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WHEN IS PADLET REVEALED AS A FRUITFUL TOOL IN ENGINEERING EDUCATION?

QUANDO O PADLET É REVELADO COMO UMA FERRAMENTA FRUTÍFERA NO ENSINO DE ENGENHARIA?

¿CUÁNDO SE REVELA EL PADLET COMO UNA HERRAMIENTA FRUCTÍFERA EN LA ENSEÑANZA DE LA INGENIERÍA?

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Abstract

The process of learning Mathematics in Engineering courses has been extensively studied, particularly regarding the use of Information and Communication Technologies (ICT) tools and digital platforms (Babo, L. et al., 2023). However, the COVID-19 pandemic disrupted traditional teaching methods, turning visible the need for adaptations and raising questions about the effectiveness of ICT tools and the decline of face-to-face group work. The need for innovative and stimulating teaching practices that motivate and engage students in the learning process became more evident during this time.

Collaborative learning (CL) has been proposed as a solution, with the Padlet platform (https://padlet.com/) being a popular tool for facilitating such interactions.

To address these challenges, the authors of this study propose the use of collaborative learning platforms in two engineering subjects: Statistical Methods in Informatics Engineering and Mathematical Analysis I. A total of 533 Informatics Engineering students, many of whom are working students, and 20 Mechanical Engineering students were divided into small groups to foster teamwork and cooperation. The aim was to create a virtual space for interaction and collaboration among students.

The Padlet platform was chosen as a facilitator for collaboration and engagement and students were encouraged to investigate class topics using various resources, such as bibliographical references, and to deepen their understanding through creative means. Padlet enabled students to share their exercise solutions, provide feedback on their peers' work, and access all the contributions made by their classmates.

The study evaluates the impact of this collaborative learning approach, considering factors such as student participation, collaboration with peers, and overall performance in the course. The authors also explore when and why these activities may or may not be effective, shedding light on the potential causes and implications.

Palavras-chave: collaborative learning, active methodologies, padlet, mathematics, solidarity

Resumo

O processo de aprendizagem da Matemática nos cursos de Engenharia tem sido bastante estudado, nomeadamente no que diz respeito à utilização de ferramentas e plataformas digitais das Tecnologias de

Informação e Comunicação (TIC) (Babo, L. et al., 2023). No entanto, a pandemia de COVID-19 veio perturbar os métodos tradicionais de ensino, tornando visíveis as necessidades de adaptações e levantando questões sobre a eficácia das ferramentas TIC e o declínio do trabalho de grupo presencial. A necessidade de práticas pedagógicas inovadoras e estimulantes que motivem e envolvam os alunos no processo de aprendizagem tornou-se mais evidente neste período.

A aprendizagem colaborativa (CL) foi proposta como solução, sendo a plataforma Padlet (https://padlet.com/) uma ferramenta popular para facilitar tais interações.

Para enfrentar esses desafios, as autoras deste estudo propõem o uso de plataformas de aprendizagem colaborativa em duas disciplinas de engenharia: Métodos Estatísticos em Engenharia Informática e Análise Matemática I. Um total de 533 estudantes de Engenharia Informática, muitos dos quais são alunos trabalhadores, e 20 estudantes de Engenharia Mecânica foram divididos em pequenos grupos para promover o trabalho em equipa e a cooperação. O objetivo era criar um espaço virtual para interação e colaboração entre os alunos.

A plataforma Padlet foi escolhida como um facilitador de colaboração e engajamento e os alunos foram incentivados a investigar os tópicos da aula usando vários recursos, como referências bibliográficas, e aprofundar sua compreensão por meios criativos. O Padlet permitiu que os alunos compartilhassem suas soluções de exercícios, fornecessem feedback sobre o trabalho de seus colegas e acessassem todas as contribuições feitas por seus colegas.

O estudo avalia o impacto dessa abordagem de aprendizagem colaborativa, considerando fatores como participação do aluno, colaboração com colegas e desempenho geral no curso. As autoras também exploram quando e por que essas atividades podem ou não ser eficazes, esclarecendo as possíveis causas e implicações.

