Innovative Learning Practices as a Driver of Students´ Performance

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Abstract: Higher education institutions have faced the imperative of adapting pedagogical approaches to meet the demands of the twenty-first century and the changing needs of their students. This study investigates how active learning methodologies impact undergraduate students' academic performance in two different academic fields: engineering education and the social sciences. The study was conducted in a Portuguese higher education institution, the Polytechnic University of Coimbra, using a sample of 97 undergraduate students. Results reveal that active learning approaches particularly problem-based learning (PBL) enhance student engagement, learning experiences, and competencies. Moreover, the research indicates significant differences in the effectiveness of these approaches between engineering and the social sciences, with engineering students demonstrating a more pronounced improvement in their academic performance. These findings highlight the importance of integrating innovative active learning practices into higher education environments to better prepare students for the challenges of modern societies.

Keywords: Active learning practices, Problem-based learning (PBL), Higher education, Students ‘performance

1. Introduction

Implementing active learning methodologies in the classroom's contexts is seen as central to the success of the educational process. These innovative educational practices are expected to boost student’s engagement with the learning process. The future graduate needs to acquire not only technical skills but also transversal and human-centered skills and attitudes, such as adaptability, flexibility, interdisciplinary collaboration, teamwork, creativity, communication, critical thinking, and complex problem-solving, to be prepared for the demands of the twenty-first-century labour market (Leal-Rodríguez and Alborat-Morant, 2019).

Bonwell and Eison (1991), in their seminal work Active Learning: Creating Excitement in the Classroom, define active learning as “instructional activities involving students in doing things and thinking about what they are doing." This is a broad concept that includes a wide range of teaching and learning strategies in which students are required to engage actively in the learning process. Active learning stands thus in contrast to traditional learning approaches in which students are passive receivers of knowledge from an expert. Methods that promote active learning focus on developing students’ skills and values rather than transmitting knowledge and require that students process content themselves to learn. The learners are engaged in discussions, teamwork, real-world problem-solving, decision-making, and cooperative hands-on projects to develop higher-order thinking skills such as convergent thinking, creative thinking, and analytical thinking, which are crucial for students to succeed in today's world (McGuinness, 2021; O’Loughlin, 1992; Carr et al., 2015; Petress, 2008). The role of the teacher in active learning classrooms is substantially different from the traditional methods. Instead of functioning as a transmitter of knowledge or an expert with answers, the teacher assumes the role of a facilitator of learning processes, guiding students on their journeys of self-discovery by offering advice but also allowing the students to work out their strategies and making their own mistakes (McGuinness, 2021). In this way, the teacher provides support and tools for the students to do their own research into the topic they need to learn about or the problem they need to solve.

There is evidence in the literature that active learning methodologies improve students’ learning outcomes and performance (see, for example, Sukackė et al., 2022; Mabley et al., 2020; Li et al., 2019; Freeman et al., 2014; Trullàs et al., 2022). Focusing on engineering education, Sukackė et al. (2022), conducting a systematic literature review on the implementation of three active learning methods (problem-based learning, project-based learning, and challenge-based learning), point out that “implementing active learning methods in engineering education is becoming the new norm and is seen as a prerequisite to prepare future engineers not only for their professional lives but also to tackle global issues''. Leal-Rodríguez and Alborat-Morant (2019), in turn, from an empirical study involving a sample of 80 students belonging to a Bachelor´s Degree in Business Administration at a Spanish Business School, show that promoting innovative experimental learning practices constitutes an effective approach to improving students’ competences and academic performance. In the same view, Deeley

(2010) points out the benefits of experience-based learning, demonstrating that, overall, this learning approach has the potential to lead to students' intellectual and emotional enhancement. Chapman et al. (2016) also demonstrate that innovative learning methods have a positive impact on the class and improve students' performance. Moreover, Trullàs et al. (2022) conclude that problem-based learning is an effective approach to medical education based on a scoping review of available international evidence concerning the effectiveness and usefulness of PBL methodology in undergraduate medical teaching programs. The results demonstrate that through PBL students not only acquire knowledge but also skills that are required in the medical profession.

