gamification, it is important to detail the interactions and the rewards obtained by them. This is presented in Fig. 3.

TABLE 5. Detail for enrolled and participant students in subject 1.

	15/16	16/17	17/18	18/19
Enrolled in	30	24	20	25
Attend to lectures (1)	23	18	18	22
Tasks per student	13	15	11	9
Join gamification	-	-	18	-
Active (2)	-	-	13	-

1: Students who attended to lectures regularly and did almost every evaluation tasks
2: Students who join gamification experiment and also bought at least one gadget and activated it.

TABLE 6. Detail for enrolled and participant students in subject 2.

	15/16	16/17	17/18	18/19
Enrolled in	13	11	13	13
Attend to lectures (1)	13	11	12	13
Tasks per student	10	11	11	11
Join gamification	-	10	-	11
Active (2)	-	10	-	3

1: Students who attended to lectures regularly and did almost every evaluation tasks
2: Students who join gamification experiment and also bought at least one gadget and activated it.

TABLE 7. Detail for enrolled and participant students in subject 3.

	15/16	16/17	17/18	18/19
Enrolled in	22	9	6	19
Attend to lectures (1)	21	8	6	15
Tasks per student	12	12	12	12
Join gamification	-	8	-	-
Active (2)	-	8	4	-

1: Students who attended to lectures regularly and did almost every evaluation tasks
2: Students who join gamification experiment and also bought at least one gadget and activated it.

TABLE 8. Results for student disengagement.

Subject	15/16	16/17	17/18	18/19
Subject 1	2.01 %	0.74 %	1.01 % (1)	14,65%
Subject 2	3.85 %	0.00% (1)	8.33 %	16,78% (1)
Subject 3	12.3 %	3.13 % (1)	5.56 %	-

1: Course with gamification

TABLE 9. Results for student effectiveness.

Subject	15/16	16/17	17/18	18/19
Subject 1	91.97 %	86.67 %	96.97 % (1)	88.38%
Subject 2	86.92 %	92.56 % (1)	90.15 %	87.41% (1)
Subject 3	95.24 %	91.67 % (1)	100%	-

1: Course with gamification

TABLE 10. Results for student performance.

Subject 1	15/16	16/17	17/18	18/19
Subject 1	7	7.6	7.6 (1)	6.3
Subject 2	6.9	7.5 (1)	7.2	5.6 (1)
Subject 3	7.1	7.5 (1)	8.2	-

1: Course with gamification

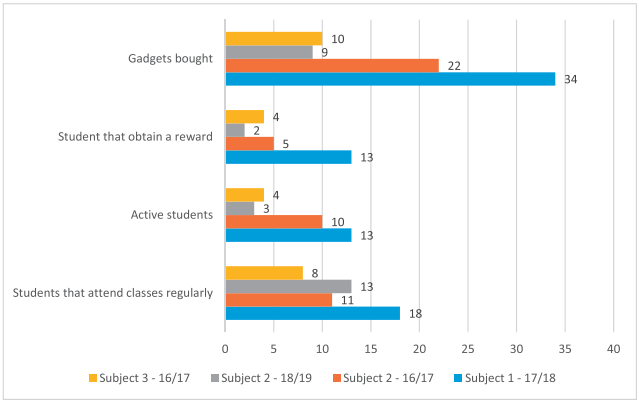

FIGURE 3. Details of user behavior in gamification.

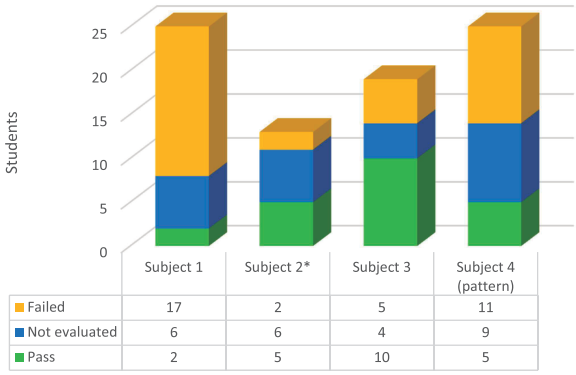

FIGURE 4. Evaluation results for course 2018/2019 (*: Gamification).

