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Using Padlet On Math Collaborative Learning In An Engineering Course

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ABSTRACT

This paper describes a study, with the objective of evaluating the possibilities of knowledge construction through collaborative learning (CL) in the innovative Padlet environment. During the practical classes of a math curricular unit of an engineering course, activities and assessments were carried out using Padlet. Program themes are organized by columns as a wall. Each students group accesses a problem proposal using a QR-Code. In the first part of the class, the group must solve the problem correctly, using all the materials and technologies they deem necessary. In the second part, each group will correct another group's problem. The teacher provides the necessary support with the role of advisor in carrying out the proposed problems. Through the direct observation of the teacher during CL classes using Padlet, the experiences of the authors and the evaluation of the students in these contents, it was possible to collect information that allowed demonstrating that the students developed capacities and reached competences, some of them specific to professionals in the area of this course. Students' opinion gathered with a questionnaire will also be very important data to be presented regarding their interest in this collaborative activity. In conclusion, this paper will describe, analyse, and discuss the interest in using a CL environment for the development of knowledge and for student motivation in teaching/learning math for engineers. Students' perspectives will be observed regarding their motivation and interest, allowing teachers to expand the range of perspectives on the contents covered and enriching the necessary discussions for future activities development.

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1 INTRODUCTION

Facing the new society based on the creation, publication and sharing of information in a network, digital tools can and should be used as essential and complementary resources in the teaching and learning process. National and international research has pointed to collaborative learning (CL) as a facilitator in the teaching and learning process. CL is a teaching-learning methodology where students work together in groups or individually on a collective task. It could be a group activity where subjects undertake different parts of the task but contribute to a common goal, or it could be a shared task where students work together. Collaborative schools are generally successful in dealing with difficulties (students with and without disabilities must work together and support each other in building effective schools), are schools with lower dropout and repetition rates, and teachers seem to be more satisfied and committed to the work they develop [1–4].

Mathematical Analysis (MA) is usually taught in the first years of engineering courses. This curricular unit (CU) has a large number of failures and evasions due to the students' learning difficulties and the bases they bring from secondary school. It is up to the teacher to motivate his students, encouraging them to reflect and understand the proposed contents and to be aware of the importance of learning in their lives.

Padlet [5] is a collaborative platform, like a dynamic wall in a virtual panel format, where users can publish texts, photos, links, videos or any other content of interest. The Padlet also allows you to deepen your knowledge on the subjects addressed, record learning and reflections, stimulate curiosity, share with other users, that is, develop more active skills. Therefore, this tool is an important didactic resource [6, 7] that provides new pedagogical strategies, streamlining learning and allowing the teacher conditions to stimulate students' interest, which can be successfully used in the classroom. In addition, it ensures that the teacher is a facilitator of the teaching and learning process, while the student, the protagonist of this process, exercises his autonomy and creativity by translating his results into knowledge [8, 9]. Thus, the objective of this study is to discuss the potential of using Padlet as a CL environment, diversifying activities and enriching classes, capturing the active participation of students both in the classroom and outside of it, in addition to stimulating their critical thinking. How can the use of Padlet contribute to student learning? Can collaborative classes in virtual and controlled environments be useful for student success today? Are teachers, as tutors, capable of transmitting the mathematical knowledge and skills required of engineering students? These and other issues will be addressed and discussed throughout the experiments described in this paper.

2 METHODOLOGY

In the second semester of the academic year 2022/2023, in the CU of Mathematical Analysis of the Degree in Electrotechnical and Computer Engineering at the Polytechnic Institute of Coimbra, in laboratory practical classes, collaborative learning tasks were implemented using the Padlet. The classes were planned in such a way that the tasks were conceived with the intention of encouraging the active participation of the students, as well as developing skills intrinsic to the function of a researcher, assuming that they could be co-builders of their knowledge itself. Learning was focused on the acquisition of syllabus contents prescribed in the subject's syllabus, arousing interest in the contents to be explored.

