Gamifying education: a practical example in Chemical Engineering

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ABSTRACT

Nowadays, e-learning is living with the standard lectures, assuming a more significant role in compensating for the difficulties of the pandemic. Numerous pedagogical methodologies can be easily implemented in high education and promote students motivation and interest in learning. This work analyses a practical example of gamification on the university, taking into account the effect of Kahoot! application of the percentage of students who succeed in a specific topic and its motivation for the following topics. Our results suggest a positive effect of gamification implementing up to 25-30 % more students succeed in the topic under evaluation. However, during the subsequent years, the changes in the lifestyle of study also play a role in students' performance. It is necessary to evaluate practical cases as presented here to understand better the use of these technics in high education, especially in technical subjects described in this work.

Keywords: Teaching strategies, Higher education, e-teaching, Chemical engineering, Gamification in Education.

1. INTRODUCTION

Active learning is not a new concept in education. In fact, in 1991, Bonwell and Eison[1] pointed that the use of active learning techniques in the classroom was vital due to their possible significant impact on the students' learning procedure. Nowadays, a significant number of pedagogical methodologies can be implemented in high education to promote student learning in the sense of active learning. Some of these methods have receiver much attention in the last few years, such as flipped classroom[2], learning-by-doing[3], design thinking[4] or gamification[5], among others.

Most of these methods are even applicable in e-learning, which is a promising methodology based on the use of Information and Communication Technologies (ICTs). E-learning, considered an additional tool to traditional learning, had become the only way during last year due to the COVID pandemic situation[6] when the face-to-face classes were not possible to perform. That is the reason that explains the high development of these educational tools. Figure 1 shows and schema of the e-learning method gathering other pedagogical methodologies applicable[7].
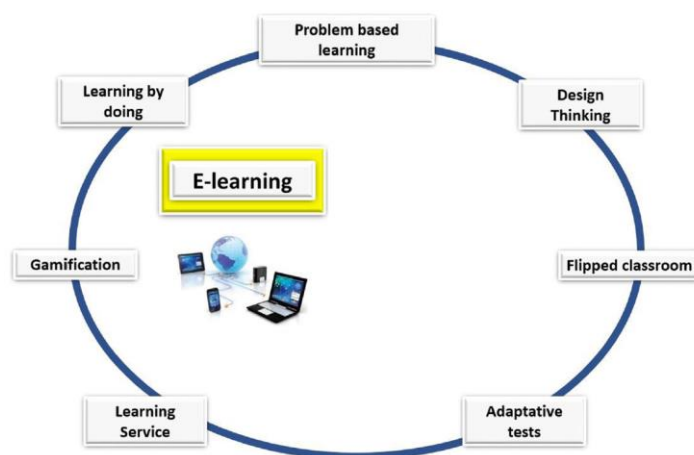

Figure 1. Methodologies that could be applied within E-learning[7].

Among the methodologies named, perhaps gamification can be considered one of the most interesting for students[8]. This pedagogical methodology consists of using game mechanics, dynamics and frameworks to promote the desired behaviors[9]. In the context of high education, it means avoiding the stress and loss of interest from students that can reduce learning outcomes due to online and traditional teaching[10].

There are numerous tools or platforms used to implement this game-based methodology, such as Kahoot!, Socrative or Mentimeter. Among these tools, probably Kahoot! is one of the most well-known among teachers and professors. Kahoot!, as described in their webpage[11], is a dynamic application that allows implementing questionnaires (true or false, multiple-choice, puzzle, poll, among others) in the daily routine of the class. The idea behind the use of this methodology is simple: catch, keep and promote students' attention to the class content, positively affecting their knowledge developing in line with the learning outcomes.

In this work, we have implemented Kahoot! as a dynamic tool for gamifying education related to chemical engineering concepts, mainly to learn about industrial chemical reactors. Our study allows us to evaluate the impact of gamifying on the specific section of the subject in which it was applied.

2. METHODOLOGY

2.1 Questionnaires design

Gamification pedagogical method was implemented in a subject titled Chemical Reactions Engineering, which is related to the main principles of chemical engineering discipline, the chemical reactions kinetic and its industrial application. Using Kahoot! dynamic tool, a multiple-choice and True or false questionnaire was created to evaluate an specific topic of the subject, related to the implementation of "Chemical Reactions to Industrial Scale".

This topic, less mathematic and complex to adapt to different pedagogical methods, is one of the most favorites of students. Implementing this method here is expected to positively affect the following learning outcomes from the next topics related to the mathematical design of industrial reactors.

