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USING AN (INTER)ACTIVE LEARNING APPROACH IN MATHEMATICS: A CASE STUDY

USANDO UMA ABORDAGEM DE APRENDIZAGEM (INTER)ATIVA EM MATEMÁTICA: UM ESTUDO DE CASO

UTILIZANDO A UN ENFOQUE DE APRENDIZAJE (INTER)ACTIVO EN MATEMÁTICAS: UN ESTUDIO DE CASO

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Abstract

Active methodologies are important resources in the current learning context. In teaching mathematics, active methodologies play an important role, because in addition to being efficient strategies for mobilizing learning, they allow the student to be responsible for their own learning. And if interactive approaches can also be included in this context, where student learning is carried out through actions between the students themselves and between the students and the teacher, learning becomes more meaningful, building (inter)active learning. This paper presents a case study using an (inter)active learning approach. The results obtained through direct and participant observation of the teacher and the evaluations obtained demonstrate that learning was more efficient, effective, and motivating. That students developed digital skills, but also cognitive skills, allowing their social integration in the future. Using an (inter)active learning approach in mathematics can achieve better results in student motivation and skills development.

Keywords: active learning, (inter)active learning, mathematics, skills, higher school.

Resumo

As metodologias ativas são recursos importantes no atual contexto de aprendizagem. No ensino de matemática, as metodologias ativas desempenham um papel importante, pois além de serem estratégias eficientes de mobilização da aprendizagem, permitem que o aluno seja responsável pela sua própria aprendizagem. E se neste contexto também podem ser incluídas abordagens interativas, onde a aprendizagem dos alunos é realizada por meio de ações entre os próprios alunos e entre os alunos e o professor, a aprendizagem torna-se mais significativa, construindo uma aprendizagem (inter)ativa. Este artigo apresenta um estudo de caso usando uma abordagem de aprendizagem (inter)ativa. Os resultados obtidos através da observação direta e participante do professor e das avaliações obtidas demonstram que a aprendizagem foi mais eficiente, eficaz e motivadora. Que os alunos desenvolvam competências digitais, mas também competências cognitivas, permitindo a sua integração social no futuro. A utilização de uma abordagem de aprendizagem (inter)ativa em matemática pode alcançar melhores resultados na motivação dos alunos e no desenvolvimento de competências.

Palavras-chave: aprendizagem ativa, aprendizagem (inter)ativa, matemática, competências, ensino superior.

Resumen

Las metodologías activas son recursos importantes en el contexto actual del aprendizaje. En la enseñanza de las matemáticas, las metodologías activas desempeñan un papel importante, ya que además de ser estrategias eficientes para movilizar el aprendizaje, permiten que el estudiante sea responsable de su propio aprendizaje. Y si en este contexto también se pueden incluir enfoques interactivos, donde el aprendizaje de los estudiantes se realiza a través de acciones entre los propios estudiantes y entre los estudiantes y el profesor, el aprendizaje se vuelve más significativo, construyendo un aprendizaje (inter)activo. Este artículo presenta un estudio de caso utilizando un enfoque de aprendizaje (inter)activo. Los resultados obtenidos a través de la observación directa y participante del profesor y de las evaluaciones obtenidas demuestran que el aprendizaje fue más eficiente, eficaz y motivador. Que los estudiantes desarrollen competencias digitales, pero también competencias cognitivas, permitiendo su integración social en el futuro. El uso de un enfoque de aprendizaje (inter)activo en matemáticas puede lograr mejores resultados en la motivación de los estudiantes y en el desarrollo de competencias.

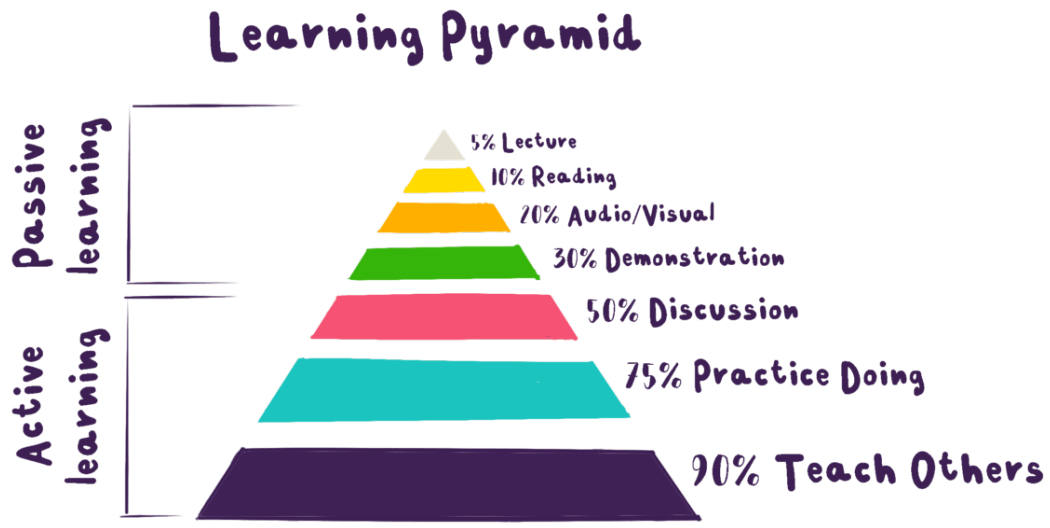
Palabras-clave: aprendizaje activo, aprendizaje (inter)activo, matemáticas, habilidades, eneseñanza superior.