Palavras-chave: aprendizagem colaborativa, metodologias ativas, padlet, matemática, solidariedade

Resumen

El proceso de aprendizaje de Matemáticas en cursos de Ingeniería ha sido ampliamente estudiado, particularmente en lo que se refiere al uso de herramientas y plataformas digitales de Tecnologías de la Información y la Comunicación (TIC) (Babo, L. et al., 2023). Sin embargo, la pandemia de la COVID-19 trastocó los métodos tradicionales de enseñanza, haciendo visible la necesidad de adaptaciones y planteando interrogantes sobre la eficacia de las herramientas TIC y el declive del trabajo en grupo presencial. La necesidad de prácticas de enseñanza innovadoras y estimulantes que motiven e involucren a los estudiantes en el proceso de aprendizaje se hizo más evidente durante este tiempo.

El aprendizaje colaborativo (AC) se ha propuesto como una solución, siendo la plataforma Padlet (https://padlet.com/) una herramienta popular para facilitar tales interacciones.

Para abordar estos desafíos, las autoras de este estudio proponen el uso de plataformas de aprendizaje colaborativo en dos asignaturas de ingeniería: Métodos Estadísticos en Ingeniería Informática y Análisis Matemático I. Un total de 533 estudiantes de Ingeniería Informática, muchos de los cuales son estudiantes activos, y 20 Estudiantes de Ingeniería Mecánica se dividieron en pequeños grupos para fomentar el trabajo en equipo y la cooperación. El objetivo era crear un espacio virtual para la interacción y colaboración entre los estudiantes.

Se eligió la plataforma Padlet como facilitador de la colaboración y el compromiso, y se animó a los estudiantes a investigar los temas de clase utilizando varios recursos, como referencias bibliográficas, y a profundizar su comprensión a través de medios creativos. El Padlet permitió a los estudiantes compartir sus soluciones de ejercicios, proporcionar comentarios sobre el trabajo de sus compañeros y acceder a todas las contribuciones realizadas por sus compañeros de clase.

El estudio evalúa el impacto de este enfoque de aprendizaje colaborativo, considerando factores como la participación de los estudiantes, la colaboración con los compañeros y el rendimiento general en el curso. Las autoras también exploran cuándo y por qué estas actividades pueden o no ser efectivas, arrojando luz sobre las posibles causas e implicaciones.

Palavras-chave: aprendizaje colaborativo, metodologías activas, padlet, matemáticas, solidaridad

1 INTRODUCTION

The involvement of students in school has been pointed out as one of the main factors for the reduction of risk behaviours and school dropouts, as well as for the improvement of school results. Solidarity is based on the joint participation of all those involved, aiming at the growth of all, with a focus on equality, cooperation, collectively and respect for the rights of each one. To develop solidarity, it is necessary to have a solidary social behaviour, which is not based on competition, but on collaboration and a thought based on the community. Solidary social behaviour occurs when work is carried out with the participation of all, directly or indirectly, with dialogue being fundamental for it to occur. Thus, in general, solidarity involves empathy, collaboration, collectively, union, equality, teamwork, humility, respect, dialogue, donation, interaction, and democracy. To promote solidarity through school activities, it is necessary to propose group work, cooperation being an essential part for them to build learning together (Frankenberger et al., 2018). Team activities allow considering the life experience of each person involved in the process, favouring dialogue, the exchange of knowledge, empathy, understanding of reality, among others. At school, most teachers are not in the habit of carrying out group work, however, nowadays with access to teaching-learning technologies such as collaborative methodologies, there are already several online platforms that allow the development of group work (Figueiredo et al., 2014). One such application is Padlet (Fisher, 2017; Mehta, Miletich, & Detyna, 2021; QiaoZhi, & MuSu, 2015; Padlet, 2023).