The positive effect of active learning methodologies on students' performance has already been demonstrated in studies such as Zancul et al. (2017), Fernandes et al. (2014), and Alves et al. (2016). However, despite the huge potential of innovative learning practices for fostering and enhancing learning, their implementation in classroom contexts has been limited. Indeed, several studies highlight that implementing active learning approaches is a challenging and complex process that requires a paradigm shift and involves great effort and time from all HEI stakeholders, namely leaders, teachers, students, and staff (Membrillo-Hernández et al., 2019; Zancul et al., 2017; Namasivayam et al., 2017).

Against this background, this paper aims to contribute to this literature stream by providing new empirical evidence on the role of innovative active learning methods based on collaborative problem-based learning (PBL) on students´ engagement, learning experience, and competencies. This study was carried out within the context of a Portuguese higher education institution, the Polytechnic University of Coimbra, using a sample of students from two different scientific areas, engineering, and social sciences.

The remainder of the paper is structured as follows: Section 2 describes the methodology used in this study. Section 3 presents and discusses the empirical results. The last section draws the main conclusions.

2. Methodology

The study involved a sample of 97 undergraduate students from the Polytechnic University of Coimbra, from two different scientific areas: 32 engineering students (bachelor's degree in sustainable cities management) and 65 social sciences students (bachelor's degree in media studies).

The research instrument used in the present study to collect the data from our group of respondents was an online questionnaire. For measuring the responses, a 7-point Likert scale was used. A Likert-type scale is a psychometric scale commonly used in survey research, namely in the social sciences. It is used when there is an order in responses and distances between categories are not quantitative. When responding to a Likert questionnaire item, respondents specify their level of agreement or disagreement on a symmetric agree-disagree scale for a sequence of statements. The range of the Likert scale captures the intensity of the respondent's attitudes towards a particular question (Aktas Altunay and Ezgi Yilmaz, 2023).

In our active learning experiment, the students are asked to carry out a problem-based learning (PBL) process in which they learn about a subject by working in groups to find a solution for a real-world problem. This approach is applied throughout the entire academic semester as the primary learning and teaching method. Following Eddy and Dan (2016), the PBL process comprises seven stages, as described in Figure 1.

Figure 1: Problem-based learning process (adapted from Eddy and Dan, 2016)

It should be noted that throughout the different phases of the learning process, students, organised in small teams (from four to six members), make use of a variety of techniques and tools, such as brainstorming, researching relevant sources of information, mind mapping, or future scenario planning, to engage in the learning process, achieve the learning objectives, and come up with innovative and effective problem solutions.

As discussed above, in classroom-based PBL, the teacher's role is to be a facilitator who supports students through their learning process and whose main mission is to guide and engage the students, monitor the stages, provide advice and material suggestions, and inspire discussions when student teams are working together (Masek, 2016).

3. Results

The first evidence of the PBL´s implementation as an active learning methodology concerns the students' satisfaction level with participation in this pilot program, as illustrated in Figure 2. Most of the students (86%) are satisfied with the implementation of the PBL methodology. Although represent a residual part of the sample, 3% of the students have a negative, or very negative judgment about their participation. After analysing both education areas separately, engineering students are the most satisfied with their participation. Moreover, no negative opinion has been registered, and 75% of students have chosen "agree" or "strongly agree" to evaluate their perception. It should be noted that considering only the highest grade on the Likert scale, three times more answers (34% against 9%) have been expressed among engineering students.

