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Gamification for formative assessment in the framework of engineering learning

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ABSTRACT

There are evidences that Student Response Systems (SRS) encourage student participation in the classroom by streamlining class development. Recent experiences indicate that these SRS have been used in the context of quizzes, showing that students' attention, motivation and enjoyment are increased with respect to the simple use of a simple questionnaire. The applications Socrative, Kahoot, Quizlet, Quizizz, among others, are each year more consolidated. The strategy for the development of games in the classroom is that it should be voluntary, anonymous, with a reduced cost of time (on the order of minutes). The paper shows material of Fluid Mechanics subject at university level. There is much more material in Kahoot format than in Socrative. The tool let diagnose weak points on the learning process in the classroom.

CCS CONCEPTS

Social and professional topics; Professional topics; Computing education; Computing education programs; Information systems education.

KEYWORDS

Learning, collaboration, Kahoot, gamification, assessment.

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1 INTRODUCTION

The traditional methods of teaching a master class are monotonous for students who have simple access to a large amount of information. It is necessary to promote the interest and participation of the student in the classroom in order to develop an active role in the learning process. Prince [1] reviews the evidence that shows efficient learning when you have an active role. Learning, collaboration, student cooperation and commitment as well as problem-based learning are essential. "Development of e-learning resources" [2] is a report of the Royal Academy of Engineering of the United Kingdom that promotes the development of material for telematics learning of different areas of engineering. It is recommended the creation of virtual environments, contests, social networks and MOOC course material among other strategies to improve the learning process. Similarly, Henderson et al. [3] explore practices to improve learning in the disciplines related to science, technology, engineering and mathematics. Loveland et al. [4] establish the need for collaborative work and the use of technology to improve the learning process and collateral skills. They state that both, theoretical knowledge and practical application, are necessary to improve the employability of future professionals. They propose a virtual studio where design students make successive improvements, develop their creativity and critical thinking. Gonzalez and Garcia [5] indicate that the skills to be acquired through collaboration are: individual responsibility, social skills, positive interdependence, among

others. The experience was carried out in the degree of psychology and quantifies the skills acquired through collaborative work against traditional teaching methods.

In the 1960s, the use of student response systems (SRS) was extended in the Anglo-Saxon countries. In a first stage, the use of remote controls was required to register the response. The massive use of mobile devices (tablets, smartphones, laptops...) has simplified this task since it is not necessary to invest in infrastructure and Internet access is sufficient to register the answers without installing applications. Popular platforms of SRS are Socrative, Quizlet, Poll Everywhere, among others. The difference between SRS and GSRS (Game based SRS) is that the latter has a more important component of motivation on the student. Bodnar et al. [6] establish that the main motivation of the student to participate in an educational game is that he receives an immediate feedback and perceives progress in his learning, which encourages him to be interested in the subject and to persevere. Urtel et al. [7] conducted an experience in anatomy courses that showed that competitions outside the classroom materialized in greater participation in the classroom as well as the perception by students that they help learning, although statistically, it did not show an improvement in the academic performance. Wang et al. [8] contrast three methods of questionnaires: the paper form, the Student Response System using a remote control and the Game based Student Response System using Kahoot. In every case, the content of the questionnaire was the same using three different methodologies. The results showed an increase in motivation, enjoyment and participation in the classroom in the case of competitive contest. Tan and Saucerman [9] recognize the improvement of learning through the use of Game-Based Student Response System. In their experience in the degree of biomedical engineering, they compared SurveyMonkey (Student Response System) and Kahoot (Game based SRS) resulting that the latter generates more motivation, collaboration and fun among the students.

This work presents an experiment where the GSRS Kahoot is quantified in terms of academic performance and participation in class. Section 2 presents the tools used in the process of reviewing content of the subject. Section 3 presents the results of the experience and finally the conclusions and future work are presented. For a few minutes the classroom becomes a competition. Kahoot uses multi-response questions to review aspects of the taught subject, but using a very attractive graphic environment for students. While the students want to see their name or label among the best of the ranking who have correctly answered in the fastest way possible, the teacher enjoys the high participation in the classroom and the attention of the audience. In addition, the information related to erroneous results allows you to review the fundamentals that have not been assimilated with the necessary depth to correctly answer any of the questions.