The questionnaire consisted of 20 Multiple-choice questions plus 3 True or False questions in which the students were asked for the most important concepts of that topic. The questions were prepared according to the information presented during teaching sessions, similar to the procedure to prepare for the standard final exam. The students had 60-120 seconds per question. Figure 2 shows an example of a "multiple-choice" and "True or False" questions during Kahoot questionnaire evaluation.
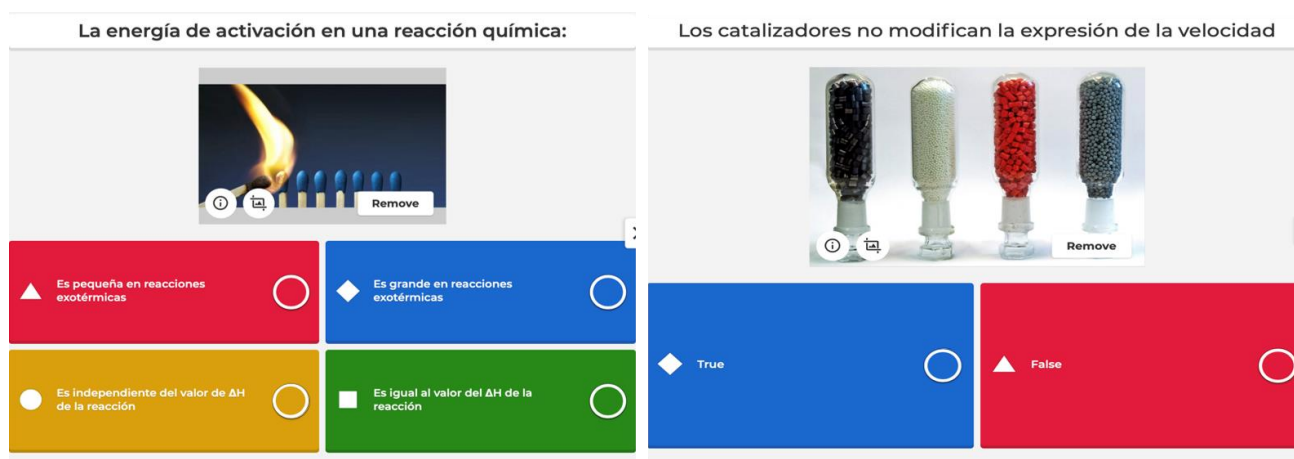

Figure 2. Examples of Multiple-choise (right) and True-or-False (left) Kahoot! questions

2.2 Evaluation of the effect of gamification on students learning outcomes

The implementation of gamification has been evaluated during the last three academic years, from 2018/2019 to 2020/2021. During the first year of study, the student of that subject was evaluated using a standard written questionnaire. Following two years, the Kahoot! application was implemented, and students got evaluated on that topic using this app instead of the standard questionnaire. The number of students keeps stable during the three courses, without significant changes (~ 45-55 students).

The academic year 2018/2019 has been considered as a black run, using the standard evaluation. In this way, it was possible to evaluate the possible positive effect of gamification implementation on such a subject, significantly impacting students' learning.

3. RESULTS AND DISCUSSION

3.1 Effect of gamification on the topic marks

This particular subject is evaluated considering the continuous work of the students. In this way, it is evaluated the work that the student performs during all the subject. Figure 3 shows the percentages of students who passed that specific topic under study and those who did not (2018/2019 standard evaluation; 2019/2020 and 2020/2021 using Kahoot).
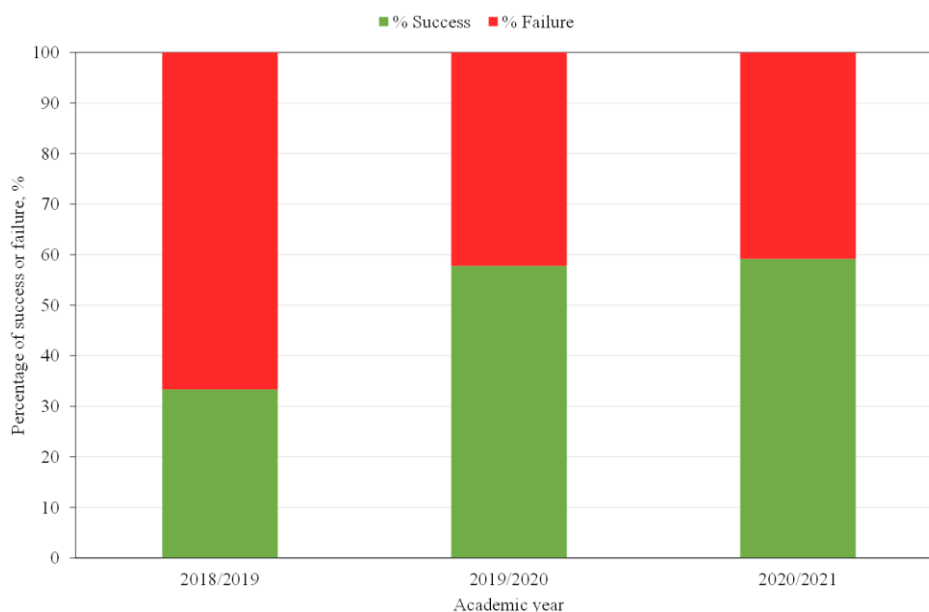