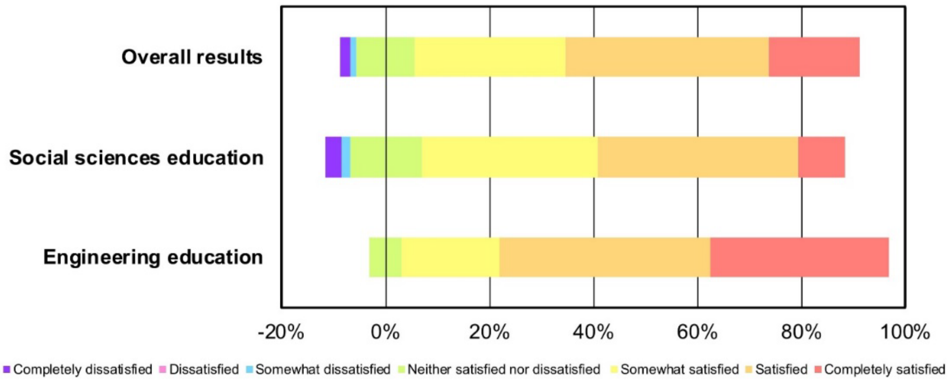

Figure 2: Students' degree of satisfaction

To better understand the satisfaction level expressed by the students, the remaining questions of the survey addressed different essential aspects, namely, questions aiming to understand students' motivation and engagement. This assessment is achieved through two questions related to class dynamics and productivity, whose results are illustrated in Figure 3 and Figure 4, respectively. Starting by analysing the joint results of both groups of students, 85% of students agreed that this pedagogical approach improved both class dynamics (Figure 3) and class productivity (Figure 4). These two parameters are an indirect way to evaluate students' motivation to attend and actively participate in classes. Indeed, according to annual reports presented by bachelor pedagogical coordinators, the main reason for academic failure is related to student absenteeism. Identical conclusions have already been identified in other studies conducted in Portugal (Teixeira, 2013), and it is worth mentioning that this problem has already been pointed out in the seventies of the last century (Mohamed et al., 1974). This latest study shows that, already in the 1970s, students' attitudes were identified as the main determining factor in the level of absenteeism. Thus, if students recognise that their time in the classroom is properly used, i.e., classes are productive, and that the learning process is student-centered, i.e., classes are dynamic, students feel intrinsically motivated to attend all classes, using to good advantage of all the benefits that being present in the classroom brings. Finally, it is worth mentioning that only 4% of the students answered that the PBL methodology didn't contribute to improved class performance.

