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Higher Education Students and PBL Methodology: An Exploratory Study of Correlations in Learning Experiences

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Abstract

Project-Based Learning (PBL) is a teaching approach centred on research and the resolution of complex, real-life problems through the design and execution of practical projects. In higher education, it stimulates independent thinking and problem-solving skills, promoting more meaningful learning. This study aimed to evaluate the effectiveness of PBL among higher education students using an instrument developed by Chang et al. (2018). It was an exploratory study that sought to identify patterns in the relationships between the involved variables. The results revealed positive and significant correlations between all the dimensions of PBL effectiveness, emphasising the strong association between motivation and the quality of the final product. This reinforces the potential of PBL in developing transversal competencies in higher education. Based on these results, the adoption of the PBL methodology over traditional methods is considered pertinent, since it responds more effectively to society's demands for the holistic development of students.

Keywords: Project-Based Learning; Effectiveness of PBL; Pearson Correlations; Design Project; Skills Development

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1. INTRODUCTION

Project-Based Learning (PBL) is a teaching methodology that involves investigating and solving complex, real-world problems through the design and execution of practical projects. This approach requires rigorous planning and completion of structured tasks, enabling students to develop essential knowledge and skills for their academic careers and professional futures (Almulla, 2020; Chu et al., 2011; Markham et al., 2003).

In recent years, the importance of research into student evaluation in academic institutions has grown, as it enables the measurement of not only the quality of teaching and learning, but also the level of satisfaction among students and teachers (Bedggood & Donavan, 2011; Bedggood & Pollard, 2001; Hildebrand et al., 1971; John, 2005; Marsh, 1987). Several studies suggest that PBL stimulates independent thinking and problem solving, leading to more meaningful learning among university students (Bolick et al., 2024; Chanchy, 1995; Kuo & Chang, 2014). It is an effective approach that boosts students' motivation and attitude to learning (Filho et al., 2016) and improves their employability, meeting the demands of industry (Kung et al., 2014; Ashraf et al., 2025).

The application of problem-based learning (PBL) has been explored in crossing disciplines within the same course, as well as in collaboration between different areas of knowledge. This has covered fields such as design, communication and marketing (Antunes & Brandão, 2024; McCall et al., 2023; Vitorino et al., 2023; Wurst et al., 2023), as well as other areas (Filipe et al., 2023; Mesquita et al., 2018; Morais et al., 2021; Rachmawati et al., 2024). Despite these advances, Warr and West (2020) emphasise the need for more examples of interdisciplinary collaboration through project-based learning in higher education, highlighting the importance of further research in this area.

The main objective of this study is to analyse the linear relationships between specific variables in a problem-based learning (PBL) context. The analysis will focus on identifying significant correlations between the selected variables using Pearson's correlation coefficient, a robust statistical tool for measuring the strength and direction of linear associations between continuous variables.

The article begins with a theoretical review of project-based learning and the assessment tools used. It then describes the PBL method, presents the results and discusses them before concluding.

2. PROJECT-BASED LEARNING METHODOLOGY

The rapid advance of science and technology means that education is facing new challenges and demands. In higher education, acquiring technical and specific knowledge alone is no longer enough to prepare students for the increasingly complex and multidimensional professional contexts they will encounter. The development of transversal competencies such as problem solving, collaboration, autonomy and critical thinking is now required. Against this backdrop, Project-Based Learning (PBL) has emerged as an effective pedagogical methodology that promotes active student engagement with real and meaningful problems, links theory and practice, and favours deeper, autonomous, action-oriented learning. The application of PBL in higher education has been identified as an appropriate response to 21st-century demands (Hmelo-Silver, 2004; Savery, 2006).

According to Hmelo-Silver (2004), PBL involves students working in groups to analyse a problem, identify knowledge gaps, engage in self-directed learning, and apply their newfound knowledge to solve the problem while reflecting on their learning process and the effectiveness of their strategies. The focus is on promoting critical thinking, decision-making and autonomy by combining theory with practice (Rosário & Dias, 2024). The teacher's role is to facilitate the learning process rather than be the main source of knowledge. While this approach does require rigorous planning and completion of structured tasks, it provides students with the opportunity to develop essential knowledge and skills for their academic careers and professional futures (Rosário & Dias, 2024; Almulla, 2020; Chu et al., 2011; Markham et al., 2003

In higher education, the application of PBL has been explored both in the intersection of disciplines within the same course and in collaboration between different areas of knowledge, covering fields such as design and

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marketing (Antunes & Alexandre, 2025; Antunes & Brandão, 2024; McCall et al., 2023; Vitorino et al., 2023; Wurst et al., 2023) among other areas of knowledge (Filipe et al., 2023; Mesquita et al., 2018; Morais et al., 2021; Rachmawatiet al., 2024).