The article discusses the practice of group work using the Padlet platform, as an instrument for building principles such as solidarity, tolerance, and acceptance of difference in two curricular units, namely: *Statistical Methods of Computer Engineering* and *Mathematical Analysis of Electrotechnical and Computer Engineering*. The results of this experiment are also presented, including the level of participation of students, their collaboration with peers and their overall performance in the course, highlighting evidence of when it is, or is not useful to use this type of activity and what are its probable causes.

1. METHODOLOGY & EXPERIENCES

1.1. Statistical Methods

A semester-long activity was introduced to students enrolled in the Statistical Methods course within the Informatics Engineering program. The primary objective of this activity was to establish a collaborative learning platform, enabling students to interact and engage with one another in the context of the course.

A total of 533 students were registered for the Statistical Methods course, with eighty-five of them attending after work hours. All students received an invitation via email and had the opportunity to sign up for the Padlet activity, which was made available on the Moodle platform for a two-week period at the beginning of the semester. Out of the 533 students, 137 expressed their intention to participate, including 28 students from the after-work course. Thus, approximately 24.3% of the regular students and 33% of the after-work students engaged in this activity (approximately 25.7% of the total students registered for the course). However, despite the expressed interest from 137 students, only 50 of them actively posted and interacted with their fellow colleagues.

The activity aimed to deepen students' understanding of the topics covered in class, including the provided references, as well as encourage them to review exercises completed by their peers. To facilitate this process, a Padlet platform was utilized, where registered students were able to publish their solutions to questions from previous exams. The teachers required students to provide their identification (name and student number) while participating in the activity. Teachers also encouraged students to publish their resolutions and provide constructive comments on the solutions shared by their colleagues.

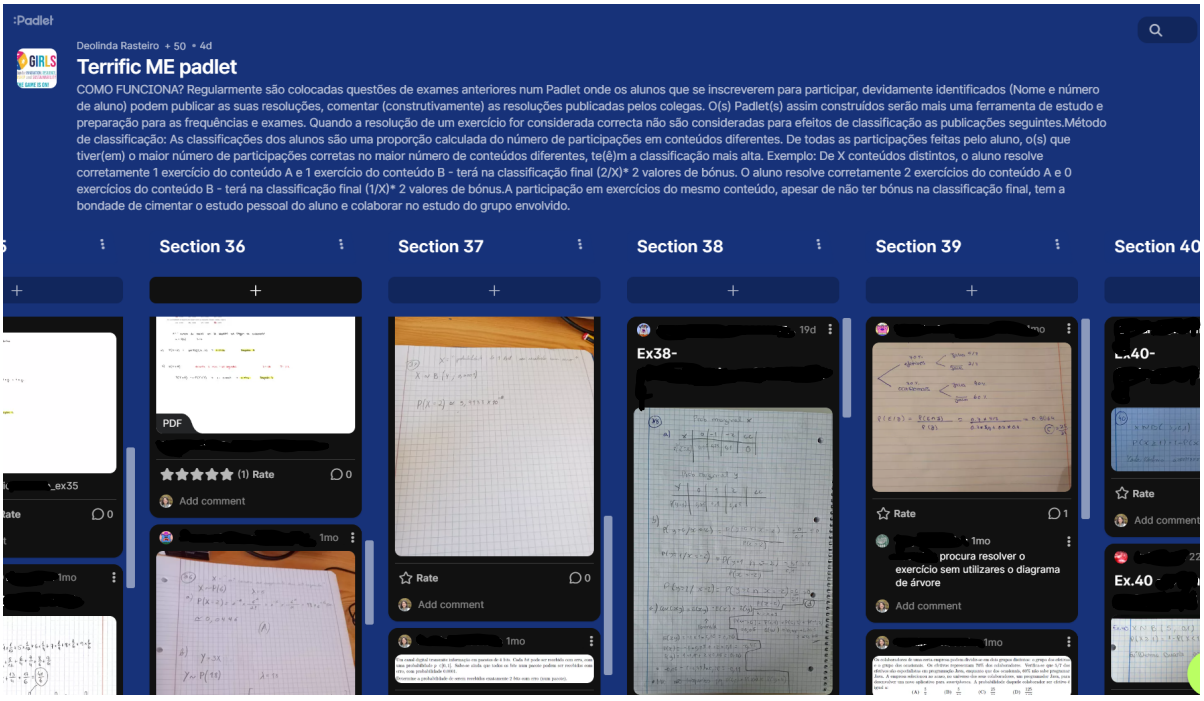
Student scores were calculated based on the proportion of their participation across different content areas. The student with the highest number of correct participations in the greatest variety of content areas received the highest rating. For instance, if there were X distinct content areas, a student who correctly solved 1 exercise from content A and 1 exercise from content B would receive a bonus value of (2/X) * 2 in the final classification. Similarly, a student who correctly solved 2 exercises from content A and 0 exercises from content B would receive a bonus value of (1/X) * 2 in the final classification. Participating in exercises of the same content, although not contributing to the final bonus values, still benefited the student by reinforcing their personal study and contributing to the collaborative learning within the group.

