

การศึกษามิติของการเรียนรู้โดยใช้โครงงานเป็นฐานและบทบาทในการส่งเสริม ความผูกพันของผู้เรียนและผลสัมฤทธิ์ทางการเรียนของนักศึกษาในระดับอุดมศึกษา*

Alfredo C. Espejo¹ คณิศร์วิภา วรธนະสาร² Ramona B. Bayoging³

Juan Rodrigo B. Del Villar⁴

(วันที่รับบทความ: 2 เมษายน 2569; วันที่แก้ไขบทความ: 22 พฤษภาคม 2569; วันที่ตอบรับบทความ: 26 พฤษภาคม 2569)

บทคัดย่อ

งานวิจัยนี้เป็นการศึกษาความสัมพันธ์ระหว่างการจัดการเรียนรู้โดยใช้โครงงานเป็นฐานกับความผูกพันของผู้เรียนและผลสัมฤทธิ์ทางการเรียน โดยพิจารณา 5 มิติของ PBL และใช้รูปแบบเชิงปริมาณแบบภาคตัดขวางเชิงสหสัมพันธ์พหุกรณี กลุ่มตัวอย่าง คือ นักศึกษาในระดับอุดมศึกษา จำนวน 200 คน คัดเลือกการสุ่มแบบเจาะจงเชิงชั้นภูมิ เพื่อให้มีตัวแทนจากชั้นปีที่แตกต่างกัน การเก็บรวบรวมข้อมูล ใช้แบบสอบถามซึ่งผ่านการตรวจสอบความเชื่อมั่นและความเที่ยงตรงแล้ว การวิเคราะห์ข้อมูลใช้การทดสอบที การวิเคราะห์ความแปรปรวนทางเดียว สหสัมพันธ์เพียร์สัน และการวิเคราะห์ถดถอยพหุคูณ

ผลการวิจัยพบว่าการจัดการเรียนรู้โดยใช้โครงงานเป็นฐาน มีความสัมพันธ์เชิงบวกกับการมีส่วนร่วมของนักศึกษา ($r = .58, p < .001$) และผลสัมฤทธิ์ทางการเรียน ($r = .49, p < .001$) การมีส่วนร่วมของ นักศึกษายังมีความสัมพันธ์เชิงบวกกับผลสัมฤทธิ์ทางการเรียน ($r = .46, p < .001$) ผลการวิเคราะห์ถดถอยพหุคูณแสดงให้เห็นว่าการทำงานร่วมกันและปฏิสัมพันธ์ทางสังคมเป็นตัวพยากรณ์ที่สำคัญที่สุดของการมีส่วนร่วมของนักศึกษา ($\beta = .27, p < .001$) ในขณะเดียวกัน ความเชื่อมโยงและการประยุกต์ใช้ในโลกรจริงเป็นตัวพยากรณ์ที่สำคัญที่สุดของผลสัมฤทธิ์ทางการเรียน ($\beta = .21, p = .001$) ผลการศึกษาชี้ให้เห็นว่าการจัดการเรียนรู้ โดยใช้โครงงานเป็นฐานที่มีหลายมิตินี้มีความสัมพันธ์กับการเพิ่มขึ้นของการมีส่วนร่วมและผลการเรียน และเป็นหลักฐานเชิงประจักษ์ที่สนับสนุนแนวทางการจัดการเรียนรู้ที่เน้นผู้เรียนเป็นศูนย์กลางในระดับอุดมศึกษา

คำสำคัญ: การเรียนรู้โดยใช้โครงงานเป็นฐาน, ความผูกพันของผู้เรียน, ผลสัมฤทธิ์ทางการเรียน, นักศึกษาในระดับอุดมศึกษา, การเรียนรู้แบบร่วมมือ

* บทความวิจัย มหาวิทยาลัยนานาชาติเซนต์เทเรซา, 2569

¹ อาจารย์, คณะบริหารธุรกิจ มหาวิทยาลัยนานาชาติเซนต์เทเรซา, E-mail: espejo.alfredo@gmail.com (Corresponding author)

² อาจารย์, คณะบริหารธุรกิจ มหาวิทยาลัยนานาชาติเซนต์เทเรซา, E-mail: kanitvipa@trsu.ac.th

³ อาจารย์, คณะศึกษาศาสตร์ มหาวิทยาลัยนานาชาติเซนต์เทเรซา, E-mail: ramona.b@stic.ac.th

⁴ อาจารย์, คณะบริหารธุรกิจ มหาวิทยาลัยนานาชาติเซนต์เทเรซา, E-mail: janjan.jrdv@gmail.com

Examining the Dimensions of Project-Based Learning and Their Role in Enhancing Student Engagement and Academic Achievement Among University Students*

*Alfredo C. Espejo¹ Kanitvipa Wattanasan² Ramona B. Bayoging³
Juan Rodrigo B. Del Villar⁴*

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Abstract

This study examined the relationship between Project-Based Learning (PBL) and student engagement and academic achievement among university students. Considering five dimensions of PBL, the study employed a quantitative cross-sectional correlational-predictive design. The sample comprised 200 university students selected through stratified purposive sampling to ensure representation across different year levels. Data were collected using questionnaires that underwent reliability and validity testing. Data analysis involved independent-samples t-tests, one-way analysis of variance (ANOVA), Pearson's correlation, and multiple regression analysis.