Despite these advances, Warr & West (2020) highlight the need for more examples of interdisciplinary collaboration through project-based learning in higher education, reinforcing the importance of further research in this area. Several studies highlight the benefits of implementing Problem-Based Learning (PBL) in higher education, especially in the development of fundamental skills for the 21st century. According to Yu and Zin (2023), PBL stimulates critical thinking and autonomous learning by presenting students with complex and open-ended problems that require research, analysis and decision-making. Rosário and Dias (2024) confirm that this approach favors the integration of theory and practice, promoting greater student engagement and the development of skills such as collaboration and creativity. These authors also highlight the adoption of innovative strategies such as the use of social networks, games and content generated by the students themselves as ways of strengthening the link between theory and practice.

Sapan, Nur Shafiekah & Johari, Siti & Zulhaimi, Nurul & Hamid, Siti & Ramli, Siti. (2020) also highlights the effectiveness of PBL in promoting teamwork and improving interpersonal communication, skills that are crucial for the employability of graduates. In addition, research by Zhang et al. (2023) concludes that PBL has a positive impact on academic performance, especially in engineering, health sciences and technology courses, with an emphasis on projects lasting between 9 and 18 weeks. The study by Ali et al. (2024) showed a significant correlation between the application of the PBL model and creativity ($r = 0.660$) and motivation ($r = 0.834$) among medical students. Huang et al. (2018) also confirmed a positive relationship between critical thinking skills and student performance in PBL, especially in the areas of preparation, communication skills and critical discussion.

Together, this evidence reinforces the value of PBL as a student-centred teaching methodology, in line with the demands of contemporary higher education.

Chang et al. (2018) developed a measure to assess the effectiveness of PBL. The author describes four variables to consider when measuring the effectiveness of PBL: perception of flow experience, self-efficacy, product evaluation, and the motivation to learn. The assessment tool aims to capture the complexity of the learning experience in the context of collaborative PBL projects, considering individual aspects (self-efficacy, motivation) and group aspects (flow experience, product evaluation), allowing for a more complete analysis of the effectiveness of the methodology employed. The articulation between these aspects allows for a holistic view of the learning process, highlighting the importance of interdisciplinary collaboration and the practical application of PBL.

3. METHODOLOGY

3.1. CONTEXT OF STUDY AND PARTICIPANTS

This study aims to analyze the linear relationships between specific variables within a Problem-Based Learning context in higher education.

This study was conducted with undergraduate students from the School of Technology and Management of the Polytechnic Institute of Leiria, involving the Design and New Product Marketing courses of the curricular plan of Marketing Bachelor's degree, as well as the 3D Game Design module of the curricular plan of Digital Games and Multimedia Bachelor's degree. The students of the Digital Games and Multimedia were tasked with developing an online and digital game, acting as "clients" of the Marketing students, who aimed to create the game's brand identity (name and icon) and develop a communication strategy, both in the digital environment and at physical points of sale. Although different, the courses were integrated through collaboration between students and teachers, promoting an interdisciplinary approach during the second semester of 2024. Table 1 presents a summary of the participants involved in this initiative.

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Table 1 – Summary of the players involved in the work

Bachelor's degree participants	Working Groups
Marketing (1 Lecturer and 59 Students – 59)	11
Digital Games and Multimedia (1 Lecturer and 63 students)	21

Source: Own elaboration

3.2. DESCRIPTION AND WORK STAGES

Students from both degree programs organized themselves into working groups. Marketing students communicated with the Digital Games and Multimedia teams to obtain information about the concept behind each game, including specific details such as the game's objectives and target audience, among other aspects. Table 2 summarizes the various activities carried out by these students throughout the development process of their project.

Table 2 – Work process by marketing bachelor students

Objective	Steps
Contextualization of thematic and branding trends in gaming.	Preliminary approach to the subject, involving the execution of multiple semantic analyses to collect information on games (including brands, application layouts, visual features, market trends, and so on) and to evaluate these aspects in terms of color schemes, typography, and target audiences.
Utilization of the theoretical and practical knowledge gained during the course.	Development of a distinctive brand tailored to the specific genre of game. at the conclusion, students were required to present the brand's structural logic, including its components in color and black and white (such as the game's name, symbol, or icon). this also involved defining the color palette and scheme, as well as selecting appropriate typography and typefaces.
Fostering integration among students through information exchange and constructive feedback, thereby promoting the development of interdisciplinary skills, networking opportunities, and potential future collaborations.	Meeting with the games students to discuss their progress and current situation.
Investigation and analysis of existing product and game packaging, followed by the proposal of a new packaging design for the game. this also includes developing a communication strategy for the game and its packaging, utilizing platforms such as the *Indieblog* and other social media channels.	The development of brand communication strategies focused on packaging design and promotional materials to effectively convey the brand's identity and attract target audiences.
Demonstrate the development of the project and communicate the final proposals.	Final presentation of the project, summarising the research process, design development, and proposed solutions, including visual and conceptual explanations.