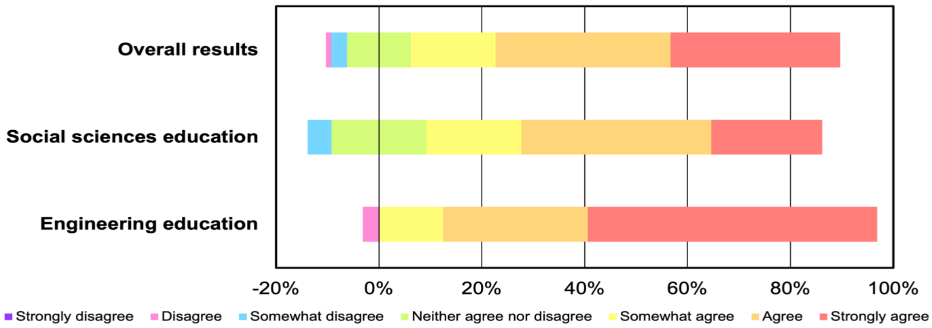

Figure 3: Students' perceptions on the improvement of class dynamics

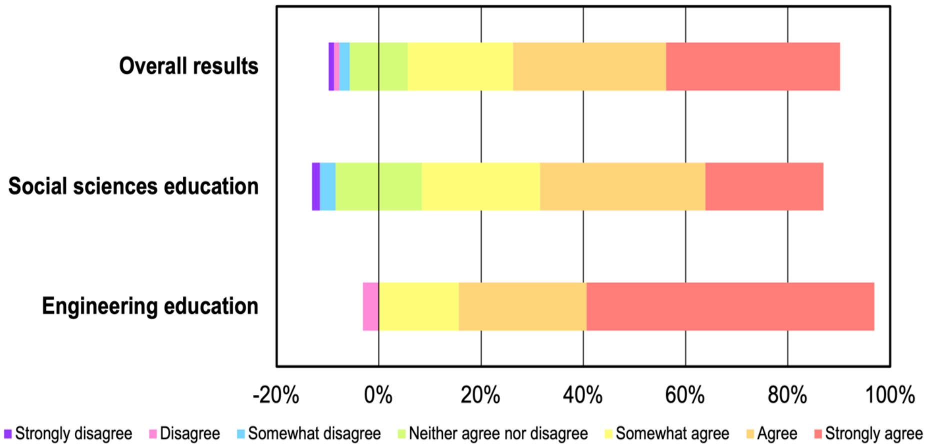

Figure 4: Students' perceptions on the increase of class productivity

When comparing the perceptions of social sciences and engineering students, it is also clear that the implementation of PBL as an active learning methodology is far more appreciated by engineering students. Not only 97% of the students have a positive perception of this student-centered approach (20% more than students from social sciences education), but the answer "strongly agree" represents more than 50% of the opinion, which contrasts with only 22% of social sciences education respondents. Another interesting observation is that engineering students didn't show neutral opinions when asked if class dynamics (Figure 3) and class productivity (Figure 4) had improved. These findings may derive from the fact that the implementation of active learning methodologies represents a very different paradigm when compared to lecturing and exercise-solving classes, which continue to be the common pedagogical approaches.

As concluded by Neves et al. (2021), educators need to be competent in technical and professional issues, but they also need to develop their pedagogical skills to be able to develop innovative teaching strategies and methodologies. Indeed, the outcomes from the present innovative learning approach experiment show that students are satisfied with this pilot program.

Intrinsically related to students´ motivation is their level of academic performance and their willingness to see this active learning methodology implemented in other subjects. These two fundamental pieces of evidence are depicted in Figure 5 and Figure 6, respectively. Based on students' positive perceptions of class dynamics and productivity, it is expected that their perception of the influence of the PBL approach on their final grade (Figure 5) would be positive, which is confirmed by the empirical outcomes. Overall, 85% of students consider that their experience allowed them to achieve better academic results. Although the numbers are not expressive, 3% of students answered that PBL methodology didn't influence their final grade, and 12% had no opinion. This conclusion is in line with other studies carried out in several educational areas, such as natural sciences (Aidoo et al., 2016), health sciences (Qin et al., 2016), and humanities and social sciences (Kozanitis and Nenciovici, 2022). Comparing social sciences and engineering students' perceptions, the previously identified pattern remains. For 56% of engineering students, PBL methodology strongly contributes to a higher final grade, compared to only 15% of social sciences students (Figure 5). Some students seem to have no well-defined position (6%), but no students have negative perceptions. In contrast, 5% of social sciences students don't recognise the added value of this pedagogical approach for their final grade.

