THE HUNGER GAMES: ENHANCING UNDERGRADUATE TEACHING THROUGH CONTINUOUS EVALUATION AND FRIENDLY COMPETITION

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Abstract

In most undergraduate subjects the evaluation is continuous in order to make a formative assessment and provide the students with valuable feedback on his/her performance development. While this procedure has proven to be effective to enrich the teaching-learning process, it may lack of a motivational nature. Aiming to enhance such a continuous evaluation, this work suggests the inclusion of gamification tools in the form of a friendly competition that is termed “the Hunger Games”. The competition is anonymous, so that confidentiality is preserved, but it allows students to make additional efforts to win the game and be competitive in their classroom. At the same time, students can visualize their progress and how they gradually reach the final goal. The tool is designed so that its use becomes almost automatic by simply using a predefined Python code that is connected to the Moodle platform at the University of Malaga. Results confirm the goodness of the proposal, which can be extended to any subject as long as the evaluation is performed in a sufficiently continuous manner.

Keywords: Gamification, undergraduate students, engineering, active learning.

1 INTRODUCTION

Traditional evaluation based on the score of the final exams is only useful to grade the students, but it becomes useless as a formative tool within the course duration. For this reason, it is generally accepted that a continuous evaluation favors the teaching-learning process and provides students with valuable information to improve their performance before it is too late [1]. Unfortunately, this feedback is typically given to students in an individual manner, hence gamification does not come into play. Game-based learning and the use of gamification tools have become a popular manner to design dynamic lectures, enhance the interaction between students and promote entertainment [2,3]. In many cases some simple actions in the form of competitive activities and rewards can significantly increase the interest of students [4,5]. Gamification is also especially suited to develop soft skills, which are particularly relevant in the field of engineering, where applications are typically designed within multidisciplinary teams [6]. Activities must be designed in any case to promote a positive competition without entering in risk to generate exclusion within the classroom [7]. Engineering degrees typically have an intrinsic difficulty that sometimes diminishes the motivation of students, leading to low scores and low degree of engagement, and for this reason it is important to design the curriculum in such a way that satisfaction is promoted [8-10]. Continuous evaluation allows a closed-loop regulation of the student performance along the course, promoting engagement to some extent [11,12], but it can be enhanced with the addition of some gamification tools.

Aiming to gamify the continuous evaluation of an undergraduate engineering subject, this work describes an experience where the information is weekly provided to students promoting a friendly competition in the so-called ‘The Hunger Games’. In such activity, the scores of the students become public under the nickname of a famous scientist/engineer (e.g., Nikola Tesla, Stephen Hawkings), so that they can compare their performance with the rest of classmates. Anonymity is preserved, but the spirit of competition is present because they can compare with such famous characters. This procedure is also useful for lecturers to send encouraging messages not only to outstanding students, but also to those who are improving their competences and approaching the necessary level to pass the subject (e.g., “Nikola Tesla is leading the competition closely followed by Isaac Newton and Emil Levi. We are approaching the middle of the course, so let’s make a final effort to cross the line!”).

The innovation is done in sustainable manner, making the action almost automatic and keeping the amount of time and efforts from the lecturers to a minimum. Although it may seem a secondary aspect, the burden associated with educational innovations is a key issue to maintain the innovative procedure

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along the time and to ease the extension to other subjects and colleagues [13]. For this purpose, a code in Python has been created in combination with the results that can be obtained from the Virtual Campus (VC), a Moodle platform at the University of Málaga. Specifically, the scores from the VC are exported in an Excel file and processed by the customized Python script in order to link the results with the nicknames and to professionally plot the results in appealing graphs that can be shown to students. Furthermore, the innovation can be done without the involvement of any additional staff, hence it can be used by any lecturer individually, although it could be coordinated with other subjects to enrich the experience.

The experience has been tested in a subject of Electrical Machines at the School of Engineering in the University of Malaga, and the scores in the subject confirm the capability of the proposal to provide a good learning experience. It is worth noting in any case that there is no technical reason why the proposed methodology cannot be extended to any subject as long as the evaluation is truly continuous so that weekly data can be processed by the design algorithm.

