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STRATEGIES TO IMPROVE STUDENT ENGAGEMENT: COMPARISON OF ASSESSMENT RESULTS AND STUDENT FEEDBACK

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Abstract

Enhancing student participation and performance in first-year engineering courses is a recurring challenge in higher education. This study analyses the results of a student survey carried out to evaluate the effectiveness of various teaching strategies implemented in a first-year Calculus course. The course integrated group work, peer assessment, interactive participation through Vevox in lectures, online tests and a final written exam. The survey collected students' impressions of the impact of these strategies on their learning experience, motivation and understanding of fundamental mathematical concepts. The results indicate that students valued collaborative activities, such as group work and peer assessment, for promoting deeper understanding and active participation. The use of Vevox was particularly appreciated in the theory sessions, as it promoted real-time interaction and immediate feedback. In addition, the online tests and group work provided opportunities for continuous assessment, allowing students to track their progress throughout the semester. A comparative analysis of student performance revealed a 14 per cent increase in the pass rate compared to the previous academic year, which suggests a positive impact of these methods on student success. The qualitative responses also emphasised greater commitment and a more structured learning experience. These findings highlight the importance of diverse, student-centred learning strategies to improve outcomes in basic engineering courses. The study provides information for educators seeking to optimise teaching methodologies in STEM education, particularly in mathematically intensive subjects such as Calculus.

Keywords: *Active learning, survey, calculus, engineering.*

1. Introduction

At our university, four distinct Calculus courses are offered, each tailored to degree programs that share similar academic requirements and disciplinary focuses. In our study, our course is intended for degree programmes that focus on Physics and around 500 students are enrolled. In the academic years 2023/24 and 2024/25, the latter with significant improvements, we implemented an instructional design to engage students in their learning.

At the end of the course, students were invited to complete an anonymous online questionnaire aimed at collecting feedback on their learning experience. The questionnaire included both closed-ended and open-ended questions. In addition to assessing various aspects of the course through Likert-scale items, students were asked to identify up to three aspects of the course they found particularly positive and to explain their reasons. They were also invited to indicate up to three aspects of the course they found less satisfactory, along with the reasons for their dissatisfaction. This combination of quantitative and qualitative items enabled a more comprehensive understanding of students' perceptions and areas for potential improvement.

2. Instructional methods applied

The Calculus course includes four weekly contact hours divided into two blocks, focusing on theoretical concepts, examples, group work and interactive discussions using Vevox. Besides teaching Differential and Integral Calculus in one variable, the course aims to promote relationships among students, encourage group work, develop work habits, foster discussions and hold students accountable for their learning.

Students are randomly assigned to different groups throughout the semester to enhance interaction and communication skills. Weekly group tasks are submitted on Moodle for teachers' evaluation using

rubrics, which provide clarity and fairness in grading. Peer assessment is conducted three times during the semester, where students evaluate themselves and their peer using rubrics. Continuous assessment includes assignments (12%), peer and self-assessment (8%), two online tests (15% each) and a written test (50%). Online tests use multiple-choice questions, while the written test includes open-ended questions to assess deeper understanding. The detailed explanation of these instructional methodology is described in Nolasco, Oliveira, & Vettori (2025).

Gamification is used to create a stimulating learning environment, with various games designed for group play to promote teamwork and communication. These games help enhance learning by encouraging active participation and collaboration among students. The games used are described in Oliveira (2024).

3. Analysis and discussion of survey results

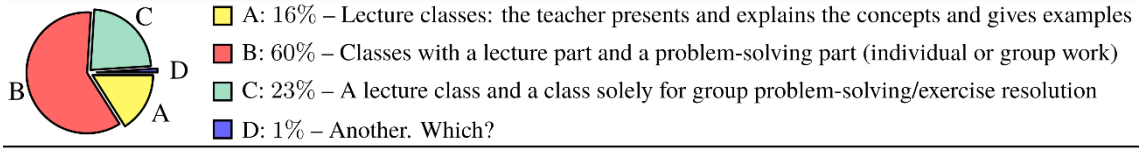
The questionnaire included 13 questions, 3 of which were open-ended questions to gather students' opinions on the positive and negative aspects of the course and a third open-ended question to understand what they would like to see changed in the course's operation.