Source: Own elaboration

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3.3. DATA COLLECTION INSTRUMENT

The PBL technique was mainly used with Marketing students. So, to see how well it worked, we used a questionnaire made with Google Forms and put it on Moodle (the school's internal learning platform) in April 2024. The questionnaire was developed based on the scale presented by Chang et al. (2018) measured on a 5-point Likert scale, where 1 was considered the lowest value and 5 the most positive response.

The analysis was restricted to the use of Pearson's correlation, as the intention is not to explore causality, but to assess the intensity and direction of linear associations between the selected variables.

3.4. ANALYSIS AND DISCUSSION OF RESULTS

Normality tests were performed for all study variables using the Kolmogorov-Smirnov and Shapiro-Wilk tests. The results indicated that most variables were normally distributed, except for the Flow Experience Perception variable, which did not meet the normality criterion according to the Shapiro-Wilk test ($p = 0.035$).

Considering the sample size ($n = 59$) and the fact that Pearson's correlation coefficient is relatively robust to small violations of normality in moderate samples, a graphical analysis was performed using scatter plots between *Perception of Flow Experiente* and the other variables (*Self-Efficacy, Product* and *Motivation*). These graphs revealed a positive linear trend in all cases, with no extreme outliers or non-linear patterns.

Based on these elements, and on the assumption of linearity verified graphically, the use of Pearson's correlation was considered appropriate for analyzing the associations between the variables.

The results of the Pearson correlation analysis revealed positive and statistically significant associations between all the variables analyzed (Table 3). The *Perception of Flow Experience* showed moderate to strong correlations with *Self-Efficacy* ($r = 0.590$; $p < 0.001$), with Product Evaluation ($r = 0.712$; $p < 0.001$) and with Motivation to Learn ($r = 0.609$; $p < 0.001$). *Self-efficacy* was strongly correlated with *Product* ($r = 0.822$; $p < 0.001$) and *Motivation* ($r = 0.737$; $p < 0.001$). Finally, the highest correlation was observed between *Product* and *Motivation* ($r = 0.877$; $p < 0.001$), indicating that higher levels of motivation are strongly associated with better performance in students' final products.

Table 3 –Pearson correlation matrix between the dimensions of PBL effectiveness, AE corresponds to Self-efficacy and P corresponds to Perception of Flow Experience

Variables	Correlation (r)	Interpretation
P – AE	0.590**	Moderate to strong, positive
P – Product	0.712**	Strong, positive
P – Motivation	0.609**	Moderate to strong, positive
AE – Product	0.822**	Very strong, positive
AE – Motivation	0.737**	Strong, positive
Product – Motivation	0.877**	Very strong, positive

Source: Own elaboration

The flow experience being positively associated with all other variables, reveals that students who feel 'immersed' and involved in tasks (state of flow) believe more in their abilities (self-efficacy), feel more motivated, and produce better final work. Self-efficacy proves to be a central factor, with very high correlations with Product Evaluation (0.822), which indicates that more confident students tend to deliver better quality work. Regarding Motivation (0.737), it is believed that the greater self-confidence, the greater the willingness to learn. Finally, the strongest correlation of all (0.877) is between product evaluation and motivation, which suggests that motivated students not only participate more, but also produce more consistent and higher quality work.

4. CONCLUSION

This study aimed to explore the effectiveness of project-based learning by analyzing the correlations between its main dimensions in a higher education context.

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After using the PBL methodology with Marketing Bachelor's degree students, the questionnaire proposed by Chang et al. (2018) was applied, and it was found that all dimensions—Flow Experience Perception, Self-efficacy, Learning Motivation, and Product Evaluation—revealed positive and statistically significant correlations between all of them. Motivation for learning showed the highest correlation with product evaluation (r = 0.877), suggesting that more motivated students tend to produce higher quality work. Self-efficacy showed strong correlations with motivation (r = 0.737) and product evaluation (r = 0.822), indicating that confidence in one's own abilities is strongly associated with commitment and performance. The perception of flow experience, although with slightly lower correlations, was also significantly related to all other dimensions (r ranging from 0.590 to 0.712), confirming its importance in the active involvement of students. These data strongly support the idea that the effectiveness of the PBL methodology does not depend solely on the structure of the project, but on how the student experiences the learning experience. Experiencing flow, feeling capable (self-efficacy) and motivation are interrelated conditions that enhance better results (product). This confirms the model proposed by Chang et al. (2018), in which motivation, emotional involvement and perceived competence reinforce each other in the success of flow.

Although this study is exploratory in nature and uses a small sample, the results obtained allow us to identify relevant trends regarding the perception of the effectiveness of the PBL methodology. These preliminary data point to the pedagogical value of PBL and justify further studies with a larger sample size to validate and deepen the patterns observed in this research.

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