2 METHODOLOGY

2.1 Context

The proposed experience has been tested in the subject Electrical Machines 2 (EM2) at the School of Industrial Engineering in the University of Malaga (Spain). Although this teaching-learning project has been carried out during several academic courses, the employed data in this work are referred to the course 2022/2023. This subject is common for three different degrees from Malaga University: Degree in Electrical Engineering, Double Degree in Electrical and Mechanical Engineering and Double Degree in Electrical and Electronical Engineering. In fact, the lectures are taught in a simultaneous/synchronous manner for the mentioned degrees. From the point of view of academic data, this subject is defined as a mandatory subject of 6 ECTS for the students of Electrical Engineering and a basic formation subject for the students of both double degrees. EM2 is lectured in the second semester of the third course of the Electrical Engineering Degree and in the Double Degree of Electrical and Electronical Engineering. Nevertheless, for the case of Double Degree of Electrical and Mechanical Engineering, EM2 is timely located in the second semester of the fifth course. Therefore, there is a certain degree of difference from the perspective of the student maturity.

Focusing on student profiles, there is a heterogenous population if the cutting-edge mark to access to the degree is considered as the basis of the comparison. In the Degree of Electrical Engineering the required mark is 5.0/14, whereas for the case of the Double Degree of Electrical and Electronical Engineering this significant value is 7.85/14. The required mark is even higher in the Double Degree of Mechanical and Electrical Engineering, the entry mark is 11.3/14. Table 1 shows the cutting-edge marks to access to the degrees and the number of students of each degree in EM2 (course 2022-2023). As detailed in Table 1, the population of the classroom is heterogeneous according to the required cutting-edge scores to access to the degree. This scenario can generate a certain complexity for the teachers when the goal is to obtain a notable motivation as many students as possible.

Table 1. EM2 population

Degree	***Cutting-edge mark***	***Number of Students in EM2***
Electrical Engineering	5.00/14	33
Electrical and Electronical Engineering	7.85/14	17
Electrical and Mechanical Engineering	11.3/14	25

From the point of view of the technical content, EM2 is focused on two different electrical machines: dc machines and synchronous machines (ac electrical machine). However, as it is postulated in the European Higher Education Area (EHEA), the development of soft skills is considered a relevant point of the teaching-learning process. Therefore, the course has been designed considering the implementation of different activities, where these desired abilities should be developed. For example, in the academic course taken as study case, the learners of EM2 have carried out tasks as:

1 Elaboration of a video in group.

2 Solving problems of DC machines and synchronous machines using Matlab/Python.

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3 Solving dc and ac machine questions by couples.

4 Laboratory practicums in group.

5 Partial exams of dc machines and synchronous machines.

6 Electrical machine selection for a specific industrial application.

In addition, taking into account the significant role of continuous evaluation in the EHEA, the listed activities are considered in the final mark of EM2. As a consequence of the notable number of tasks related to the final student score, the implementation of a display score tool can be positive to provide to the students their current status in the subject.

2.2 Description of the gamification tool

The Hunger Games is a gamification tool that aims to show the progress of the students in the classroom in a manner that they can see their own advance and also compare their performance with that of their classmates. In the first day of lecture the students are asked to enrol in the game through a Wiki that is created in the Virtual Campus (VC), which is the name of the Moodle platform used at UMA. The enrolment is voluntary and anonymous, and to this end the name of students is substituted by a nickname that is randomly assigned by professors from a pool of names from scientist and well-known science-related characters. It should be highlighted that more than 50% of the students decided to enrol in the game, and it will be shown in the results that there is a close relation between the enrolment and the final mark. In other words, average final mark of students who enrolled the game is notoriously higher than that of the resto of the class, indicating that those students that enrolled in the game where also those with a higher degree of engagement and motivation.

Once the students are inscribed in the game, their nicknames are associated to the real name of the student in the Python code, so that any mark of the real students will appear in the graphs with the nickname. The course has activities that are evaluated almost every week, hence the feedback that is provided to students is truly continuous. For the sake of example, every two weeks a test is done in the classroom by couples, so that each pair can discuss the solution of the test and the final score is the same for both students. This procedure promotes discussion and interactivity within the classroom. Pairs are rotated each time in order to favour a rich interaction with different peers all throughout the course. In addition, other activities such as supervised problem sessions, presentations, the selection of a motor for an electric vehicle application or different kind of exams are also evaluated and incorporated to the marks that are shown in the Hunger Games (see Section 2.1).