3 EXPERIMENTS IN CLASSES

In the first classes, the students created the groups, registered in the Padlet and for each of the groups a column was allocated in the Padlet environment. In this column, the elements of the

group were identified by their names and student numbers (see figure 1). Some experiments were also carried out in order to make the students feel comfortable using the Padlet.
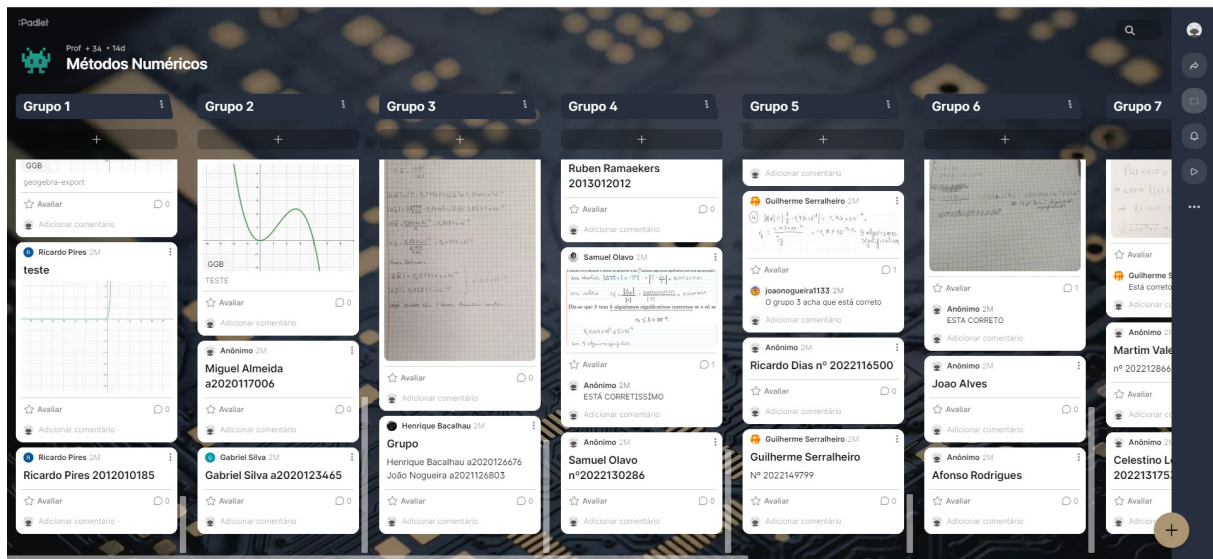

Figure 1: Example of Padlet at the beginning of laboratory classes.

In the following classes, the CU syllabus related to numerical methods were taught in these laboratory classes for 1h30m per week, where students have access to computers. In each practical class, a topic, among the existent 7, as shown in Table 1. Each task is previously planned by the teacher, following the objectives so that learning is achieved by the students. For example, in topic 1 on absolute and relative error, it is intended that students know how to calculate each of these errors and are able to have an idea of how the approximation should be so that the error has a given degree of precision. Thus, in this topic, the problem proposed to the students is based on the calculation of the absolute and relative error when approaching two values and the number of significant figures and decimal places obtained with this approximation. To access the proposed problem, the group must read the QR-code provided.

In the figure 2 it is possible to observe the posts of several groups on the topic "Graphical method for finding roots of nonlinear equations" of the third task (see Table 1). It can be observed that some of the groups solve the problem on paper and then photograph and upload the image, as in the case of group 3 and 5, others use digitizing tables, create a pdf and upload. Whenever possible, they use GeoGebra and/or other computer programs to graphically represent the functions, as can be seen in the images represented in groups 4, 6 and 7 (columns 3, 5 and 6 of figure 2 respectively).