The results indicated that Project-Based Learning was positively associated with student engagement ($r = .58, p < .001$) and academic achievement ($r = .49, p < .001$). Student engagement was also positively correlated with academic achievement ($r = .46, p < .001$). Multiple regression analysis revealed that collaboration and social interaction were the strongest predictors of student engagement ($\beta = .27, p < .001$), whereas real-world relevance and application were the strongest predictors of academic achievement ($\beta = .21, p = .001$). The findings suggest that multidimensional Project-Based Learning is associated with increased student engagement and academic performance, providing empirical evidence to support for learner-centered instructional approaches in higher education.

Keywords: Project-Based Learning, Student Engagement, Academic Achievement, University Students, Collaborative Learning

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¹ Lecturer, Faculty of Business Administration, St Teresa International University, E-mail: espejo.alfredo@gmail.com (Corresponding author)

² Lecturer, Faculty of Business Administration, St Teresa International University, E-mail: kanitvipa@trsu.ac.th

³ Lecturer, Faculty of Education, St Teresa International University, E-mail: ramona.b@stic.ac.th

⁴ Lecturer, Faculty of Business Administration, St Teresa International University, E-mail: janjan.jrdv@gmail.com

Introduction

Student engagement and academic achievement are widely recognized as critical indicators of effective learning in higher education. Engagement refers to students' behavioral, emotional, and cognitive involvement in learning activities, while academic achievement reflects measurable learning outcomes such as knowledge mastery and performance in assessments. However, traditional teacher-centered instruction often limits students' active participation and reduces opportunities for collaboration and problem-solving, which may negatively affect both engagement and academic performance (Gal and Ryder, 2025; Ghafar, 2023).

Project-Based Learning (PBL) has emerged as a learner-centered approach that enhances engagement and improves academic outcomes. Through collaborative and authentic tasks, PBL promotes inquiry, problem-solving, and knowledge construction. Research indicates that PBL enhances motivation, deep learning, and students' engagement across cognitive, behavioral, and emotional dimensions (Zhang and Ma, 2023), while authentic project contexts increase participation and perceived relevance of learning experiences (Chang, Choi and Akbulut, 2024).

Despite its potential, several gaps remain. First, many studies examine either student engagement or academic achievement independently, with limited research investigating both simultaneously. Understanding both outcomes is important, as engagement is associated with improved academic performance (Karunaratne et al., 2025). Second, student engagement is often measured using a single source, typically self-report data, which may not fully capture participation in collaborative learning environments (Mutanga, 2024). Third, limited empirical evidence exists regarding the effectiveness of PBL in general university classroom settings where lecture-based instruction remains dominant, and meta-analytic findings suggest that PBL effectiveness varies across contexts (García and Cózar, 2025).

This study addressed these gaps by examining the relationship between Project-Based Learning, student engagement, and academic achievement among university students. Grounded in constructivist learning theory, experiential learning theory, and social interdependence theory, it investigated how the dimensions of Project-Based Learning influenced both engagement and academic achievement. The findings provided empirical support for learner-centered instructional approaches, contributing to the literature by offering practical guidance for designing instructional strategies that enhance participation, collaboration, and academic performance in higher education.

Research Objectives

1. To determine whether there is a significant difference in students' engagement and academic achievement across demographic groups.
2. To examine the relationship between student engagement and academic achievement in a Project-Based Learning environment.

3. To identify the dimensions of Project-Based Learning that significantly influence engagement among university students.

4. To identify the dimensions of Project-Based Learning that significantly influence academic achievement among university students.

Research Hypothesis

H₁ There is a significant difference in students' engagement and academic achievement across demographic groups.

H₂ There is a significant relationship between student engagement and academic achievement in a Project-Based Learning environment.

H₃ Dimensions of Project-Based Learning significantly influences engagement among university students.

H₄ Dimensions of Project-Based Learning significantly influences academic achievement among university students.