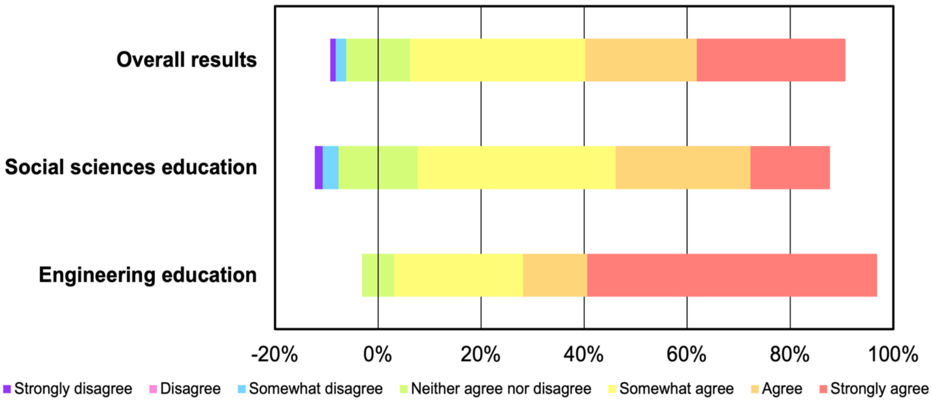

Figure 5: Students' perceptions on the increase of final grade

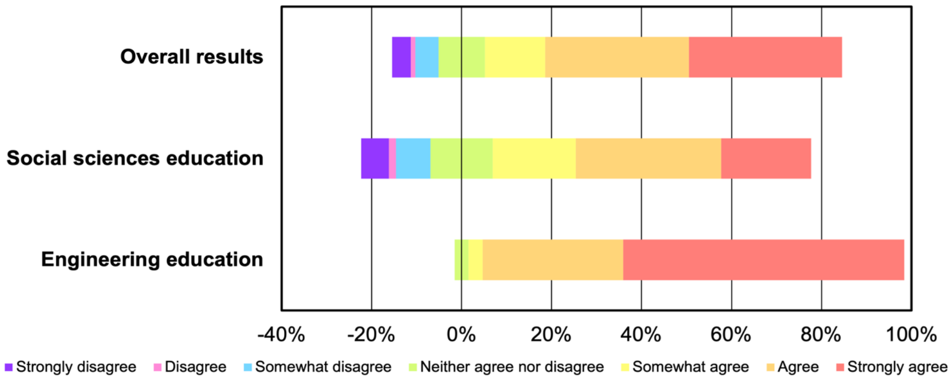

Figure 6: Willingness to the implementation of the PBL methodology in other subjects

Considering the previous positive effects of both classes' environment and final grades, the results illustrated in Figure 6 are expected, i.e., most students (79%) would like to see active learning methodologies implemented in other subjects. Once more, engineering students tend to be more willing to see this type of approach replicated in other subjects. In the first analysis, one may think that results may be related to the different completion rates of full-time bachelor's students in each field of study. However, according to the OECD (2022), in Portugal, the completion rates in the fields of education and STEM (science, technology, engineering, and mathematics) by the end of the theoretical duration of the curricula are almost identical, at 61.5% and 62%, respectively.

The last group of questions proposed in the online survey aimed to assess the impact of PBL on students' social skills, thinking competencies, and self-learning abilities. Eight different skills were assessed, among them the so-called 21st-century skills (World Economic Forum, 2016): critical thinking (problem-solving), creativity, communication, and teamwork (collaboration), digital competencies, and data analysis. Leadership and entrepreneurship are also part of the character qualities that students need to acquire or develop during their academic path to success in today's world.

Analysing the overall results, which are illustrated in Figure 7, it can be stated that more than 75% of all the inquired students consider that their skills or competencies have been positively impacted by the PBL learning process. The 21st-century skills of critical thinking (problem-solving), creativity, communication, and data analysis are, undoubtedly, the areas in which the outcomes are more noticeable (86% of the students' perceptions are positive). In contrast, students' perceptions of the impact of the PBL approach on entrepreneurship, leadership, and digital competencies present the worst results, highlighting 10% of the negative answers. The number of students without a formed opinion is equally considerable.