1 INTRODUCTION

The American psychiatrist, William Glasser (Glasser,1969), developed several studies related to mental health and human behavior, including the creation of the learning pyramid (Figure 1).

Figure 1

Learning pyramid (https://www.plushnuggets.com/forms-learning-pyramid/)

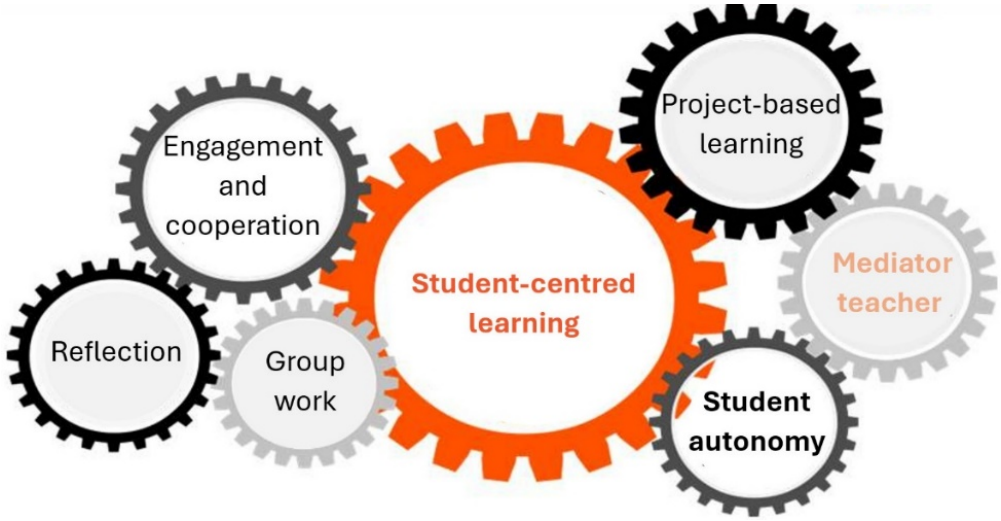


According to this theory, our level of knowledge retention is higher when we are carrying out activities that encourage participation and protagonism, while in passive activities our learning is much lower (Azambuja, & Barroso, 2022; da Cruz Garcia, et al., 2023). In the learning pyramid, actions such as reading, listening, and seeing are passive levels of learning, in which 5% to 20% of knowledge is retained by the student. On the other hand, when student learning is carried out through discussion, pedagogical practices, or applications of knowledge to teach others, learning is at active levels and 50% to 90% of knowledge is retained by the student. Active learning methodologies are therefore extremely important in the student's teaching-learning process, as they allow different approaches, activating the deeper levels of the learning pyramid.

In active learning methodologies, the student assumes a protagonist role in their learning (they are largely responsible for the learning process) and is encouraged to look for new ways of assimilating knowledge from the class. Thus, students learn more because they participate in the learning process, activating the deeper layers of the learning pyramid. Active learning encompasses a set of approaches related to the ability to create meaningful learning experiences, inside and/or outside the classroom. It encompasses several approaches (Lima, et al., 2017; Santos, et al., 2022; Wallace & Knudson, 2024), all focused-on student autonomy, involvement, action, and reflection on their learning as represented in Figure 2.

Figure 2

Active learning approach



Several studies have been carried out with the application of active learning in mathematics teaching, and in the case of higher mathematics education (Santos, et al., 2022; Tharwat & Schenck, 2023; Duran et al., 2024, Gani, 2024). And if interactive approaches can also be included in this context, where student learning is carried out through actions between the students themselves and between the students and the teacher, learning becomes more meaningful, building (inter)active learning. This is active learning where interactions between the protagonists (students and teacher) are marked by connections (learning pyramid) that allow overcoming difficulties and resolving doubts (50% Discussion), exploring knowledge (75% Practicing Doing) and teaching others (90% Teach others). The objective of this work was to investigate how students interact in the (inter)active learning of mathematics. The research questions underlying this work were: What was the greatest evidence of change perceived in students? What obstacles and challenges did teachers encounter?