The materials published by the students were reviewed and corrected by the professors, who provided feedback on whether the resolutions needed revision or if they were correct as it may be observed in Figure 1. All participating students had access to the entire body of work developed throughout the activity. At the conclusion of the activity, students were eligible to earn a maximum of 2 additional points that would be added to their final grade.

The evaluation of students' involvement, collaboration, and solidarity, along with the results obtained, will be discussed, and presented in the results and discussion section.

Figure 1

Proposed Padlet activity



1.1 Mathematical Analysis

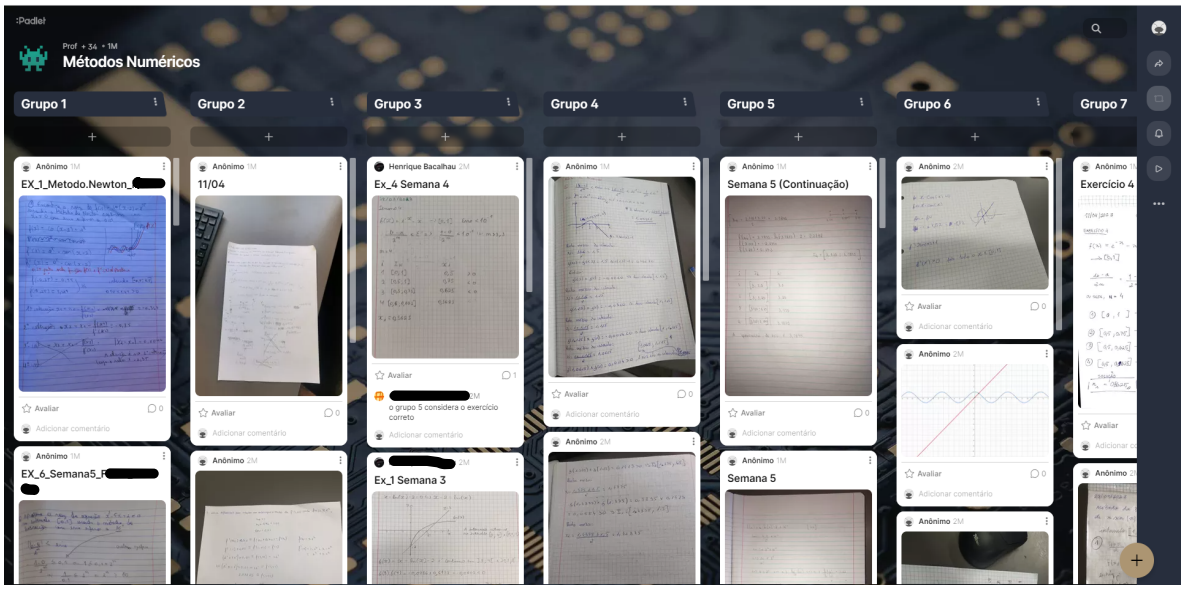
In the Electrotechnical and Computer Engineering course, the curricular unit of *Mathematical Analysis* is taught in the first year to newcomers to higher education. Students with very weak basic knowledge of mathematics and great difficulties. That is why the Instituto Superior de Engenharia de Coimbra offers the same curricular unit in the second semester in a sliding way so that a greater number of students can obtain the basic skills. The experience described here takes place in the 2nd semester with only 20 students who did not obtain a positive grade in the 1st semester, intending to continue their studies in this UC in the 2nd semester. As students have already attended this UC, classes are held in a collaborative environment where the professor has a guiding role.