2 METHODOLOGY

There are several studies that show the benefits of SRS to promote participation in the classroom, the satisfaction of the

student to participate and the motivation of the students to improve their learning that ends up being materialized in better results in the evaluation tests. From the point of view of the teacher, the participation of the students supposes a significant sample to evaluate the process of learning and identify the aspects susceptible of revision to improve the final results.

2.1 Possible Student Response Systems

There are three different approaches to conduct a questionnaire review of the contents of the subject. The first method is a questionnaire made with google and that can be done by the student from home before the exam. The anonymous results of the students are visualized by the teacher in an Excel, Parra et al. [10]. The second way to review is a multi-response questionnaire conducted in Socrative to perform in the classroom, in real time students and teachers see the correct answers and the percentage of students who have answered each answer. This allows the teacher to review concepts that may have been poorly understood. Parra [11] shows the experience of the use of Socrative questionnaires for the review of the subject. Other possible Student Response Systems are: Quiz Socket, Poll Everywhere, Menterimeter...

The third option is the use of Kahoot to reproduce the same questions but with the incentive of the competitive nature of the game.

2.2 Method based on Competitive Games

The method used for the Game based Student Response Systems was Kahoot. The teacher launches from his computer the game that is projected on a large screen. Students connect with their mobile devices to a web page (<https://kahoot.it/>) where they enter the course code (seven-digit PIN) and a nickname that allows them to participate anonymously. Fig. 1 shows the projection of the classroom screen and the student's device when a question is launched.

The objective for the student is to answer correctly and as quickly as possible. The score received and the subsequent rank is based on the response speed. Fig. 2 shows the classroom screen and the student's device when the solution to the question is given.

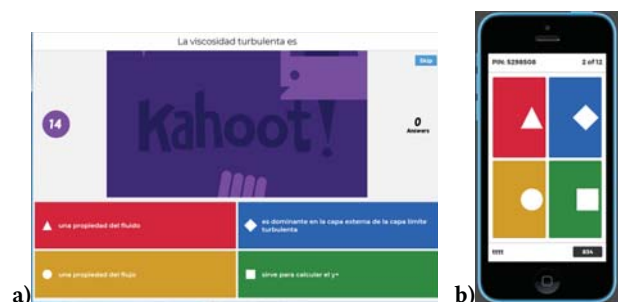


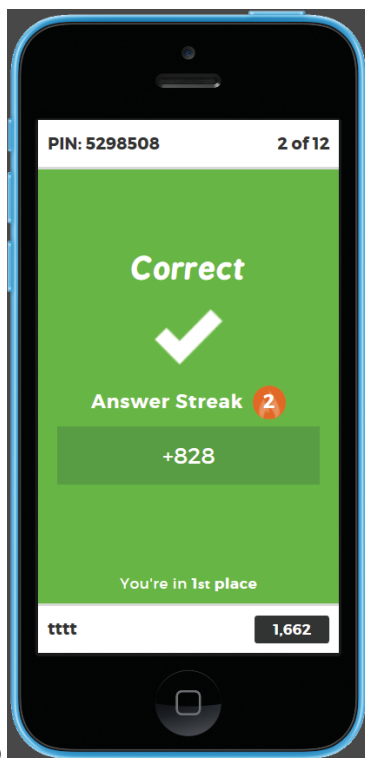
Figure 1. (a) Sample of a question on the screen. (b) Sample of the student's mobile device from where the question is answered

Students are motivated by competition, Fig. 3 a and b. Actually, the teacher is interested in the statistical treatment of the answers to identify the concepts in which to deepen, Fig. 3c. In fact, it is more beneficial to include several correct answers, so that students gain confidence and the wrong answers can be detected more accurately so that they can be corrected and analyzed in detail.

At the end of the contest, the teacher can download an Excel with all the data of the questions as well as feedback from the students with their degree of satisfaction, as shown in Fig. 4.

