

LEARNING BY SOLVING AND SENSING: DATA-INFORMED PERSPECTIVES ON PROBLEM-BASED LEARNING

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Abstract

This study explores students' perceptions of the impact of PBL on their communication, collaboration, critical thinking, and motivation when applied in a blended learning context. PBL is grounded in the principle that learning occurs through the active resolution of authentic, real-world problems, thereby fostering critical thinking, collaboration, and autonomous learning. The research is based on quantitative data collected through a structured questionnaire consisting of two main sections: (1) perceived effects of PBL on different acquired skills, and (2) attitudes toward PBL compared with traditional teaching methods. The study involved 96 first-year students enrolled in 2023/24 academic year in a professional first-cycle programme at the Faculty of Public Administration, University of Ljubljana, in a blended English for Specific Purposes course. The Moodle Learning Management System (LMS) supported the PBL approach, while MS Teams facilitated group communication. The findings of this study contribute to the ongoing discourse on innovative teaching methodologies in language education and underscore the potential of PBL to bridge the gap between theoretical knowledge and practical application.

Keywords: *Problem-based learning, learning analytics, blended learning, higher education, student engagement.*

1. Introduction

Problem-based learning (PBL) is a pedagogical approach that puts students at the center of the learning process. It encourages active engagement and collaboration, as well as the development of higher-order cognitive skills. Grounded in constructivist theory, PBL emphasizes active, student-centered learning through engagement with authentic problems. PBL promotes critical thinking, collaboration and self-directed learning, all of which are essential for professional success, yet are often underrepresented in traditional, lecture-based instruction (Barrows, 1996; Savery, 2006). In today's higher education landscape, integrating PBL into a blended learning environment that combines face-to-face interaction with digital learning platforms offers new opportunities for flexibility and personalization, as well as enabling continuous learning. It also facilitates constant monitoring and evaluation of students' engagement, motivation, and learning outcomes.

PBL offers significant advantages, primarily through its emphasis on problem-solving, teamwork, and self-directed learning, which are skills essential for success in professional contexts. However, these competencies are often marginalized within traditional educational systems that prioritize standardized assessments and are reluctant to adopt innovative teaching practices. By engaging learners in authentic, real-world challenges, PBL encourages active participation and responsibility for one's own learning process. A crucial starting point for developing collaborative and autonomous learning strategies is metacognitive awareness. This involves critically assessing one's cognitive processes, identifying personal strengths and weaknesses when approaching complex tasks, and taking effective action to accomplish learning objectives (Hmelo-Silver, 2004).

The transition from higher education to employment increasingly requires graduates to possess transferable skills that extend beyond their disciplinary expertise. PBL demonstrates a strong alignment with the competencies demanded in contemporary labour markets. Workplaces today emphasize skills such as critical thinking, effective communication, teamwork, adaptability and digital literacy, as well as domain-specific knowledge (OECD, 2018). Recent research confirms that employers increasingly value soft skills, such as teamwork, communication and adaptability, over purely technical expertise (Berkman, 2025).

In practice, problem-based learning (PBL) engages students in real-world problems, developing their critical thinking and innovative problem-solving skills. It also strengthens their teamwork, oral and written communication, and decision-making skills through collaborative tasks, presentations, and reflective discussions (Yu & Zin, 2023). Iterative feedback and self-assessment promote metacognitive awareness, self-regulation and confidence (Hmelo-Silver, 2004). Furthermore, integrating digital tools into PBL activities, such as collaborative platforms and online research resources, improves students' technological proficiency and aligns their capabilities with the digital transformation occurring in contemporary workplaces, thereby preparing them for technologically advanced work environments (Rahman, Fitria, Nurhidayah, & Yuliandani, 2022; Wyke, Aarup Jensen, Krogh, Ravn, & Svidt, 2022).

Considering this, the focus of PBL on self-directed learning and metacognitive awareness prepares students for lifelong learning, which is a vital skill in rapidly evolving professional environments. Consequently, PBL enhances academic achievement and prepares graduates for employment and future success in knowledge-based economies.