Figure 3. Percentage of success and failure during topic evaluation

As shown in the figure, gamification had an apparent positive effect on the percentage of students who succeeded during the evaluation of this specific topic. This increase was up to 30% during the first year of the implementation, keeping the same level during the following year. This positive effect has also been reported on references[12].

As described in the methodology, the questionnaire had two kinds of questions, "Multiple-choice" and "True or False". By using "True or False" questions, the critical points of this topic were evaluated. Figure 4 shows the success and failure ratio in the two kinds of questions used in this questionnaire.
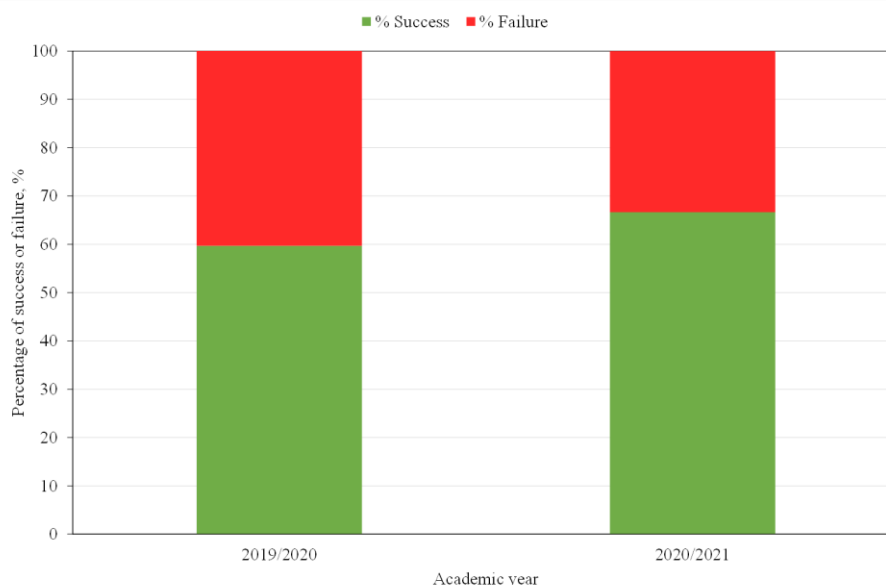
Figure 4. Percentage of success and failure of most important sections of topic (True-or-False questions)

According to these results, it is possible to claim that Kahoot! implementation increased the ratio of students that succeed in this topic and the better understanding of the learning outcomes of this topic. The incidence of the pandemic in the world society last year makes it unclear if the slight increase from 2019/2020 to 2020/2021 was only due to gamification or the COVID situation, which affected the lifestyle of students during lockdown[13,14].

3.2 Effect of gamification on the student motivation

The preliminary character of this part of our study did not allow us to make a quantitative evaluation of students' motivation for facing the following topics of the subject. However, Kahoot! application provides a student's ranking with trophies, which is expected to motivate their outcomes learning in the following topics. Figure 5 shows an example of the student's ranking.

Figure 5. Student's ranking

4. CONCLUSIONS

This work describes a practical example of gamifying education on Chemical Engineering. For this purpose, it was evaluated the percentage of students that succeeded and failed during the evaluation on a specific topic of the subject during three academic years. According to these results, it is possible to claim the positive impact that gamification produces on technical subjects, increasing students' learning motivation. Moreover, it seems to be a promotor effect of gamification on better understanding of this topic's most important learning outcome. It is necessary to continue evaluating student behaviour during the subsequent years, studying the possibility of implementing this method in several subject topics to keep the attention and healthy competitiveness between the students.

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