3.1. Closed questions

The population of the study was around 500 students and 128 responded to the questionnaire, 76% of whom were attending the course for the first time and 24% were repeat students.

Regarding the kind of lectures they preferred, the answers are summarised in Figure 1. There is still a significant number of students, 16%, who prefer traditional classes, but 60% of them want hybrid classes.

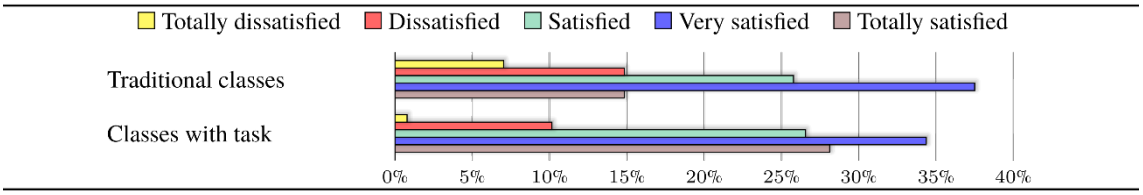
Figure 1. What type of classes do you prefer?



It is worth noting that this type of teaching methodology has increased class attendance, even those classes that did not have group assignment. 75% of students attended almost all no-assignment classes and 91% attended the assignment classes.

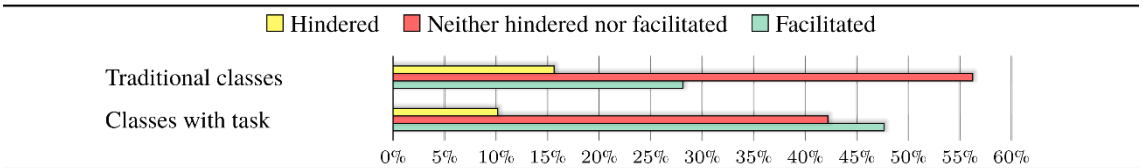
Closed-ended questions regarding the students' level of satisfaction with the methodology used were included in the questionnaire since they facilitate the analysis of responses and because we feared that students might not respond to open-ended questions (which did not happen). In general, students were satisfied with the different types of lectures, but in particular more students were "very satisfied" with traditional lectures than with classes with task.

Figure 2. Degree of satisfaction with the different types of lectures that took place in the course.



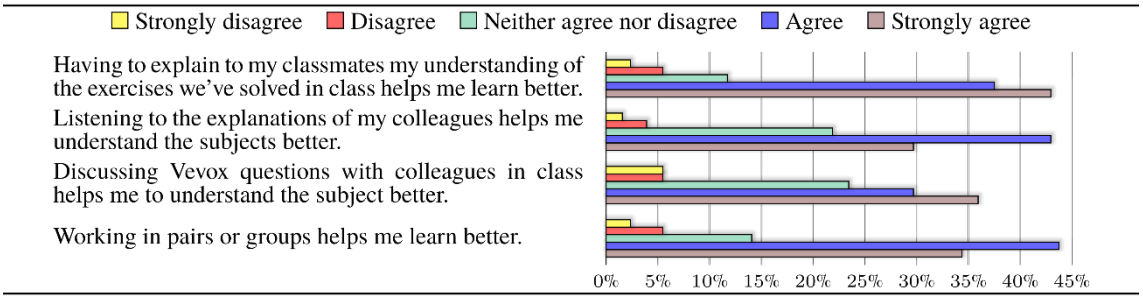
One aspect we were curious about was the effect of the different lectures on their learning. Surprisingly, it does not seem that the different classes have a big impact on students' learning (see Figure 3).

Figure 3. About the teaching environment on learning.



What were the features of this instructional design that helped students to “learn better” was another question we were very interested in. So, we asked them to classify in a 5-point Likert scale – 1 totally disagree to 5 totally agree - four statements. The answers are given in Figure 4.