2. Research

This study examines the implementation of PBL within an English for Specific Purposes (ESP) course at the Faculty of Public Administration at the University of Ljubljana. Given that this was their first exposure to such an instructional method within their faculty's curriculum, the primary aim was to explore students' perceptions and experiences of PBL. Within the ESP framework, PBL offers students meaningful opportunities to develop language skills that directly align with their academic needs and future professional roles. Engaging with realistic scenarios enhances students' linguistic proficiency and enables them to acquire transferable skills essential for addressing challenges in public administration practice. This paper focuses on examining students' perceptions of PBL in an ESP course for administrative sciences. The following research questions were posed: (1) How do students perceive the impact of PBL on the skills they have acquired? and (2) How do students' attitudes towards PBL compare with their attitudes towards traditional teaching methods?

2.1. PBL implementation

During the 2023/24 academic year, a single PBL cycle was incorporated into a blended learning course that combined face-to-face instruction with Moodle-based activities. LLM was not used by students during this time. As the participants were unfamiliar with PBL, detailed explanations and continuous guidance were provided throughout the process, during classroom interactions and via the e-classroom where students completed tasks. Prior to the PBL phase, students acquired essential ESP skills, such as delivering oral presentations, writing summaries and communicating formally via email, in order to prepare for the new approach.

Initially, the students were organised into groups of three to six members. They were introduced to the principles of teamwork, assigned roles and signed responsibility agreements before selecting real-life problems, such as insufficient student housing or parking issues, and formulating research questions. To find solutions, the students consulted online resources and empirical research, such as questionnaires or interviews. Teamwork outside of class was facilitated via MS Teams, where shared folders enabled collaborative document creation. The teacher provided weekly feedback and guidance. The PBL cycle concluded with a formal report, a video presentation in English and a recorded meeting, all demonstrating the appropriate use of language. The implementation of PBL by week is presented in more detail in Kranjec and Keržič (2025).

2.2. Data and methodology

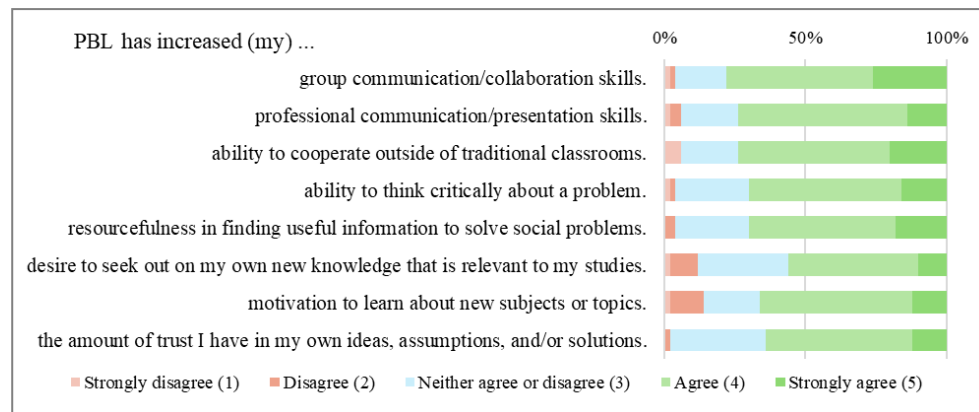
The study involved 94 first-year students enrolled in the first-cycle professional program. Based on empirical insights from the literature, a questionnaire was adapted and designed to align with the objectives of PBL implementation (Fleaher et al., 2021; Tan & Shen, 2019; Willis et al., 2002). The instrument consisted of 16 statements grouped into two categories: (1) perceived effects of PBL on various learning dimensions and (2) attitudes toward PBL compared to traditional teaching methods. Responses were measured using a five-point Likert scale ranging from 1 (strongly disagree/not at all) to 5 (strongly agree/extremely). The questionnaire was implemented in the e-classroom in the last week of the PBL project. A total of 48 students completed the questionnaire.

