Gamification and Agile: An Alternative Approach to Learn Mechanics

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Abstract

Statics, Kinematics and Dynamics of machines and mechanisms have been among the subjects with highest failure rates by the students in the bachelor's degree of Mechanical Engineering at the Rovira i Virgili University. In the academic course 2017-18 a new strategy with different methodologies was implemented to raise the student success. The methodologies used were Agile philosophy and Kahoot questionnaires (gamification). By means of Agile, the students, which are organized in teams, must study a real mechanism in order to analyze its kinematic and dynamic behavior and to deliver a detailed report to a client (a fictitious company) at the end of the course. Each team has a different mechanism. The experimental study must be performed in successive steps through both semesters. Each step takes two-three weeks and a list of requirements to complete. This methodology, thus, requires continuous teamwork, avoiding student last-minute poor deliveries. On the other hand, by using a personal response system doing a Kahoot! questionnaire during a class (kahoot.com), you can easily quantify how much of this lesson the students have understood and which concepts must be reinforced. Moreover, gamification via Kahoot! contributes to engage students to the subject and creates a more positive and active atmosphere in the classroom. The results of applying simultaneously both techniques in the course 2017-18 and in the first semester of 2018-19 have been extremely satisfactory. The majority of the students think that Kahoot questionnaires help them to better understand the subjects, and they are more connected during the lessons. Regarding Agile project, the results of a survey reveals that almost all the students think that the methodology applied has facilitated them to better understand the concepts. Finally, a decrease in the subjects' dropout and an increase in the number of students that pass the subjects have been obtained.

Keywords: *Agile, Kahoot!, Mechanics, Learning Games, Collaborative Work.*

1. Introduction

Mechanics and Theory of Mechanisms is divided into two subjects (Mechanics and Theory of Mechanisms I (MTMI) and Mechanics and Theory of Mechanisms II (MTMII) in the bachelor's degree of Mechanical Engineering (GEM) at the Rovira i Virgili University (Tarragona, Catalonia). Both subjects are respectively developed during the first and second semester of the second course of GEM. In each subject are enrolled more than 65 students every year.

The student success rate in both subjects was highly disappointing due to the high number of students that failed or dropout these subjects, mainly in MTMII. Dropout rate was skyrocketing (up to 23% in 2016-17 MTMII academic course), and higher than the second course student dropout rate in GEM (5.8%). Therefore, a change in the subject methodology was needed. Our goal was to create "a positive learning atmosphere in class" for all MTM students, to increase their motivation towards MTM, and thus, to decrease the students' dropout. To achieve these objectives, the MTM lecturers decided to change radically the classroom methodology, introducing two new types of assessment activities in 2017-18 academic year: *Kahoot!* questionnaires [1-2] and Agile project [3]. If students had difficulties to find reasons to study some subjects, we were sure that changing the teaching methodology may help to discover to the student's new reasons to be more engaged to learning mechanics.

2. Methodology

The assessment activities were the same for both subjects from 2010-11 to 2016-17 academic courses. The first, called "delivery problems (DP)", were developed in class and in pairs of students, every two weeks. At the end of the class, each pair of students handed in the problem solved to the lecturer. The lecturer returns back to the student the problem evaluated in the subsequent session of DP. There were five DP in each subject. They had a weight of 10% on the final grade per subject.

The second type of task included in the assessment were problems but resolved at home and delivered via Moodle platform (MP). In total, each student did four to six MP per subject. The assessment was of 10% of the final grade per subject. The rest of the student grade were traditional

exams: two exams (65%) and one test (15%). All these activities composed the assessment of the students in order to obtain the final mark per subject.
In the academic course 2017-18 a new strategy with different methodologies was implemented to rise the student success in MTM. The methodologies were Agile philosophy and Kahoot questionnaires. With the new methodology the evaluation system was composed by 20% Agile, 10% DP, 5% Kahoot, 65% two exams.

2.1 Agile

The aim of the project is to learn kinematics and dynamics of mechanisms using a real one degree of freedom mechanism under the so-called Agile methodology. Agile is based on principles of collaboration between students, adaptability and non-stop improvement of the work done.
By means of Agile, the students, which are organized in teams of five, must study a real mechanism and to deliver a detailed report to a client (a fictitious company) at the end of the course. Each team has a different mechanism. The mechanism has to obey some other requirements: the movement of the handle should perform a full rotation and the mechanism should be easy to manufacture.
The experimental project must be performed in 10 steps through both semesters. Each step has a duration of two-three weeks and a list of requirements to complete. Each step is called Sprint. 5 Sprints are done in MTM I and the others 5, during MTM II. Table 1 shows the 10 Sprints that the students must complete through the academic year.
At the end of each Sprint, each team shows in class (this session is called DEMO) its product progress to the client (the professor) achieved during this period. Additionally, the team must facilitate the activities that they have done to perform the Sprint, specifying who has done each task. The students combine manual determination of the kinematics and dynamics of the mechanism with numerical calculation by WinMecC [4] simulation program.
This methodology, thus, requires continuous work of the team during all academic year, avoiding student last-minute poor deliveries.