Figure 1 shows an example of a graph that was generated by the Python code and uploaded to the VC in the middle of the course once some evaluated activities have taken place. It can be observed that the average score is indicated with a cyan dotted line, the three higher marks are shown in orange colour and the leader is highlighted with a yellow star. The graph is generated by connecting the Excel file where the marks are introduced with the Python code. The process of graph generation is consequently automatic and does not imply a high time burden for the teachers, which is a desirable feature to maintain the activity along the years and to export the gamification tool to other subjects. Since the Excel file is also obtained from the VC automatically, the process mainly consists in pushing a button to obtain the Excel file and another one to generate the graph shown in Figure 1.

Apart from showing the graph, the inclusion of this gamification tool aims at motivating students and create an atmosphere of friendly competition. For this purpose, a new graph is uploaded every week with some messages of encouragement for the students. Furthermore, the evolution is also commented in class on some occasions to promote entertainment.

Students that are technically very skilful typically enter into competition for the first place, but the tool is designed to encourage all students. For this reason, some of the messages do not only focus on the leader, but on the evolution of the class group. At the end of the day, it is a valuable information for the students to check his/her performance, and with this tool it is shown in a more entertaining mode.

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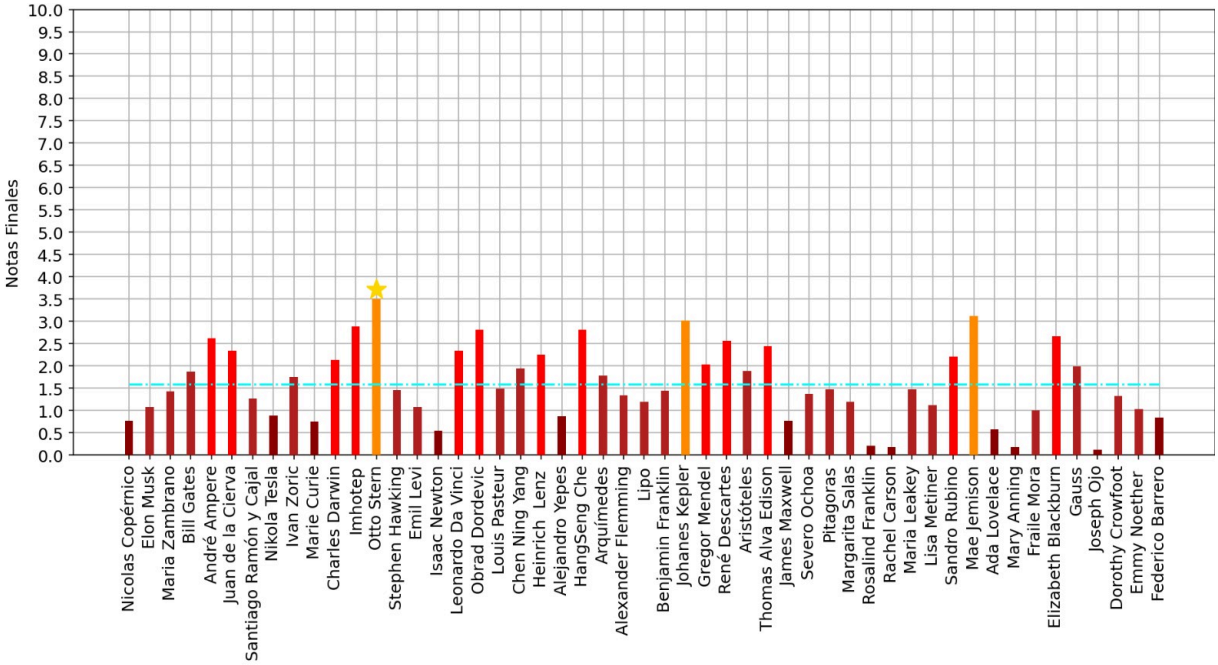

Figure 1. Example of a graph from the Hunger games in the middle of the course.

As it typically occurs in gamification, the tool also includes some rewards. Nevertheless, this reward is not in the form of an additional mark in the subject, but it aims at being a reward for the students to feel proud of the achievements without giving a mark privilege. The first reward is to win the game itself. In order to honour this achievement, the professors have made a hall of fame with the students that ended the subject being in the three first positions. This hall of fame remains along the years so that their names will be there forever (unless until the same professors keep on being lecturing the subject). Secondly, the three best students are rewarded with a book from the professors, including a special dedicatory. Although the rewards are humble from an economic point of view, they aim of generating positive feelings in the students towards the subject.