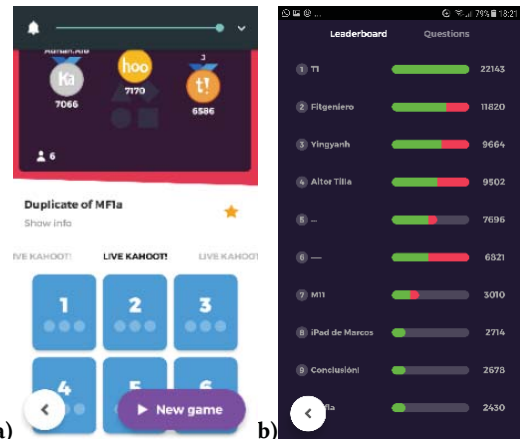


a)



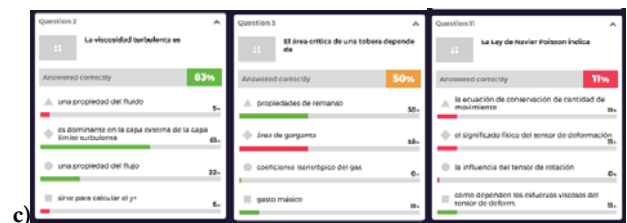
b)

Figure 2. (a) Sample of the correct answers on the classroom screen. (b) Sample of the results on the student's mobile device



a)

b)



c)

Figure 3. (a) Sample of the winners' podium. (b) Sample of the rank of results (c) Sample of results of different questions indicating the success rate

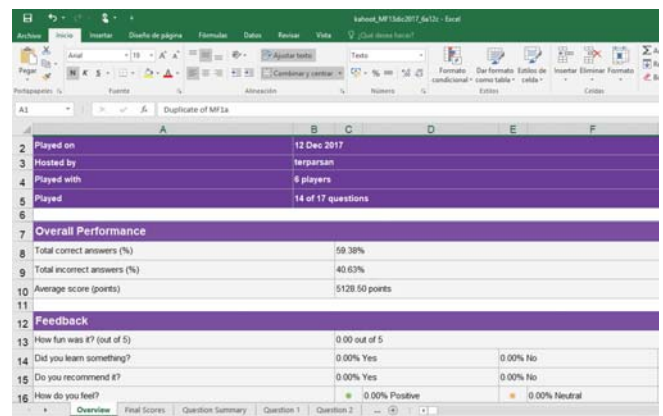


Figure 4. Scheme of the Excel forms with the results of the competitions for the teacher

2.3 Procedure online

Another aspect of interest is that the questionnaires can be published and shared. The teacher finds it easy to search for questionnaires of a specific topic that can be used or serve as inspiration to create other questionnaires.

The search for questionnaires can be done by level of education from kindergarten to university, by language and subject. It is also possible to launch a questionnaire in Challenge format, which is open for a maximum period of 14 days for the students to do it at their convenience. Fig. 5 shows a questionnaire format ready to be shared.