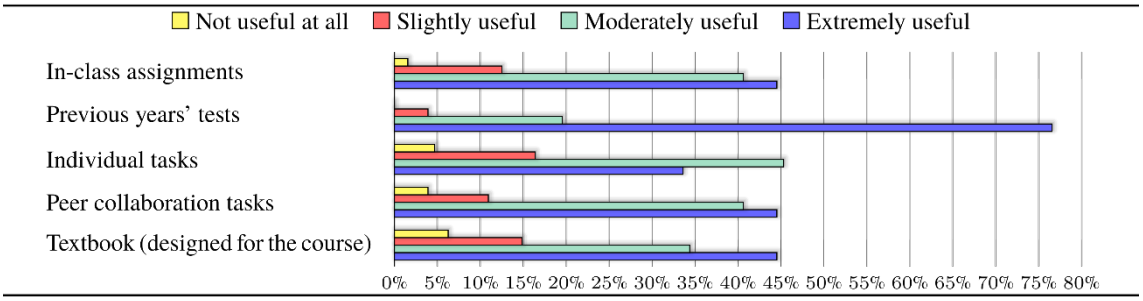
Figure 4. Classification of 4 instructional features used.



“If you want to go fast go alone, but if you want to go far go together,” is a common saying, that is reflected in these students’ opinions. We also believe that engaging students in lectures, making them think together to find solutions for the problems/exercises they must solve, is one of the best ways of learning.

Several resources were available through Moodle platform, as the textbook designed specifically to this course, including several examples, worked out exercises as well as proposed exercises (instead of separate worksheets), tests/exams from previous academic years, slides, etc. We asked which tools were useful for their learning.

Figure 5. Which of the following resources do you find useful for your learning?



The most useful resource is Tests from previous academic years, with 76% of the students rating them as Extremely useful. All the other resources have roughly the same ratings, being considered useful or extremely useful by more than 78% of the students.

One other question was related to the use of online platforms for studying/learning: 40% answered they did not use any platform to study and almost all the others utilised YouTube.

3.2. Open questions

In addition to completing Likert-scale items related to various dimensions of the course, students were invited to provide qualitative feedback by identifying up to three aspects they considered particularly positive, accompanied by a brief justification. They were likewise encouraged to indicate up to three aspects they perceived as less satisfactory, explaining the reasons for their assessments. This feedback was collected with the aim of gaining deeper insights into students’ perceptions and informing continuous pedagogical improvement.

3.2.1. Positive aspects/Strengths. A predominant theme in the feedback was the implementation of group assignments (TPAs), which were highlighted in approximately 56% of the responses. Students emphasised that these activities fostered key soft skills such as communication and teamwork, while also reinforcing the understanding of course content. Weekly group tasks encouraged consistent engagement and facilitated peer learning through discussion and collaborative problem-solving.

The course's assessment design was positively mentioned in about 35% of responses. Students highlighted the distribution of assessments throughout the semester, noting that it helped reduce exam-related anxiety, and provided a more balanced reflection of their ongoing effort and learning. The continuous nature of assessment was widely considered effective and motivating.

Approximately 48% of respondents valued in-class activities such as guided exercise resolution, practical tasks and immediate feedback. These activities were perceived as essential for encouraging

consistent study habits, enabling the immediate application of theoretical content and facilitating a better grasp of complex topics through practice.

Around 26% of students expressed appreciation for the clarity, structure and organization of the lectures, particularly the approach of introducing theory followed by illustrative examples. This methodology was considered effective in promoting conceptual understanding and logical progression of mathematical topics.

The use of interactive digital tools, such as Vevox, to promote engagement during lectures was referenced in 22% of the responses. These tools were praised for increasing student participation, offering real-time feedback and enhancing the overall classroom experience.

Lastly, 19% of students highlighted the assertive and approachable teaching style, often commending teachers for their clarity, availability to answer questions and to clarify doubts, and ability to foster a positive learning environment.

3.2.2. Less satisfactory aspects/weaknesses. One of the most reported issues was the excessive theoretical content with limited practical application during lectures. 30% of students frequently noted that classes were overly expository, with insufficient time allocated for problem-solving and hands-on practice. There was a marked demand for more classroom exercises, especially ones reflecting the difficulty level of actual exams, to better support conceptual understanding and retention.

A second major theme was the pacing of content delivery. 25% of students felt that the volume of material presented in each session was too dense, often delivered rapidly without adequate time for assimilation.

In terms of group tasks, while the majority of the students appreciated the collaborative learning opportunities, 17% of students criticised the lack of balance in group workload distribution and the limited time provided to complete the tasks during class.