3 RESULTS

This section analyses the academic performance of the students with the proposed teaching methodology. For this purpose, the scores from all activities have been taken into account and processed to obtain:

1 The final score: all scores are computed with the relative weight of each activity to obtain a final mark. This is in fact the index that is used to grade students.

2 The scores of dimensions: the scores from the activities are multiplied by a matrix of competences according to the procedure in [6], obtaining a score for six different types of competences (theoretical knowledge, practical knowledge, creativity, teamwork, motivation and satisfaction).

The final scores for the three subgroups are shown in Fig. 2. The best marks are obtained for E&ME (cut-off grade of 11.3 over 14) with a significant number of students that obtain a final score over 6. The marks from E&EE shows a gap between students with high and low score, with no students between 3 and 5 over 10. This indicates that students that were actively engaged with the subject did not only pass but obtained good marks. On the other hand, those that abandoned the continuous evaluation or poorly followed it did not only fail but had a very low mark. In the case of EE, marks are more distributed but with a lower average score compared to the other two groups. The cut-off mark in EE degree is only 5 over 14, and results suggest that, in spite of following the continuous evaluation, some students were in the limit to pass the exam. In any case the differences between the marks from the three degrees are less significative that the difference between the entry cut-off mark, suggesting that the course design compensates to some extent the diverse level of the students.

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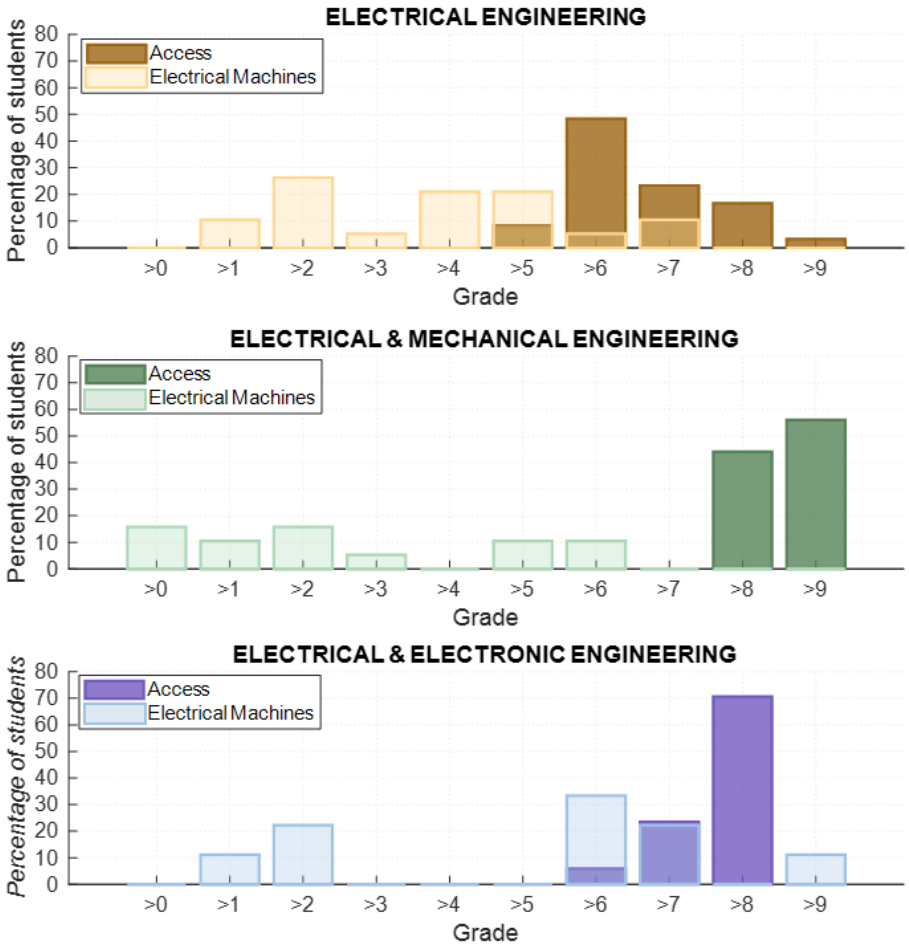

Figure 2. Comparison of the score in the electric machines subject and the cutting-edge mark to access the degree.