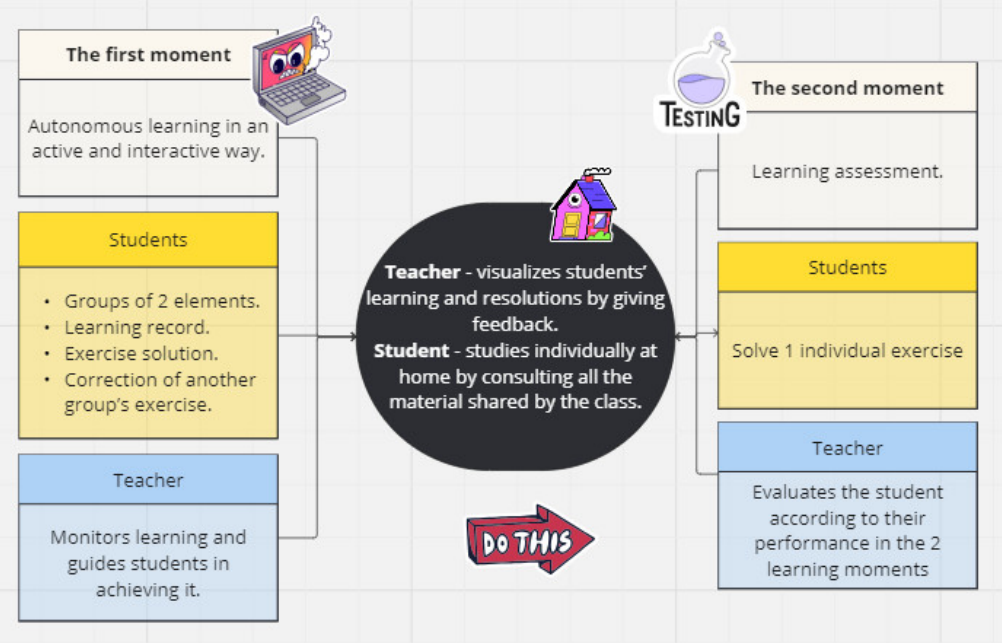
After the introduction, chapter 2 describes the methodology applied to (inter)active learning inside and outside the classroom, in chapter 3 the results and their discussion are presented. In chapter 4, conclusions and future work are presented.

2 METHODOLOGY

In the first semester of the 2023/2024 academic year, in Calculus 1 classes, students were invited to learn the contents of numerical methods using (inter)active learning. During practical classes lasting one hour and thirty minutes, the learning methodology followed the cycle described in Figure 3, lasting 1, 2 or 3 weeks.