The 1h30m laboratory classes are organized in three parts. In the first part of the class, students perform an evaluation exercise on the syllabus taught in the previous week's class for 15 minutes. In the second part, in a group of 2, they solve one or two exercises on the content of that week autonomously. First, through a QR-code, they access the proposed exercises for each group, then consult the curricular unit's notes on Moodle and solve the exercise(s) using available technologies such as GeoGebra, Wolfram Alpha and the calculating machine. At the end of this part of the class lasting 1 hour, the resolutions are placed in the Padlet in the column associated with the group in question. Here the use of digitizing tables, mathematical writing applications such as Math Type or even paper and pen were used.

Group work and solidarity between the two elements of the group must be cohesive and characterized by strong bonds of connection, cooperation, help and support, hence favouring and stimulating the entire teaching-learning process. Another aspect to be highlighted concerns the fact that when group work is carried out in the classroom, it is necessary to define, for example, who will write the exercises resolution, who will upload them to the Padlet, and who will be the group leader. And in this case, let the group members choose the participants by affinity. In the third part of the class and lasting 15 minutes, the groups are mixed, and each group corresponds to the correction of one (two) exercise(s) from another group. The first groups to finish will be the first to exchange patches. In this part, solidarity is present in the competitiveness and productivity between the work groups. Group work is a key factor for group elements to operate at their full potential and to be able to detect errors or small inaccuracies in other groups.

Figure 2

Capture of part of the group work developed in Padlet



Within Figure 2 above, we may observe one example of the work developed by the students inside the classroom.

2. RESULTS & DISCUSSION

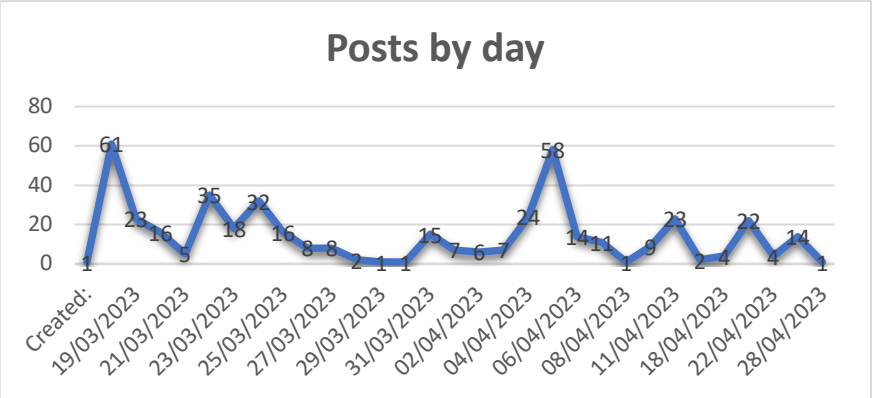
2.1. Statistical Methods

2.1.1. Padlet posts and satisfaction questionnaire

The initial result of the activity revealed a less-than-encouraging engagement rate, with only 25.7% of the students responding to the activity invitation, despite the opportunity to earn 2 bonus points. Over the observation period (from 18/03/2023 to 28/04/2023), a total of 448 posts were made, and their daily distribution can be observed in Figure 3.