2.3. Results

The findings of the study provide strong evidence that PBL positively influences several key dimensions of student learning within an ESP context (see Figure 1.). The majority of respondents reported improvements in collaborative and communicative skills, which is consistent with the theoretical basis of

PBL, which emphasises teamwork and active engagement (Barrows, 1996; Savery, 2006). Specifically, 78% of students agreed or strongly agreed that their group communication and collaboration skills had improved, and 74% indicated that their professional communication and presentation skills had improved. These results confirm that PBL effectively supports the development of the language competencies required in professional environments. This is consistent with previous research, which has highlighted the benefits of PBL for communication and problem-solving skills (Hmelo-Silver, 2004).

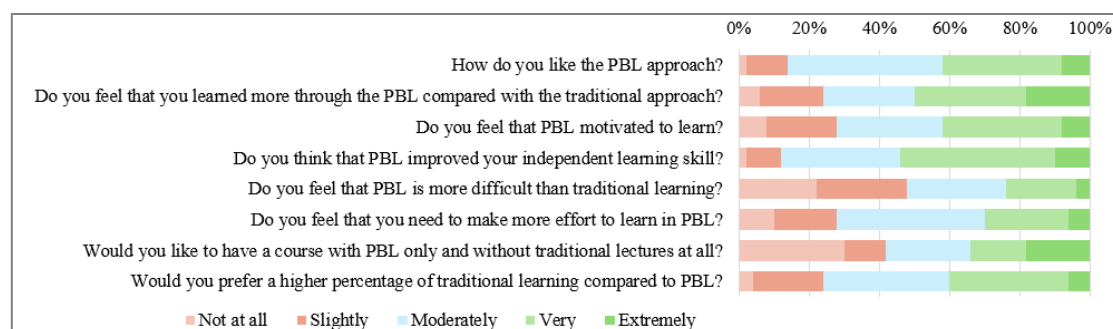
Figure 1. Students' opinions about the influence of PBL on their skills.



Similarly, PBL appears to encourage collaboration outside of the traditional classroom, with 74% of students acknowledging improvement in this area. This outcome reflects the successful integration of digital tools such as MS Teams that facilitate collaboration and document sharing. This corroborates the notion that technology-enhanced PBL environments encourage flexibility and learner autonomy (Hung, Jonassen & Liu, 2008). Critical thinking and resourcefulness also emerged as significant benefits, with 70% of students agreeing or strongly agreeing that PBL helped them think critically and find information to solve real-world problems. These findings highlight the potential of PBL to bridge the gap between theoretical knowledge and practical application, which is a key objective in higher education (Savery, 2006). However, there was more variability in the motivational and metacognitive dimensions. While 66% of students reported increased motivation to learn new topics and 56% expressed a greater desire to seek out new knowledge independently, a significant proportion of responses were neutral (20–32%). Similarly, 64% of students reported an improvement in confidence in their personal ideas and solutions, while 34% were undecided. These results suggest that although PBL promotes autonomy and self-directed learning, further support may be needed to fully develop metacognitive awareness and intrinsic motivation, as emphasised by Hmelo-Silver (2004) and Schmidt, Rotgans, and Yew (2011), for example.

The second part of the questionnaire revealed a generally positive attitude towards the PBL approach (see Figure 2). Most respondents rated their preference for PBL as 'Very' or 'Extremely', indicating strong acceptance of this method. Similarly, a high proportion of students felt that they had learnt more through PBL than through traditional approaches, suggesting that PBL is perceived as an effective method of acquiring knowledge.

Figure 2. Students' opinions about learning with PBL.



Motivation and independent learning skills were also rated highly, with most responses falling into the upper categories. This confirms PBL's role in fostering autonomy and engagement. However, perceptions of the difficulty and effort required for PBL were mixed. Many students agreed that PBL

demands more effort than traditional learning, which is consistent with its active, student-centred nature. This finding highlights the need for adequate support and guidance during the implementation of PBL.

However, when asked about a course entirely based on PBL without traditional lectures, responses were more divided, with fewer students selecting 'Very' or 'Extremely'. This suggests that, although PBL is valued, students may prefer a blended approach to a complete replacement of traditional methods. Similarly, when asked about preferring a higher percentage of traditional learning, there was moderate agreement, which reinforces the idea that a balanced combination of PBL and traditional instruction might be optimal.