Related Concepts and Theories

This study is grounded in constructivist learning theory, experiential learning theory, and social interdependence theory, which collectively explain how Project-Based Learning (PBL) enhances student engagement and academic achievement. Constructivist learning theory posits that learners actively construct knowledge through meaningful tasks and inquiry, supporting deeper cognitive engagement in project-based environments. Experiential learning theory emphasizes learning through concrete experience, reflection, and application, which aligns with PBL activities that require students to work on authentic tasks and apply knowledge to real-world contexts. Social interdependence theory highlights the role of collaboration, suggesting that shared goals and group interaction foster accountability, communication, and active participation in learning.

Based on these theoretical perspectives, the conceptual framework proposes that Project-Based Learning influences student engagement and academic achievement. PBL is a multidimensional instructional approach that includes authentic and inquiry-based learning, collaboration and social interaction, student autonomy and responsibility, real-world relevance and application, and reflection and presentation. These dimensions are expected to promote students' behavioral, cognitive, and emotional engagement by encouraging active participation, collaboration, and responsibility for learning tasks. At the same time, Project-Based Learning is assumed to directly enhance academic achievement by improving learning experiences, increasing the relevance of content, and supporting deeper understanding. Thus, the framework assumes that Project-Based Learning contributes to both student engagement and academic achievement.

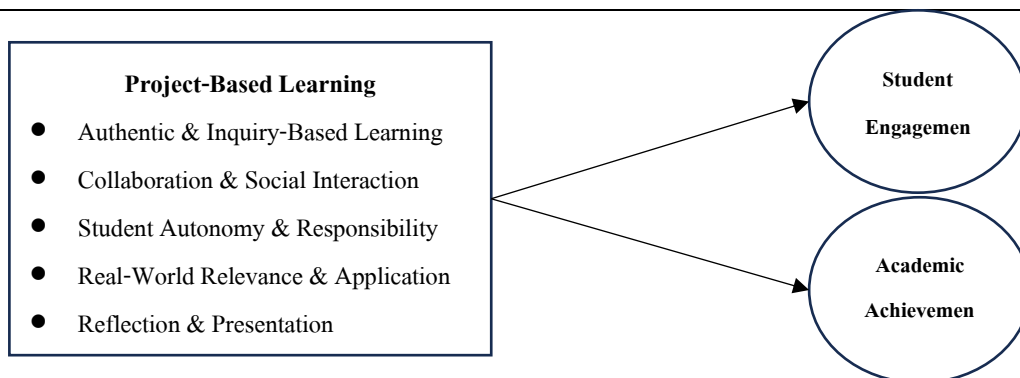


Figure 1. Conceptual framework illustrating the direct influence of the dimensions of project-based learning on students' engagement and academic achievement.

Research Methodology

This study employed a quantitative, cross-sectional, correlational-predictive design to examine the relationships among Project-Based Learning, student engagement, and academic achievement among university students. The variables were measured as naturally occurring perceptions without manipulation (Creswell & Creswell, 2023). Correlational and multiple regression analyses were conducted to determine the predictive influence of Project-Based Learning dimensions on student engagement and academic achievement, while inferential tests examined differences across demographic characteristics.

The population consisted of university students who participated in Project-Based Learning activities. An a priori power analysis using G*Power 3.1 indicated a minimum sample size of 92 participants for multiple regression with five predictors ($f^2 = .15$, $\alpha = .05$, power = .80). To improve statistical power and estimate stability, 200 students were selected through stratified purposive sampling to ensure representation across year levels. Only students who had experienced Project-Based Learning were included.

Project-Based Learning served as the independent variable and was represented by five dimensions: authentic and inquiry-based Learning, collaboration and social interaction, student autonomy and responsibility, real-world relevance and application, and reflection and presentation. These dimensions were measured using a researcher-developed questionnaire that demonstrated good reliability ($\alpha = .89$) and acceptable validity (CFI = .94, TLI = .93, RMSEA = .06). In terms of implementation, PBL was conducted over 10 weeks, during which students completed 8 projects aligned with the course objectives. The learning activities required students to identify problems, conduct inquiry, collaborate with peers, apply concepts to real-world contexts, and present their project outputs. To ensure consistency across classes or groups, the instructors followed a common instructional guide, project timeline, learning tasks, and assessment criteria. Before implementation, the lecturers were oriented on the instructional guide and project procedures to ensure uniform delivery across groups. This standardization was intended to minimize variations in

teaching procedures that could influence students' engagement and academic achievement. The dependent variables were student engagement and academic achievement. Student engagement was measured using an instrument adapted from the Student Engagement in Schools Questionnaire (Hart et al., 2011), which demonstrated established reliability ($\alpha = .86$) and acceptable validity indices (CFI = .96, TLI = .95, RMSEA = .05). Academic achievement was assessed using a researcher-developed test aligned with the course objectives and supported by a Table of Specifications. To minimize potential bias, the test was reviewed by four experts in the field, who evaluated its relevance, clarity, and alignment with the intended learning outcomes. The validation process indicated strong content validity, as reflected in an S-CVI/Ave of .94. Item analysis was also conducted to examine the quality of the test items, with a mean difficulty index of .64, which falls within the acceptable moderate range and indicates that the items were appropriate for assessing students' academic achievement (Rezigalla, 2022). The test likewise demonstrated good reliability, with a Cronbach's alpha coefficient of .84.