Figure 3

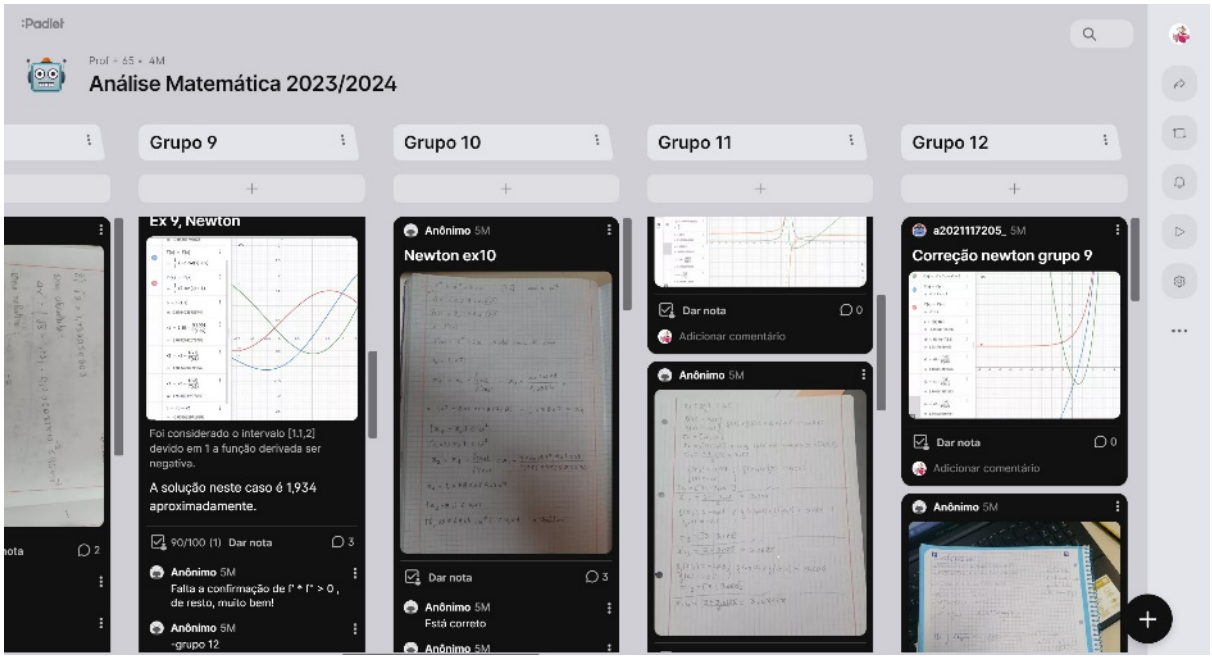
(Inter)active learning cycle



In the first week, corresponding to the first moment, students consulted the materials available on the syllabus, and in groups of 2 members, discussed and collaboratively shared a wall (Fisher, 2017; Padlet, 2023) where they posted their learning records (see Figure 4).

Figure 4

Example of the Padlet wall



Then they solved one or two exercises proposed on the content and posted them on the wall to share with all the students in the class. At the end of this sharing, each group had the role of correcting the exercise solved by another group, giving their feedback or their solution if there was an error. The teacher monitored learning and guided students to achieve it. In the second stage, students were assessed individually regarding the content learned. Between these two moments, the teacher visualizes the students' learning and resolutions by giving feedback, the student studies individually at home consulting all the material shared by the class.

This process was repeated during 14 weeks of classes corresponding to 4 cycles (Ci, i=1,...,4) of (inter)active learning, describing 4 different topics from the syllabus of numerical methods: (C1) errors, (C2) differentiability, (C3) solving equations not linear (graphical method and analytical confirmation, Bisection method and Newton-Raphson method) and (C4) numerical integration (trapezoidal rule and Simpson's rule). The duration of each (inter)active learning cycle depends on the content in question, and for (C1) and (C2) the duration was 1 week, for (C3) 3 weeks and (C4) 2 weeks.

3 RESULTS AND DISCUSSION

Throughout the semester, students felt motivated, did not give up and remained in classes week after week. The learning cycles followed identical procedures, where the following perceptions on the part of the teacher were visible through direct observation:

1. Learning new content – students feel lost and uncomfortable at first, then with the collaboration of their groupmate and the support of the teacher, they begin to feel more comfortable and feel that they have acquired the expected skills.
2. Proposed exercises – students demonstrate the skills acquired and work collaboratively, through the discussion of ideas and the mutual teaching between colleagues.
3. Correction of another group's exercises – at this stage, reflection and the implementation of knowledge is put into practice and for students to discover any errors or details in solving the exercise by another group is a victory.
4. Independent study at home – by consulting Padlet during the week before carrying out the assessment, it was possible to verify that access by students was frequent and for a long time.
5. Assessment - the individual assessment was carried out on paper, with several versions available with an equal degree of difficulty. The students, in general, applied themselves to their resolutions and justified all the steps to solve the exercise.

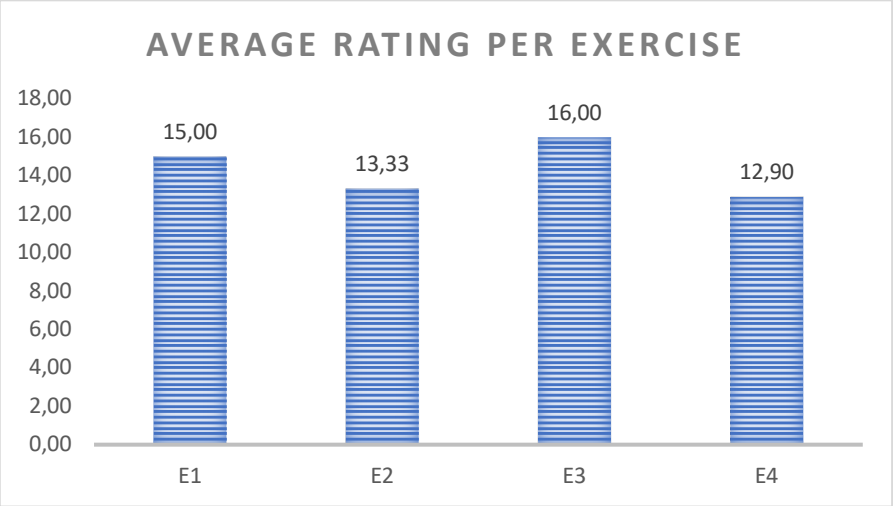
Of the 50 students who attended classes, only 4 students dropped out in the first classes. It was the first year in which the number of attendances remained practically constant throughout the 14 weeks of classes. 46 students developed active and interactive learning in Calculus I. Four (inter)active learning cycles were carried out (Ci, i=1,...,4) (Figure 3), with evaluation in 4 corresponding exercises (Ei, i=1, ...,4). The results are shown in Figure 5 and were very encouraging.