Each practical class referring to a topic was divided into 3 parts, as shown in figure 3. Part 1, lasting 15 minutes, consisted of the individual resolution of an exercise on the topic learned in the previous class. Each exercise was quoted at 0.57% of the CU assessment mark. In part 2 of the class lasting 1 hour, students in groups of 2, independently research and learn the topic, with the guidance of the teacher. They discuss, in pairs and solve 1 or 2 random problems from a proposed list that they can access by reading the QR-code. The resolution is carried out with all the technologies they have available, such as the calculator, online applications such as WolframAlpha, Math Solver or GeoGebra and other applications that they have either on their computer or on their mobile phone. At this point they sometimes use digitizing tables, or paper and pen to register their resolution. At the end of solving the problem, they upload them to the Padlet in the column corresponding to their group.

Table 1: Topics, questions and objectives of tasks performed in laboratory classes.

| Tasks	Details	
1st	Topic	Absolut and Relative Error: Definition, Formula
	Questions	Calculate the absolute and relative error when approximating two values. How many significant figures and decimal places does this approximation have?
	Objective	To know the meaning of absolute and relative error and identify a certain degree of accuracy.
2nd	Topic	Approximation by Differentials.
	Questions	Approximate the value of a function near a known value by differentials.
	Objective	To calculate the differential of a function and use differentials to approximate values for expressions.
3rd	Topic	Graphical method for finding roots of nonlinear equations.