MTM I Sprints	MTM II Sprints
1. Team formation and project planning.	6. Possibility to change the team or / and the mechanism
2. Election of the mechanism of one degree of freedom.	7. Determination of the mass properties and the center of gravity of each link
3. Mechanism simulation by WinMecC	8. Measurement of the maximum and minimum angular acceleration and acceleration of the centers of gravity
4. Position and displacement Analysis	9. Measurement of the maximum and minimum Inertial Force and Inertial Torque
5. Velocity Analysis	10. Determination of the required torque to start the mechanism

Table 1. Objectives of each Sprint

At the end of the course, each team must do a viva voce presentation of its project to convince to the client (the lecturers) that its product is the best. After the demonstration, the client announces which is the best team and artifact. This assessment is of 20% of the final grade of each subject. Figure 1 shows one students' mechanism analyzed during 2017-18 course and its simulation by WinMecC.

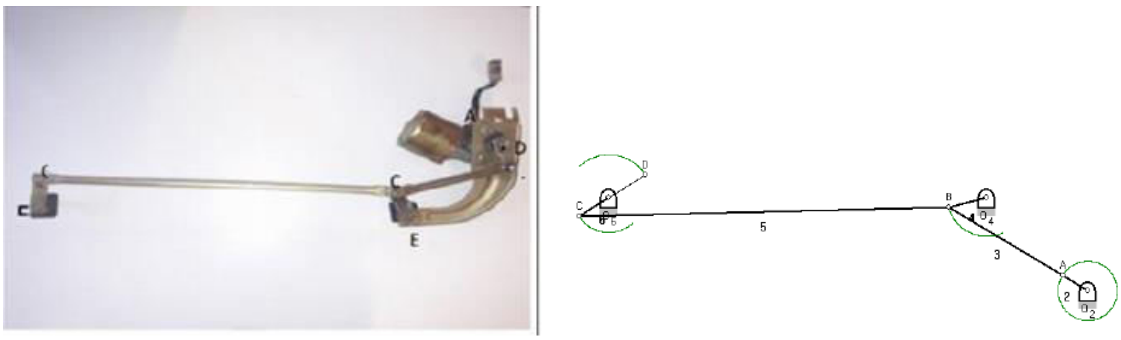

Fig.1. Windscreen wiper mechanism and its simulation by WinMecC

2.2 Kahoot

Kahoot is explained at its web page as a learning game that you can create in minutes. The professor makes a series of multiple-choice questions, and they choose the format and number of questions. The students answer the questions on their own devices (smartphones, tablets or laptops); while questions are displayed on the screen as Figure 2 shows. After each question displayed and answered, Kahoot shows on the screen the global results and the ranking with the top five. Thus, the students have immediately the feedback of their learning.

Seven Kahoots composed by at least five questions are performed at the end of the class in each subject. Each question has four possible answers, but only one is correct. It takes no longer than 10 minutes to complete one Kahoot.

Fig. 2. Kahoot question (four choices) about the type of joints that the hinge has and the simulation of the student mobile to answer the question.

3. Results

The students answered a survey about these two new methodologies at the end of each semester. The survey questions are listed in table 2 and the corresponding results are shown in Figure 3. 52.3% of the MTM students answered to this survey.

Kahoot questions	
Q1	Kahoots helped you to better understand the subject
Q2	Kahoots make you to be more motivated in class
Q3	The time invested in Kahoot is compensated with the learning that is realized
Q4	Kahoot results demonstrate the understanding of the acquired knowledge in class
Q5	The time to answer Kahoot questions is enough
Q6	Gamification would be positive in other subjects
Q7	If Kahoot had a higher weight on the total grade of the subject, you would have been more careful
Q8	Kahoot have helped to have better relationship with teachers
Q9	Do Kahoot serve you to clarify concepts?
Q10	The discussion after Kahoot answers allows me to clarify some concepts
Q11	It would be better to make a Kahoot in each class instead of one by topic
Agile questions	
Q12	Carrying out the project has helped you to better understand MTM
Q13	I have applied the Agile methodology during the execution of the project
Q14	The time spent on the project is recompensed by the learning that takes place
Q15	Teamwork was easy: they all worked in the same way
Q16	The time given for each Sprint is enough
Q17	The Sprint's DEMO helps me to organize the work done and to improve the presentation of the results.