Regarding assessment methods, many critiques were directed at the use of multiple-choice questions in online tests, which were perceived as inequitable. 18% of students argued that this format penalised minor mistakes disproportionately and failed to adequately assess reasoning skills. Some suggested reverting to written tests, where partial credit for valid reasoning could be awarded, fostering a fairer evaluation process.

Lastly, access to learning resources — such as solved exercises, example sheets and previous exams — was reported as insufficient by 9% of the respondents. Students emphasised the need for greater availability of supportive materials, including solutions to group tasks, to facilitate independent study and exam preparation.

This feedback underlines the importance of maintaining a pedagogically diverse and student-centred approach in STEM education, where regular evaluation, group engagement and interactive teaching methods can greatly enhance student learning outcomes and satisfaction. It is important to mention that these students are in their first year, coming from secondary education, with different work habits and teaching rhythms. Our struggle as teachers is to encourage students to understand the concepts and discuss them instead of solving a large number of exercises that allow them to memorise routines and learn only procedures (Oliveira M. d., 2023).

3.3. Assessment results

Conducting a comprehensive and rigorous analysis of the results, obtained through the application of the described strategies, and comparing them with outcomes from previous years, presents significant challenges. This difficulty arises from numerous changes: the students (naturally), the assessment style, the teaching staff and the courses involved. Nevertheless, within a more confined scope, some noteworthy observations can be made.

Table 1. Results of common courses over the last three years.

Academic Year (Students):	2022/23 (330)	2023/24 (364)	2024/25 (365)
Passed / Assessed	59.48%	58.49%	71.04%
Passed / Total	48.48%	51.10%	65.21%
Missing / Total	18.48%	12.64%	8.22%

Due to the reorganisation of the Calculus units in the academic year 2023/24, only the courses involved in this unit between 2022/23 and 2024/25 are considered in Table 1. In Table 2, all students are included, as no further changes occurred. The assessment style was quite ‘classic’ in 2022/23; in 2023/24 we began to implement the ideas presented in this paper, albeit with some flaws in organization and execution.

Table 2. Detailed results for all courses over the last two years.

Exam Season	Academic Year (Students):	2023/24 (507)	2024/25 (511)
Normal	Passed / Assessed	58.70%	59.53%
	Passed / Total	49.90%	54.99%
Resit	Passed / Enrolled after failing	12.66%	43.15%
	Improved / Enrolled after passing	36.36%	81.25%
Combined	Passed / Assessed	61.21%	72.27%
	Passed / Total	53.85%	67.32%
	Missing / Total	12.03%	6.85%

Our primary objective could be described as "convincing (weaker) students that they can learn mathematics," which can be achieved if they 1) at least try and then 2) succeed in passing. The data shows that both objectives were met. Indeed, in both Tables 1 and 2, it is evident that the percentage of students missing any type of assessment has decreased to an optimal level, while the percentage of students passing has significantly increased.

It is important to note that the change in assessment style in 2023/24 did not simplify students' lives, as the similar percentage of "Passed/Assessed" confirms, at least in the Normal Season (cf. Tables 1 and 2).

However, this year we implemented stricter control over students' actual presence during group works. While absences from classes are not (and cannot be) considered, missing group works would proportionally lower the corresponding grade. This 'mandatory' and consistent attendance (in the last two years, we have not observed the typical decline in weekly attendance over the semester) may explain the small number of students not assessed and the unexpectedly high percentage of students who passed or improved their grade in the Resit Exam (Table 2). Observe that in this exam, students are assessed solely based on the grade obtained in a single written test. We hope that the active application of the concepts and techniques in class led the students to understand them in a manner that was perhaps not immediate, but deeper and more enduring.

4. Conclusion

The pedagogical survey conducted among students enrolled in Calculus course revealed a highly positive reception to the course's structure, particularly in relation to its interactive and diversified approach to teaching and assessment. Garcia, Pandolfi, & Morais (2023) state that "the assimilation of content when the student participates in lectures is minimal, but when he tries to explain the subject to someone else, retention and understanding are much higher," which is confirmed by our students with 80% agreeing on this point. Also, "discussion in class is one of the most common strategies promoting active learning with good reason" (Bonwell & Eison, 1991) was pointed out as one of the assets of the course.

The results obtained, both in terms of the number of students who passed the course and those who participated in the evaluations, indicate that we are on the right path.

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