	Questions	Identify intervals that contain the roots of nonlinear equations through the graphical method and ensure the existence of a single root in an interval.
	Objective	To apply the graphical method and find intervals that contain only a single root of the equation.
4th	Topic	Bisection Method: Definition, algorithm, and error.
	Questions	Approximate a root of a nonlinear equation using the bisection method with a given error.
	Objective	To know how to apply the procedure of the bisection method, identify its advantages and disadvantages, and calculate the error approximation.
5th	Topic	Newton-Raphson Method: Definition, algorithm, and error.
	Questions	Approximate a root of a nonlinear equation using the Newton -Raphson method with a given error.
	Objective	To know how to apply the procedure of the Newton-Raphson method, identify its advantages and disadvantages, and calculate the error approximation.
6th	Topic	Numerical integration: Trapezoidal Rule.
	Questions	Estimate the number of intervals in the approximation for a given error and then find the approximation by the trapezoidal rule.
	Objective	To identify when it is necessary to apply numerical integration, find the smallest number of intervals to obtain a given approximation and apply the trapezoidal rule.
7th	Topic	Numerical integration: Simpson Rule.
	Questions	Estimate the number of intervals in the approximation for a given error and then find the approximation by the Simpson rule.
	Objective	To identify when it is necessary to apply numerical integration, find the smallest number of intervals to obtain a given approximation and apply the Simpson rule.
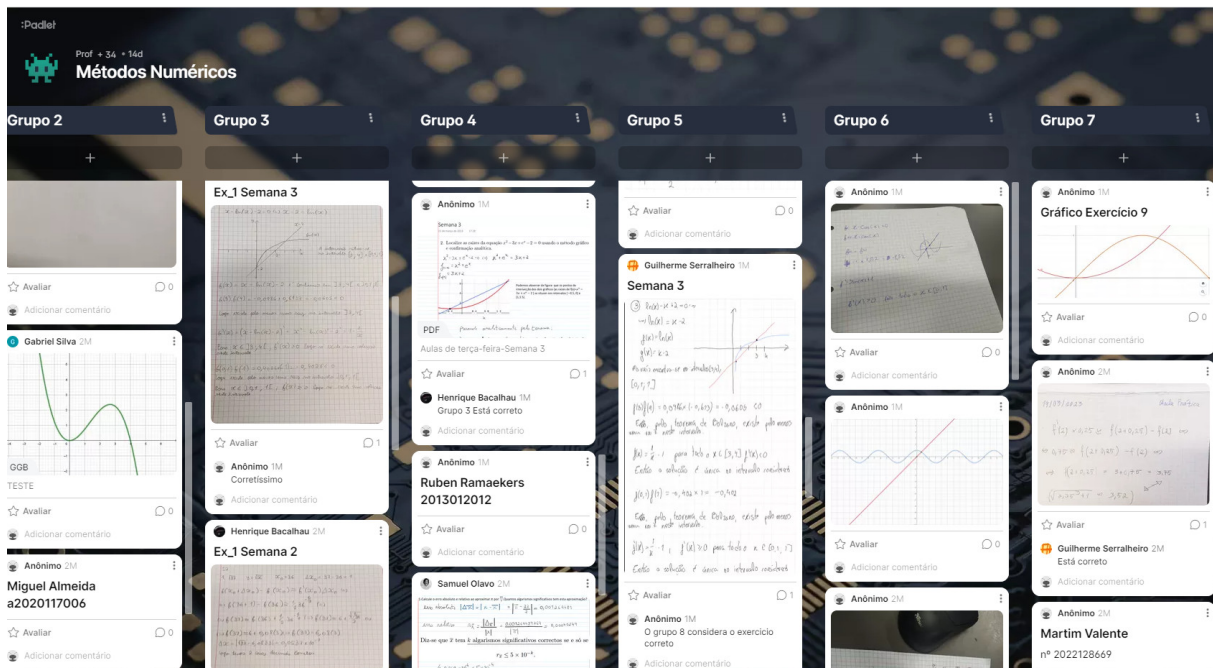
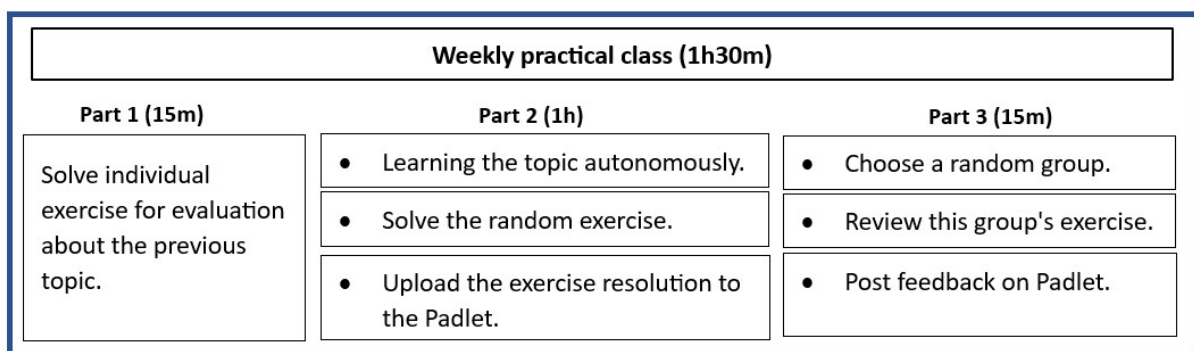Figure 2: Example of Padle in the lesson of task 3.