With an average always higher than 13 values in all exercises, obtaining an average of 16 in exercise 3 (E3). In all exercises, there were students who had the maximum score (12 in (E1), 13 in (E2), 7 in (E3) and 4 in (E4)) and the minimum was 1 in all exercises.

Of the 46 students, 15 were unable to learn these contents because they had a negative grade (although of these, 5 had 9 points and 2 had 8 points). The 7 students who obtained 8 and 9 points ended up obtaining a positive grade in the exam, because they were very well prepared, since by carrying out (inter)active learning throughout the semester they were able to acquire skills such as logical reasoning, studying independently, reflecting on the results obtained, etc., which were essential for your success in the subject.

Figure 5

Average obtained in the 4 exercises of the (inter)active learning cycle



Of the remaining 31 students, 5 students had D (grades between 10 and 11 values), 12 had C (grades between 12 and 14 values), 8 had B (grades between 15 and 17 values) and 6 had A (grades between 18 values and 20 values). Compared to the previous year (see Table 1), in which only 32 students attended classes and only 15 (47%) of them achieved effective learning in these contents, it appears that the use of active and interactive learning not only allowed greater involvement of students throughout the semester, as well as a greater number of students acquiring the necessary skills in numerical methods.

Table 1

Comparison between evaluation of numerical methods syllabus before and after the application of the inter(active) learning approach

School year	# students	# didn't pass	# grade D	# grade C	# grade B	# grade A
2023/2024	46	8	5(1)	12(4)	8(2)	6
2022/2023	32	17	6	2(2)	5	0

Note. The values in parentheses correspond to students who passed the exam.

Comparing the evaluations of the syllabus of numerical methods in the last two years, before or after the application of the (inter)active learning approach, there is an increase of 35.7% in the approval rate (the approval rate went from 46.9% to 82.6%). There was also a considerable increase in the acquisition of mathematical skills in this study plan, as the achievement of higher grades went from 5 students (grade B) to 16 students (10 in year B and 6 in year A). It should also be noted that the number of students with grades at the passing threshold in these two years remained the same (6 students).

4 CONCLUSIONS AND FUTURE WORK

Active and (inter)active learning is a teaching methodology that allows students to obtain effective knowledge, through autonomous and responsible student learning, in a pleasant and motivating environment, with the support and guidance of the teacher. Several studies record cases of application of this methodology, with very satisfactory results in terms of hard skills (specific skills in mathematics) and soft skills (skills linked to the student's profile and behavior). In this paper the main objective was to answer the following research questions: What was the greatest evidence of change perceived in students? What obstacles and challenges did teachers encounter?

Throughout the four cycles of (inter)active learning, students became increasingly involved, very participative, motivated and more responsible in their learning. The collaborative environment was enriched with the change in behavior of the students involved and autonomous learning was possible in which students actively learn the program content. The biggest challenges (obstacles) presented by the teacher were: in the first cycle, encouraging collaborative work, since these students were not used to or predisposed to doing collaborative work and using the Padlet collaborative software; in the second cycle it was to show students that autonomous learning can enrich their skills and how to guide them in this learning so that learning is effective; In the third and fourth cycle there was no longer any specific challenge, just directing students to achieve the desired learning objectives. From the direct and participatory observation of the teacher, it was possible to verify the variation in the way these students learned and took responsibility for it. The assessment in each cycle was seen by the students as the result of their learning, where they strived to obtain the best grade, with commitment and confidence. The results show that (inter)active learning improved student performance both in terms of the number of students who acquired the required mathematical skills and in terms of the classifications obtained.

The integration of collaborative work in (inter)active learning, through Padlet, allowed the creation of an attractive, interactive and motivating environment, facilitating the acquisition of learning by students. In this way, students developed digital skills, but also cognitive skills allowing their social integration in the future. The importance expressed, both by students, when called to be protagonists of their learning process, and by the teacher involved, when consenting to diversity as a way of developing strategies that inspire attitudes that lead to commitment, stands out. Using an (inter)active learning approach in mathematics can achieve better results in student motivation and skills development.

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