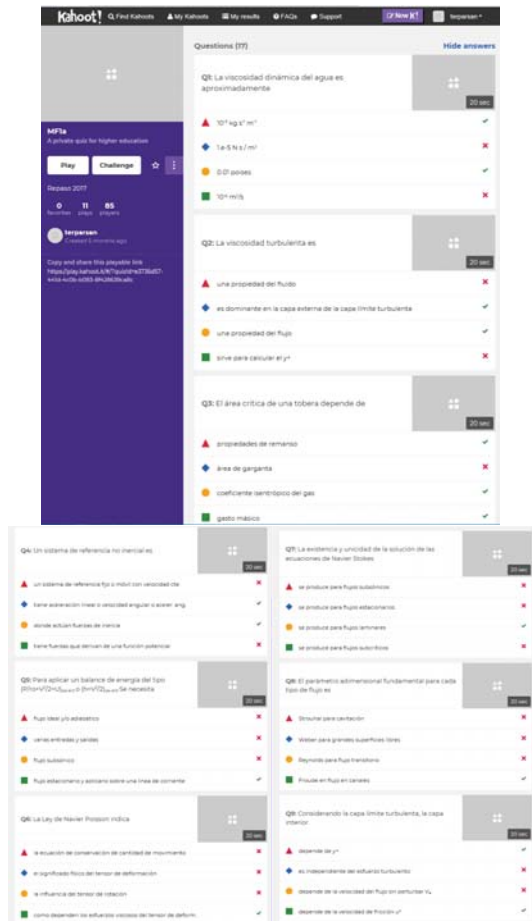


Figure 5. Sample of part of the questionnaire

3 RESULTS AND DISCUSSION

The statistical analysis of the results reveals no influence on the motivation to take the exam, among the students who made the review of the subject participating in the contest and those who did not. What did manifest itself was an increase in class participation, asking questions related to the topics of the contest. Although both groups show similar variance in their grades, the average score of the group that reviewed the subject through the Kahoot was 8% higher, with the rate of passing the exam 12 points higher than that of the group without a competition, see Fig. 6. The competition allowed the students to diagnose their level of understanding of concepts. What gave them an opportunity to work harder on the weak points. It also

allowed them to reaffirm their confidence in the concepts they had already assimilated.

Table 1. Statistical data of the groups participating in the experience

	Review with <i>Kahoot</i>	Review without <i>Kahoot</i>
Enrolled Students	100	83
Examined Students	66%	73%
Success rate of examined students	58%	46%
Average Grade	4.962	4.565
Grade variance	3.610	3.689

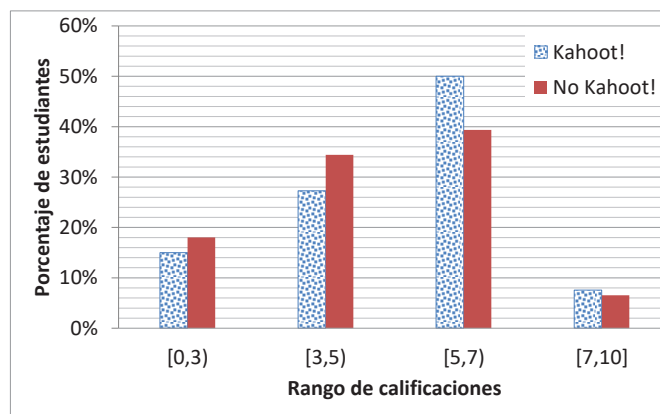


Figure 6. Grades in the final test of the two groups participating in the experience

4 CONCLUSIONS

The use in the classroom of learning based on games has increased its popularity in recent years. Although the concept of questionnaire in higher education is not new, since it has served as an evaluation tool, its use in the classroom in a context of play or competition has a direct impact on different aspects such as: participation in the classroom and attention to the development of the activity, perception in the progress of the learning process, commitment to the dedication to the subject and interest in deepening applications of the theoretical concepts.

The most novel thing is the use of the available technologies in higher education that allow to make the presentation of the questions and answers with a substantial saving of classroom time. Many tools and learning platforms based on games are inspired by competitions where students can score points by choosing the correct answer among several answers. The applications Kahoot, Quizlet, Quizizz... are each year more consolidated.

There are numerous questionnaires shared by the academic community that can be used or adapted to the contents and concepts of each class. A search of questionnaires filtered by

each level of education from infant to University and by the subject to be taught has evidenced the abundance of material, existing more material in Kahoot format than in Socrative.

The strategy for the development of games in the classroom is that it must be voluntary, anonymous, with a reduced cost of time (in the order of minutes). The only requirements are access to the internet and a mobile device. The installation of any application is not required since students must only access a web site and enter the questionnaire code. The battery of questions created for each topic can be performed quickly and dynamically in less than 10 minutes to review previous aspects. Most of the questions have a multiple choice answer with several valid answers to motivate the students and improve their confidence level while reviewing collateral aspects of the content of the question and linking concepts of different topics of the subject.

Likewise, there is the possibility of opening a game for a period of time, so that the students play at their discretion and improve their position in the ranking. The ranking is based on the identifying names that students have chosen and in no case are they required to use their real name. The statistical treatment of the success rate by questions is a valuable tool for the teacher to identify aspects that may be reinforced during the next classes.

The results of this experience do not reveal a statistical impact on the attendance of students to the exam. What is manifested is that there is a significant increase in the percentage of students who passed the subject. The similarity in the variance allows comparing the average scores being 8% higher in the case of the group that made the contest in the classroom. There was also an increase in questions in the classroom based on the aspects dealt with in the competition.

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