Figure 3: Flowchart of laboratory classes in each week.

Finally, in part 3 of the class lasting 15 minutes, each group chooses a partner group at random and corrects the problem posted on the Padlet, adding comments and new resolutions if necessary. In the figure 4, two feedbacks on the resolution of the problem on the topic are represented. On the left, the feedback from group 5 that corrected the problem of task 4 performed by group 3 and commented: "Group 5 considers the problem correct"; on the right, group 2 corrects the problem on task 1 performed by group 4 and comments: "Correct".

All proposed exercises and theirs corrections are available on Padlet during the semester. Students can and should refer to these resolutions while they prepare themselves for the following week written assessment exercise.

During laboratory classes (figure 3), the teacher participates as a mediator, facilitating the teaching-learning process and contributing to positive transformations in the development process of his students. He has the role of challenging, arousing curiosity and encouraging the use of his students' imagination through situations in which the student is challenged and manages to develop critical sense and logical reasoning. At the same time, he must guide the learning of each student so that at each completed stage, the student's improvement becomes continuous, and the construction of skills and competencies takes place.
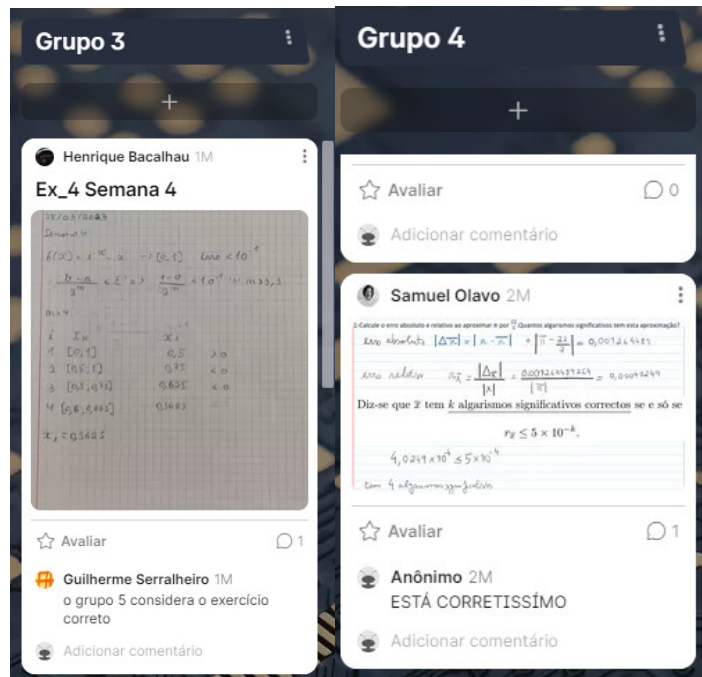
Figure 4: Exercise correction by peers group.

4   RESULTS & DISCUSSIONS

Of the 20 students who attended the laboratory classes, about 60% of the students had already carried out collaborative activities in the classroom, since many of these students had already attended this CU in the first semester. However, they had never used Padlet as a collaborative tool. In fact, only 1 student refers to having already used the Padlet, but not in a teaching-learning context.

From direct observation as an assessment tool [10], the teacher in the classroom observes the natural learning environment and collects "live" information, thus allowing momentary feedback and identifying perceptions by means of other assessment methods [11], according to the diagram shown in the figure 5.
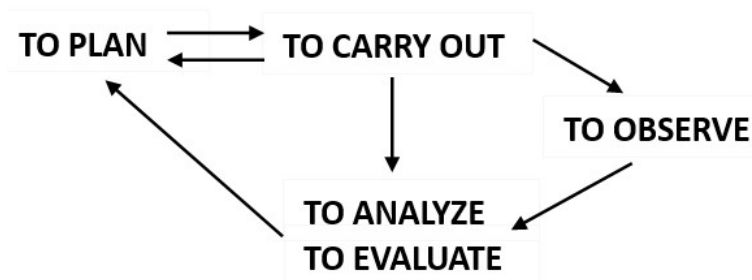

Figure 5: Classroom observation by each teacher (adapted from [12]).

During the several weeks of laboratory classes, the teacher registered the behavior of the students, both in terms of learning and in terms of collaborative activity in the group. Initially, the students were a little lost, as they did not know Padlet, nor were they used to attending math classes with access to different technologies. Regarding collaborative work, they were already used to experiences of this type carried out in the CU of the 1st semester, so cooperation and dialogue between peers was natural. As the weeks progressed, enthusiasm increased, carrying out tasks became easier, as students began to better understand how they should carry out autonomous study by the group, and the taste for the tasks grew. The peer assessment was

the task that the students liked the most, because at that moment, in addition to learning being carried out, it is a way for the student to recognize the skills and competencies that he has acquired, in an autonomous way. As a teacher, it is a pleasure to observe the progress that students have obtained in mastering the contents and the joy they show, which can be observed in the evaluation of the proposed exercises at the beginning of each class.