Figure 3

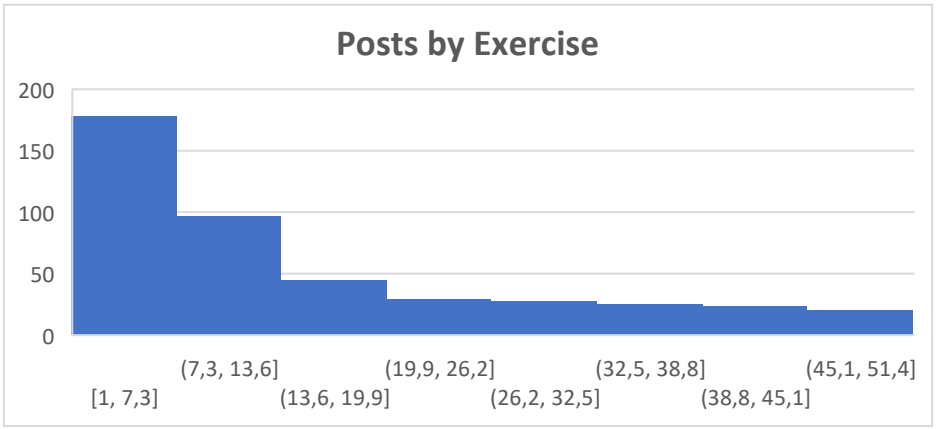
Distribution of posts by day



The distribution of posts by Exercise entrance is depicted on Figure 4, below. As we may observe, in the beginning there was a higher response rate that may be attributed to two distinct reasons: one is natural curiosity, the other is because initial exercises were simpler that the following ones.

Figure 4

Posts by Exercise

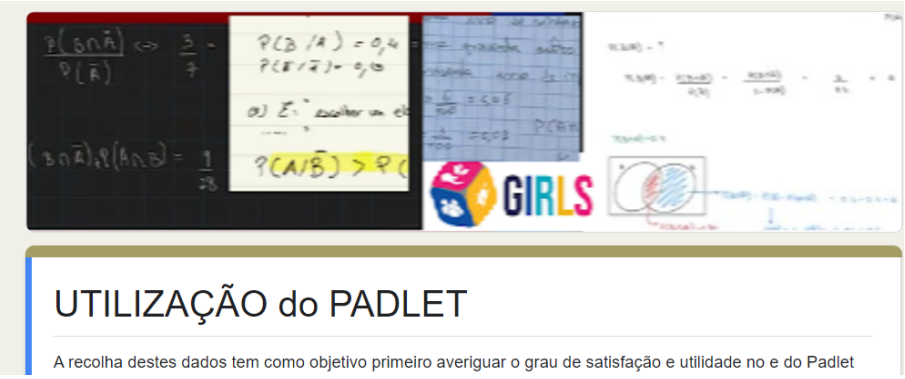


Since the response rate stabilized during the period of observation and the exercises difficulty were regularly improving, the authors tend to justify the initial index of response as curiosity.

To gather feedback from the participating students, a satisfaction questionnaire was created by teachers, who delivered it using Google Forms (Figure 5). The questionnaire aimed to assess students' satisfaction and perceived utility of the Padlet activity.

Figure 5

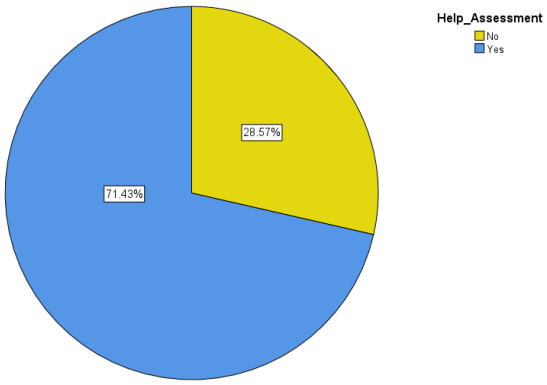
Satisfaction Questionnaire



From the data collected and resumed we may conclude that 61.9% of the engaged students had never used Padlet. Since the activity engagement in the beginning was only approximately 25.7%, the authors questioned if the students were only involved because of the 2-points bonus proposed. Besides the 2-points bonus proposed, 90.5% of the students agreed that this activity helped them to study. When asked «*Do you consider that, in addition to the bonus, which you may have in your mark, this activity helped you to obtain a better classification in the written assessment?* », the obtained answers indicate, as shown in Figure 6, that 71.43% of the students consider the activity has helped them to prepare to the written assessment.