Q18	Applying the theory to a real mechanism has helped me to understand MTM
Q19	Comments correctness of each Sprint have helped improve the work of the next Sprint
Q20	Planning the project in the first Sprint has helped me to better organize tasks
Q21	Keep the project as part of the course assessment

Table 2. Student survey

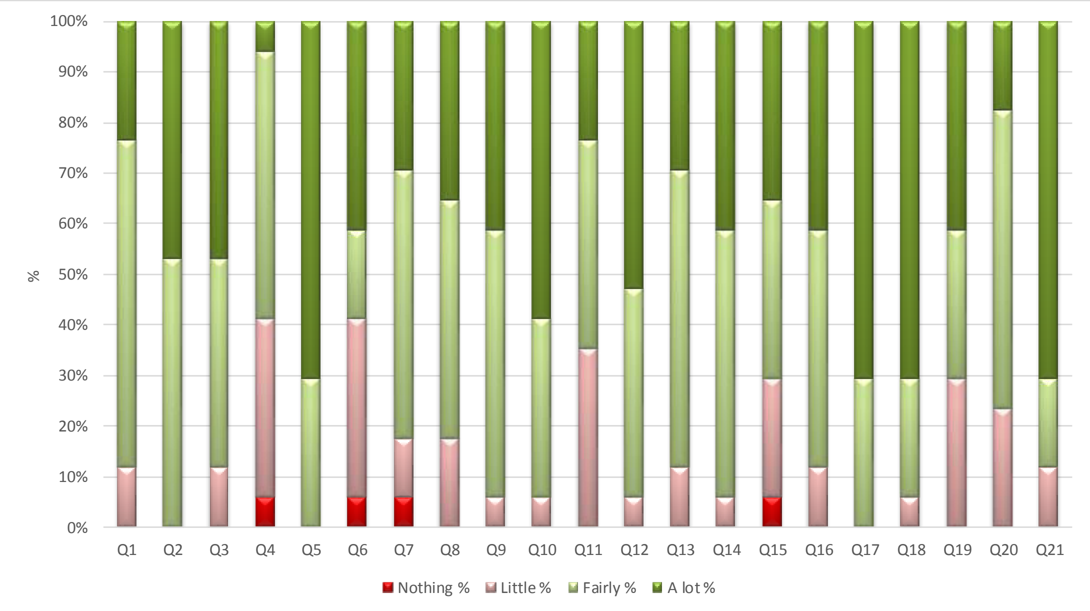

Fig. 3. Survey's results

As seen, the introduction of the gamification in class helped to our students to better understand MTM, to clarify theories, and to be more motivated in class. In relation to the Agile project, the students declared that the worst part of Agile was to work in teams, because the dedication of the students was not fair. However, the fact that the project was stated into 10 Sprints (Q17, Q16) was considered very positive. Moreover, the major part of the students wants to keep the Agile project as an assessment in both subjects because the time spent on the project is recompensed by the learning that takes place (Q14).

In relation to the academic results, Figure 4 shows the decrease in the dropout rate for each subject due to the new activities. In addition to this, the number of students that have passed both subjects increased in 7% (67.5% MTMI, 70.3% MTM II).

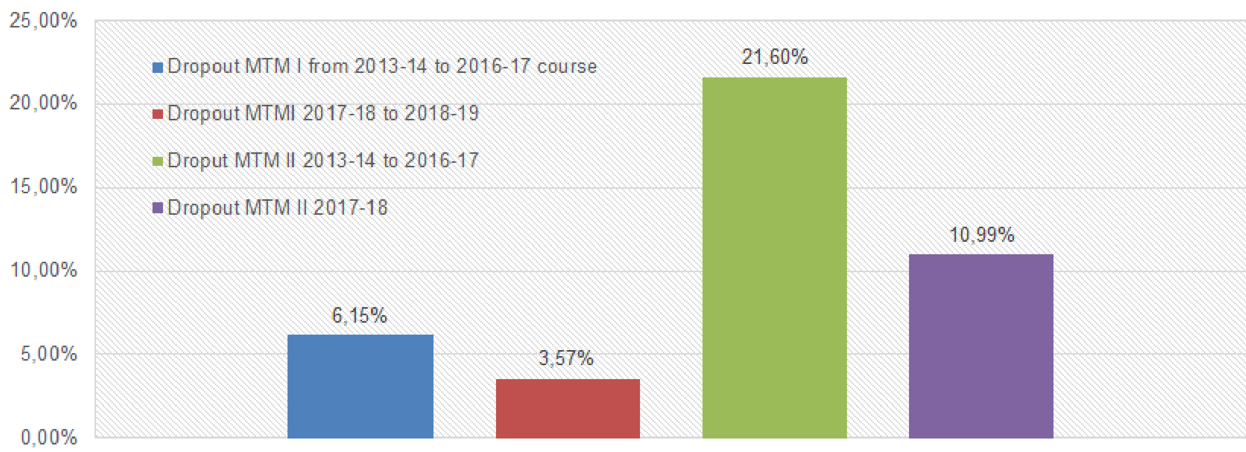

Fig. 4. Dropout rate

4. Conclusions

The results of applying simultaneously both techniques in the course 2017-18 and in the first semester of 2018-19 have been satisfactory. 70% of the students think that gamification helps them to better understand MTM. Regarding Agile project, the results of the survey reveals that 94% of the students think that the methodology applied has facilitated them to better understand the concepts. Finally, a decrease in the subjects' dropout of 7.3% have been obtained.
Although the new methodology means a lot of work, the lecturers think that, a great and positive change has been achieved in MTM. The lecturers will continue applying both techniques the next academic years.

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