Regarding the evaluation carried out weekly at the beginning of the laboratory classes, it was possible to verify that all students were able to acquire knowledge, although in some tasks 1 to 2 students did not have a positive grade. It should be noted that these cases of failure always involved different students. Figure 6 represents the scores, with a maximum of 10 values, obtained by students in task 1 (left) and 4 (right) carried out in week 2 and 5 respectively. From the analysis of these examples, it is verified that 89% of the students in task 1 and task 4 have a positive grade, only 11% of the students did not reach the intended results. However, 73% (task 1) and 55% (task 4) have grades equal to or greater than 8 out of 10, which demonstrates that the vast majority of students manage to acquire the skills and abilities necessary for their learning. In the remaining tasks the results are quite similar. There is always a group of students, quite small (about 2 students out of 20), who cannot reach the necessary knowledge, however we can conclude that the learning was effective and real.
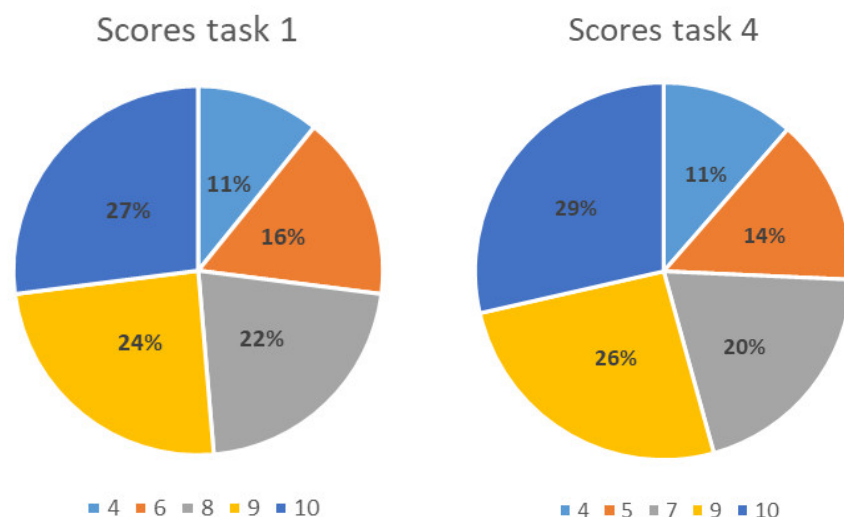

Figure 6: Student scores on task 1 (left) and 4 (right). Maximum value of the task 10 values.

5 CONCLUSIONS

The teaching of mathematics in an engineering school must capture the student's attention, be motivating, and allow students to acquire different skills and competencies that respond to the demands of the job market. Methodologies based on CL are an interesting example of how students can learn autonomously and acquired many transversal skills that will be useful to them as people and as professionals. The Padlet is a work tool that allows dynamic collaborative learning and can be used in a classroom environment in teaching-learning experiences.

In the study presented here, it was demonstrated that CL is effective learning as long as the student is involved in the constant search for his knowledge. For this reason, the presentation and monitoring of tasks in the classroom must always be accompanied and guided. The student learns to learn with his partner and together they obtain the necessary knowledge and associated skills. The teacher registers and guides, if necessary, but above all he is happy with the experience that he shows in the classroom. The use of Padlet in the CL of mathematics in an engineering course was an enriching, engaging experience that will be repeated in the next

school year. The mural is a space for sharing the productions carried out by each group, where students have the resolutions of the proposed problem available at any time. The information available on this wall is extremely important for students in their preparation for the following week's assessment. This was one of the interesting aspects of Padlet recognized by the teacher and the students. Another no less important aspect was the possibility of using the Padlet to stimulate learning through the correction of problem performed by peers. By reviewing another group's problem, students are able to improve their skills and trust in their learning, fostering effective and meaningful learning, with consolidated knowledge.

The pedagogical use of the Padlet, as a technological tool, proved to be fundamental to implement CL and to experience the acquired knowledge in a more productive and relevant environment for the students' academic performance. The results show that it is possible to promote the development of students' mathematical skills and competencies, and to stimulate critical thinking, at the same time, using technology as an ally throughout the teaching-learning process.

6 ACKNOWLEDGMENTS

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