TABLE 11. Final marks for course 2018/2019.

Subject	Average mark	Variance
Subject 1	2.9	4.7
Subject 2	5.6*	7.8
Subject 3	5.3	8.2
Subject 4 pattern	4.1	6.4

*: Application of the gamification framework.

Active students (those referred in Tables 5-7) were those who bought at least one gadget and used it to improve their score in the game.

The values presented in Fig. 3 show that most students who joined gamification participated buying more than two gadgets in average and most of them also obtained a reward. As it can be presumed, not all the students participated in the same degree, but at least all were interested in buying something that implies two posts in the public forum. This fact means that they feel comfortable with the rules and tried to improve their score to beat others. This eventually means getting better marks and the acceptance of the gamification experiment.

III. DISCUSSION AND CONCLUSION

As a whole, it is difficult to measure the effects of this kind of experiment when the students are not the same from one year to another. However, they come from similar socio-economic environment, city or region, they have similar age, and all of them have passed the same first two years of the degree that they are studying. Our personal perception is that students who participate in these types of experiments try to do their best because their marks are public and compared, engaging to competition seriously. Besides, the efforts of the lecturers to carry out those kinds of educational techniques are welcome by the students. This helps to keep a good classroom environment. As can be observed in Table 5, most students who were attending classes regularly joined gamification. Those students who did not participate (only four) were mainly students in their last year with very few subjects left, however, they did not claim about gamification and did not demand similar rewards. Despite the fact that the results obtained during the experiment, do not present significant improvement in all the results for the three parameters, it is clear that the experiment throws important results, which outperform those obtained in years when gamification was not applied in several cases.

We have also to remark that, taking into account only the results of student engagement (Table 6), the number of tasks handed in when the gamification framework was applied is near the 100%, while in other cases it was over the 10%. Those good results means that students keep engaged during all the semester when they are in a competition with their partners. This is observed even when they have to deal with other five, or even more subjects. This effect is more remarkable in the case of optional subjects, because students who fail this kind of subject usually feel that their contents are less important. Therefore, if students work during the semester it is more probable that they pass, achieving good marks too. Moreover, if students achieve better marks due to their continuous work, it is easier to fight against demotivation and avoiding dropouts. This has been noticed as the number of task handed in when gamification was applied is increased and from the conversations with the students.

It is noticeable that the results obtained in course 2018/2019 are not as good as previous years, mainly in student disengagement and performance. We have contact other lecturers to try to get a conclusion about this particular result. We have added a similar mandatory subject (Subject 4) of the same third year in the same degree and with closely related topics to the other three subjects, that also shares the same assessment method showed in Table 1. It is important to remark that only the final marks can be compared because lecturers of subject 3 and 4 are not the same who previously participated in the gamification experiment.

As can be observed in Fig. 4, the number of students that did not accomplished the evaluation tasks, or even the final exam (Not evaluated) are very high. Moreover, the number of students that finally pass the subjects are dramatically low in all the subjects but Subject 3. Despite those bad results, for Subject 2, in which gamification was applied, the percentage of students that passed the course was 38.46%, more than the percentage for Subject 1 and 4 (8% and 20% respectively).

In addition, the marks shown in Table 11, reveal that the results of Subject 2, in which gamification was applied, has the best average mark. Therefore, it can be concluded that even for groups of student who showed poor study results, gamification could achieve better general student performance. On the whole, from the personal comments from the students and their behavior during the semester, we can also conclude that the application of gamification was positive in general for the learning process of all the students who participated and did not suppose any interference in the evaluation process.

Future work should try to apply gamification, or other competition based assessment method, for the first and second year, because the rate of dropouts at those stages are much higher than in more advanced courses.

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