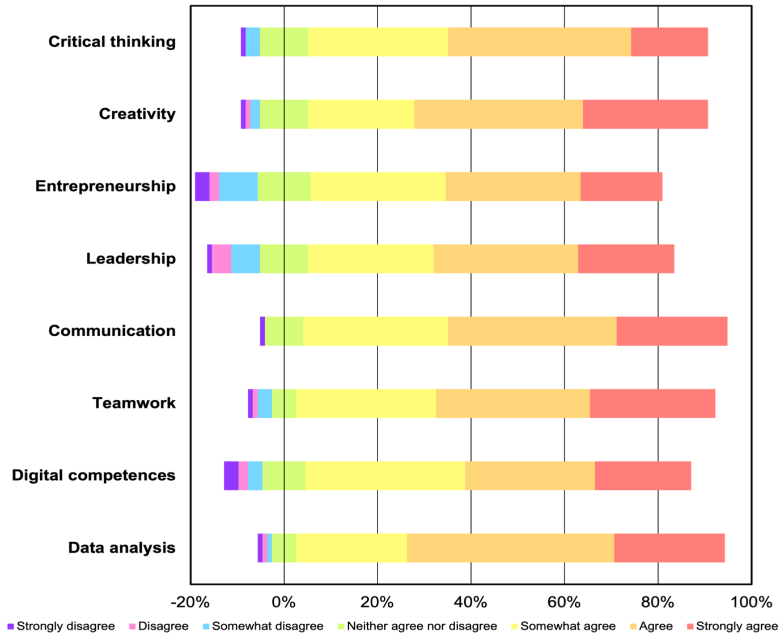

Figure 7: Students' perception on the improvement of transversal skills: overall results

Although further investigation is required, these results may arise from the pedagogical approach itself. Indeed, and in contrast with other student-centered methodologies, such as co-creation and project-based learning, PBL practices do not presuppose direct contact with third-party organisations or companies. This lack of competitive atmosphere or the non-existence of a well-defined goal does not stimulate the entrepreneurial profile of students, as they may not be able to understand the applicability of the proposed challenges.

Regarding digital literacy, results show that the implementation of the PBL methodology does not directly affect this competence. Although students are invited to use digital tools that are unfamiliar to many of them, there is no obligation to use them. Students can achieve all the goals by using common digital resources that they already dominate. Finally, problem-based learning implies that students work in groups of four to six members. Therefore, teamwork is naturally developed, but only a small number of students take on a team leadership role.

The discrepancy between the two fields of education identified in the previous analysis remains valid when examining students' perceptions of the impact of PBL methodology on their skills. Social sciences students (Figure 8) tend to have a less positive perception than engineering students (Figure 9).

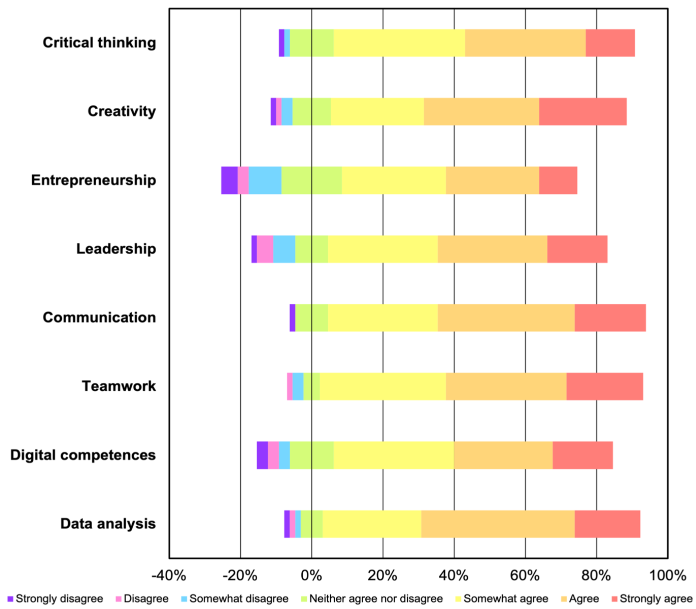

Figure 8: Students' perceptions on the improvement of transversal skills: social sciences education