Further analysis involved calculating the average values the first and second categories of students' responses, with the second category divided into those who preferred PBL versus traditional learning and those who did not. We then added the points obtained through PBL, the points collected from quizzes in the e-classroom that were unrelated to PBL, and the final grade for the course. We conducted a correlation analysis focusing on those six indicators. Both Pearson's r and Spearman's ρ were calculated to capture linear and rank-based associations, given the mix of Likert-scale and performance-based measures. As expected, the strongest positive correlation was observed between the PBL points and the final grade ($r = 0.54$; $p < 0.001$), since higher PBL scores directly contribute to the overall grade. A moderate negative correlation was found between not preferred PBL versus traditional learning and the final grade ($r = -0.32$; $p < 0.03$), suggesting that students with a more negative perception of PBL tend to achieve slightly lower grades. Other variables showed only weak correlations (r between ± 0.10 and ± 0.20), indicating that subjective perceptions are not strong predictors of academic performance.

3. Discussion and conclusions

The present results show that success in PBL tasks is the main factor in determining the final grade, while attitudes towards PBL and traditional learning only indirectly influence the outcome. Although negative perceptions of PBL may coincide with lower achievement, this effect is weaker than the direct impact of task completion. Students who report greater improvement through PBL also express more positive opinions about PBL compared to traditional learning. This convergence suggests that PBL fosters not only cognitive development but also motivational and attitudinal benefits, reinforcing its pedagogical value. The correlation between the total number of PBL points and the final course grade suggests that the competencies assessed through PBL activities contribute meaningfully to the final outcome. Conversely, the weak and non-significant correlations involving average quiz scores suggest that traditional quizzes may not reflect the skills emphasised in PBL, such as problem-solving and collaboration, nor the knowledge required for the final exam. For educators, these findings emphasise the importance of assessment alignment. If course objectives prioritise PBL competencies, evaluation strategies must reflect these goals to ensure fairness and validity. Furthermore, cultivating positive attitudes towards PBL could boost engagement and perceived learning gains. The findings suggest that students with negative attitudes towards PBL may benefit from additional guidance and orientation activities to explain the advantages of active learning and help them adapt and engage more effectively. Finally, while self-reported improvements in skills are not strong predictors of achievement, encouraging metacognitive strategies through reflection and discussion can improve long-term learning outcomes and promote deeper engagement with the material.

Overall, the data indicate that PBL is highly effective in enhancing collaborative and digital competencies, while its impact on motivation and confidence requires further exploration. Future research should investigate strategies to strengthen these dimensions, such as incorporating reflective activities or peer feedback mechanisms. The integration of learning analytics indicators, such as the number of LMS logins, participation in online discussions, and task submission patterns, would provide a valuable complement to students' self-reported perceptions. Furthermore, AI-enhanced analytics introduce additional possibilities, including the predictive modelling of student engagement, early identification of learning difficulties, and adaptive feedback systems tailored to individual learners, which could timely indicate students with negative attitudes towards PBL and motivate them for active engagement. This could represent a significant step toward more personalized, responsive, and data-driven higher education. Future research should explore mixed methods approaches that combine surveys, behavioral data, and qualitative reflections, while also addressing ethical considerations in the use of learning data and the design of intelligent dashboards that support reflective learning for both students and instructors.

By integrating authentic problems, interdisciplinary collaboration, and digital tools, PBL equips graduates with the competencies essential for navigating dynamic labour markets. By centering learning on authentic, complex problems, PBL cultivates a suite of competencies, including critical thinking, collaboration, communication, adaptability, and digital literacy, that employers consistently identify as essential for success in dynamic work environments. Unlike traditional content-driven approaches, PBL

emphasizes transferable skills and reflective practice, enabling graduates to navigate uncertainty, manage interdisciplinary projects, and respond ethically to real-world challenges. Higher education must prioritize methods like PBL that foster lifelong learning and professional resilience.

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