Figure 6

Positive activity influence in the assessment



2.1.2. Padlet posts and written assessment

To corroborate these received answers, we compared the number of students approved in the written assessment to the number of those students that participated in the activity.

In fact, in case of after work students, from the 44.71% of the ones that were assessed, 60.53% approved, and from those 60.87% participated in the activity. Regarding regular students, from the 43.90% of the ones that were assessed, 70.09% approved, and from those 37.80% participated in the activity.

Table 1

Statistics from the written assessment

Student Type	Students Total	Assessed	Approved	In Activity	Approval. Rate
After Work Students	85	38	23	14	60.53%
Regular Students	533	234	164	62	70.09%

Regarding the feedback given by professors, 90.5% of the students considered that it was enough, and 85.7% of them wished that colleagues gave more feedback. As for the materials posted by their fellow colleagues, 95.2% considered that they were of help to complement their own study. When asked «*Would you like there to be more interaction with and from your colleagues? (Comments and questions to your resolutions)?*», 66.7% of the students wished more interaction from their colleagues. Finally, to be able to conclude whether students' solidarity was only towards the colleagues participating in the activity or in general, it was asked to students «*Do you agree with the sharing of the published resolutions with all your colleagues enrolled in the course? »,* 95.2% agreed.

2.2. Mathematical Analysis

After 4 weeks (week 2, 3, 4 and 5) of laboratory classes in *Mathematical Analysis*, the students answered a survey with the objective of measuring interest, motivation, and solidarity among the group members. 14 students answered the questionnaire, demonstrating that the group work was productive, that they had an important role in this group and that they think that their learning was effective, as can be seen in Table 2.

Table 2

Identification of group work and the relationship between its elements

Questions	% Yes
Your contribution was important for the group as an element?	92.9%
The dynamics of group work contributed to the development of the proposed exercise?	100%
Are you confident in what you learned in the classroom?	78.6%
Did you enjoy using Padlet?	92.9%
Padlet promotes greater participation and collaboration among group members?	92.9%

The teacher/student mediation was essential for overcoming the different stages of work design?	100%
The mediation between the different elements of the group was essential for overcoming the different stages of work design?	92.9%
Do you like that innovative learning activities are applied in the classroom?	100%
Do you consider that this work methodology can contribute to the development of skills inherent to academic (engineering) and professional choices.	100%

Cooperation, perfectionism. motivation, responsibility, and commitment were the words most identified by the students about the relationship between the elements of the group. This reinforces the solidary experience of these students in small groups. Finally, in an open response about what the students liked most about the laboratory classes, 50% of the students chose group work (Figure 7).

Figure 7

What do you like most about laboratory classes?