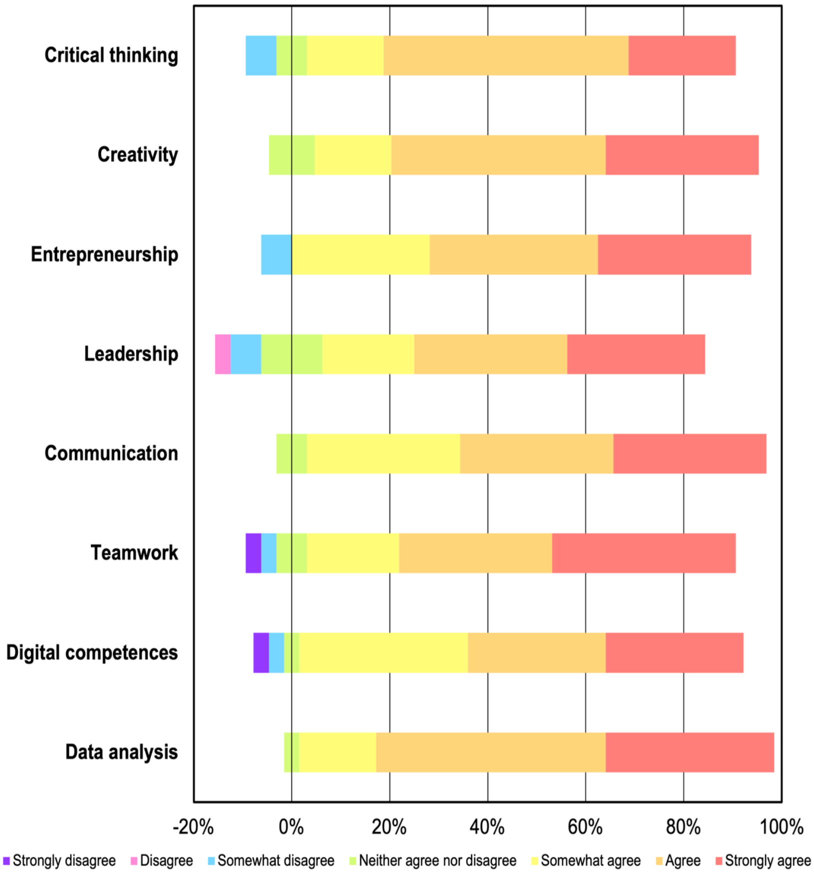

Figure 9: Students' perceptions on the improvement of transversal skills: engineering education

4. Conclusions

There is an evident and pressing need for a change in the prevalent approaches and methodologies employed in higher education. An alternative to conventional learning paradigms is the shift to student-centred education through active learning approaches. Numerous studies have demonstrated the effectiveness of these strategies in increasing students' motivation and performance. The results of this study corroborate and enrich these conclusions. The high degree of students' satisfaction and their desire to use innovative teaching and learning practices in other disciplines should be noted. Regarding classroom dynamics and productivity, two factors that will boost student motivation during the learning process, most students agree that using the PBL technique improves these aspects. These metrics offer insight into how students develop a stronger connection with the curriculum, which leads to more active and diligent engagement and improved integration with teachers and the school community. The active methodology has helped teachers make their lessons more fruitful and efficient. Moreover, when the PBL technique is implemented, it is evident that students are becoming more conscious of their actions and taking more responsibility. Memorization-focused learning has given way to the practical application of knowledge-based learning. When comparing engineering education to social science education, the results reveal notable variations in PBL strategies' efficacy, with engineering students demonstrating a more pronounced improvement in their academic performance. Concerning competency progress, most students reported that they had developed more transversal skills, particularly in the areas of communication, creativity, critical thinking (problem-solving), and data analysis.

These findings foster a redefinition of the pedagogical role traditionally assigned to educators and the exploration of more innovative learning practices. From the perspective of students, it is evident that the integration of active learning methodologies is perceived as conducive to achieving more favourable academic and professional outcomes. Empirical evidence regarding students' satisfaction indicates a positive influence on motivation and engagement within both classroom settings and the broader learning context.

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