Apart from the global mark, it is insightful to evaluate the how students' grade in different dimensions. Fig. 3 splits the scores into six dimensions: theoretical knowledge, practical knowledge, creativity, teamwork, motivation and satisfaction. It is firstly remarkable that all dimensions are reasonably homogeneous, indicating that all of them have been significantly excited. Typical cognitive aspects such as theoretical and practical knowledge have good grade, but other dimensions such as creativity or motivation have also been promoted. In fact, the ability with a highest score is teamwork, suggesting that the designs of many different group tasks and including a friendly competition among students successfully enhances this soft skill.

Finally, the scores are analyzed splitting the final marks for the group that participated in the Hunger Games and for the rest of the class. It is found that the average score for the students who participated in the proposed gamification tool is 4.82, whereas the average students for the rest of the class is 1.72, hence showing that the profile of students who enrolled in the Hunger Games is closely related to highly motivated students that in the end get a better mark. In fact, 84% of students who passed the subject had participated in the Hunger Games, while only 16% of students passed the subject with no participation in the games.

4 CONCLUSIONS

Although the continuous evaluation in undergraduate studies is desirable and essential, it can be enhanced with the inclusion of simple gamification tools. This work shows that it is possible to design a tool for friendly competition (the so-called 'Hunger Games') that provides weekly feedback to students. The proposed gamification tool promotes engagement and motivates students to improve their progress and to eventually win the game. All students are encouraged to improve their performance and the best students are additionally rewarded with a book and a recognition in the hall of fame of the subject. Most importantly, the tool does not imply any time burden for students and very low amount of work for professors once the Python code that computes the marks from the Excel file is created. Since the

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gamification tool is designed with a general purpose, it can be easily extended to other subjects by only performing little adjustments to the Python code.

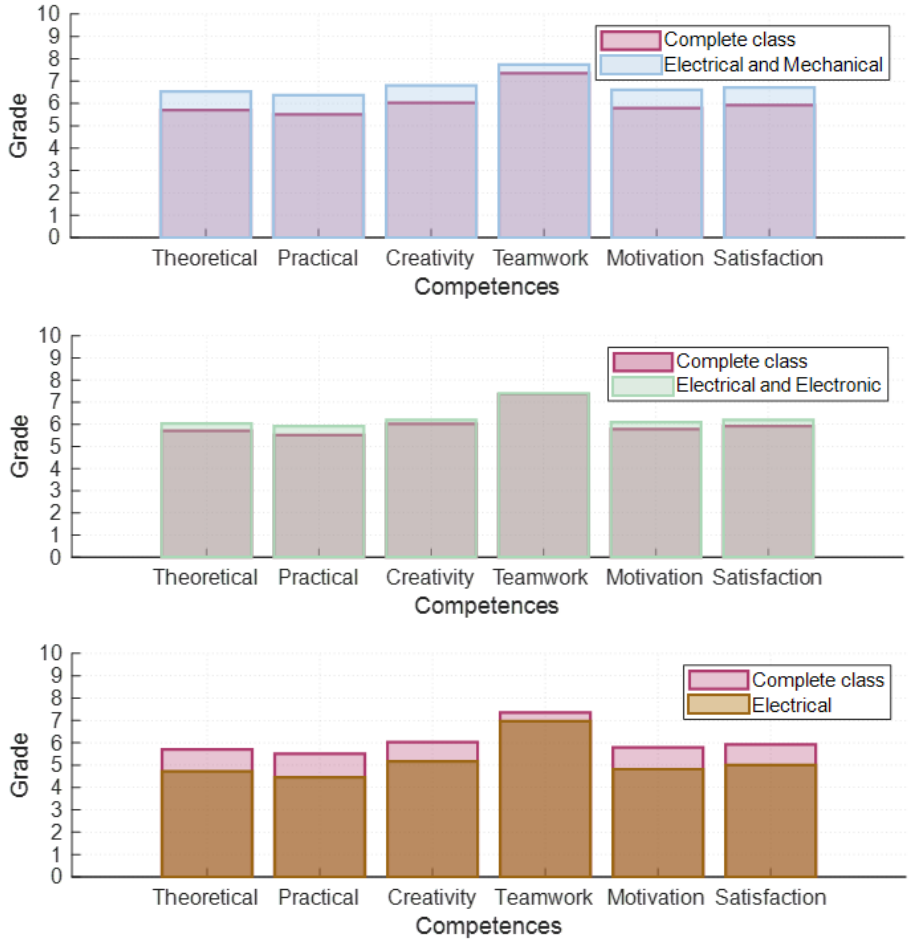

Figure 3. Students' results grouped into dimensions for each degree and the for the complete class.

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