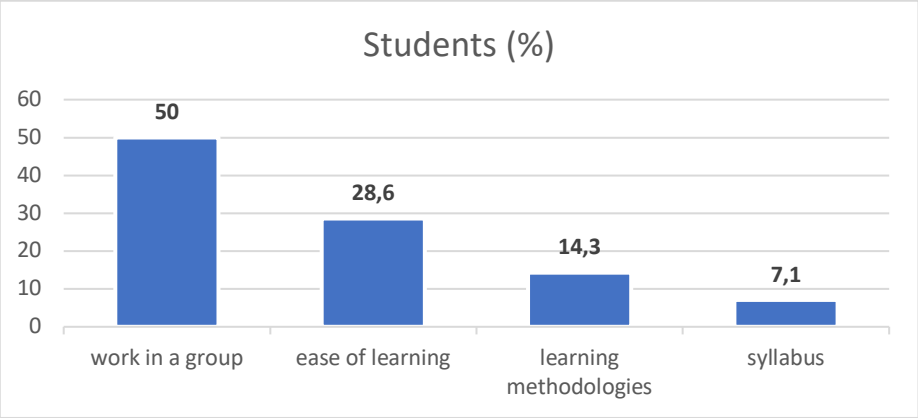
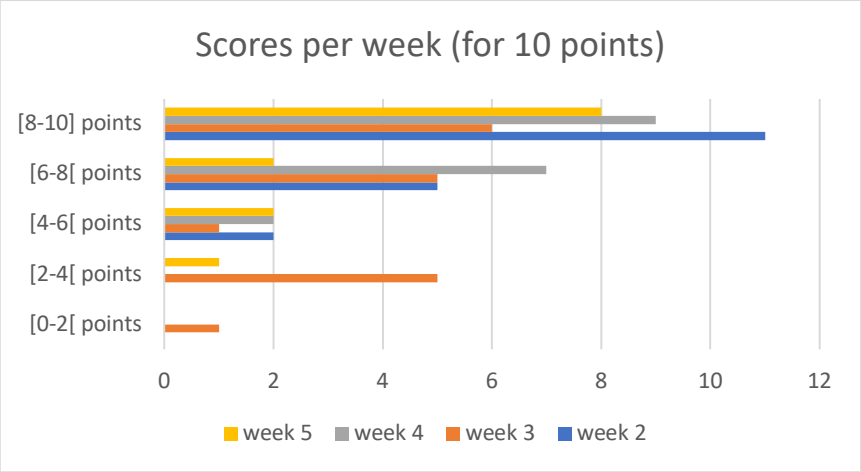


Figure 8

Scores obtained in the 4-week assessments



Regarding effective learning, it can be said that of the 20 students enrolled in the UC, only 18 carried out the assessments during the laboratory classes, obtaining the classifications shown in the figure. It should be noted that in week 3 only 13 students were evaluated and that the assigned classifications correspond to a range of 0 to 10 points in each week.

3. FINAL CONSIDERATIONS

Regarding the experience held on *Statistical Methods* course, from this activity a couple of conclusions may be redrawn. The first conclusion is that the percentage of students engaged in this activity was below professors' expectation and the percentage of students that undertaken the written assessment was also surprising (≅ 51%). Students prefer to clarify their questions about contents and exercises resolution at office hours or by e-mail where the only intervenient are the professor and themselves. Therefore, individual study is preferred by the student's majority. Another conclusion is that, even though we have faced times where ICT was widely used, Padlet, which is a very know collaborative platform, was an unknown tool for 60% of the students. Almost all students agreed that this activity helped them to study, and the feedback provided by professors was enough. A small percentage, 14.3% of the students wished that colleagues gave more feedback.

From both experiences it is important to recognize that student preferences and attitudes towards online activities may vary. As a teacher, being responsive to student feedback, monitoring participation levels, and adapting activities based on student engagement can help create a positive and inclusive online learning environment. The willingness of students to participate in online activities can vary depending on several factors such as their personal preferences, the nature of the activity, the level of engagement fostered by teachers, and the overall course structure. While some students may readily embrace online activities and actively participate, others may be less inclined to engage.

Group work can be a teaching and learning strategy that contributes, on one hand, to promoting pedagogical differentiation, since it presupposes that the student is integrated into a group with the aim of being able to learn and teach the remaining elements and, on the other hand, the development of various skills. By working in groups and practicing reflections with and among the students, little by little, they build the notions of solidarity, justice, and responsibility. To share their collaborative work with all the other students is, for the students engaged in the Padlet activity, not a problem. Therefore, we may conclude that although a small percentage of students wishes to work in collaboration, those who want are solidary with all the others. In the two experiences presented here, using the same Padlet collaborative platform, but using different views of learning, it was possible to demonstrate that the use of this methodology allows the student, in addition to obtaining knowledge skills, to obtain many other skills such as communication, responsibility, empathy, collaboration, solidarity, which prepare you for the job market where companies work with multidisciplinary teams that have different technical skills, experiences, personalities, behaviours and knowledge.

In the future, we intend to continue this practice in the classroom, as it helped with issues of solidarity, tolerance, and acceptance of differences within the classroom, as well as the development of cooperative group work.

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