Data were collected through voluntary, anonymous, self-administered questionnaires after students completed Project-Based Learning activities. Informed consent was obtained, and confidentiality was ensured. Descriptive statistics summarized the variables, while independent-samples t-tests and a one-way ANOVA examined demographic differences. Pearson correlation assessed relationships among variables, and multiple regression determined the predictive influence of Project-Based Learning dimensions. Assumptions of normality, linearity, homoscedasticity, and independence were checked. All analyses were conducted using SPSS with significance set at $p < .05$.

Results

Table 1. Differences in Student Engagement and Academic Achievement by Demographic Groups

Demographic Variable	Category	n	Engagement Mean (S.D.)	Achievement Mean (S.D.)	Test	Statistic	p	Effect Size
Gender	Male	92	3.78 (0.54)	24.18 (3.42)	t-test	$t = -1.18 / -2.06$	.239 / .041*	$d = .16 / .28$
	Female	108	3.86 (0.50)	25.09 (3.18)				
Nationality	Thai	124	3.81 (0.52)	24.36 (3.28)	t-test	$t = -0.76 / -2.11$	.448 / .036*	$d = .11 / .27$
	Foreigner	76	3.87 (0.51)	25.24 (3.19)				
Year Level	First Year	54	3.71 (0.56)	24.12 (3.44)	ANOVA	$F = 3.72 / 1.94$	.013* / .124	$\eta^2 = .054 / .029$
	Second Year	52	3.82 (0.51)	24.58 (3.29)				
	Third Year	48	3.89 (0.49)	25.03 (3.21)				
	Fourth Year	46	3.94 (0.47)	25.21 (3.18)				
Previous PBL Experience	No	88	3.69 (0.55)	23.91 (3.40)	t-test	$t = -3.12 / -3.48$	.002* / .001*	$d = .49 / .47$
	Yes	112	3.94 (0.47)	25.38 (3.06)				

Note. Cohen's d values of .20, .50, and .80 represent small, medium, and large effects. η^2 values of .01, .06, and .14 represent small, medium, and large effects.

^a Tukey post hoc test indicated that fourth-year students reported significantly higher engagement than first-year students ($p < .05$).

* $p < .05$.

Table 1 presents the differences in student engagement and academic achievement across demographic groups. No significant difference in student engagement was found by gender, $t(198) = -1.18$, $p = .239$, with a small effect size ($d = .16$). However, a statistically significant difference was observed in academic achievement, $t(198) = -2.06$, $p = .041$, although the effect size was small ($d = .28$). Female students ($M = 25.09$, $S.D. = 3.18$) obtained slightly higher achievement scores than male students ($M = 24.18$, $S.D. = 3.42$). Similarly, student engagement did not significantly differ by nationality, $t(198) = -0.76$, $p = .448$, with a negligible effect size ($d = .11$). In contrast, academic achievement differed significantly by nationality, $t(198) = -2.11$, $p = .036$, with a small effect size ($d = .27$). Foreign students ($M = 25.24$, $S.D. = 3.19$) reported higher achievement scores than Thai students ($M = 24.36$, $S.D. = 3.28$).

For year level, one-way ANOVA revealed a significant difference in student engagement, $F(3, 196) = 3.72$, $p = .013$, with a small-to-moderate effect size ($\eta^2 = .054$). Fourth-year students ($M = 3.94$, $S.D. = 0.47$) reported higher engagement than first-year students ($M = 3.71$, $S.D. = 0.56$). Tukey's post hoc analysis indicated a significant difference between first-year and fourth-year students. Academic achievement did not significantly differ across year levels, $F(3, 196) = 1.94$, $p = .124$, with a small effect size ($\eta^2 = .029$). Significant differences were observed in both student engagement and academic achievement based on previous Project-Based Learning experience. Students with prior PBL exposure reported higher engagement, $t(198) = -3.12$, $p = .002$, with a moderate effect size ($d = .49$), and higher academic achievement, $t(198) = -3.48$, $p = .001$, also with a moderate effect size ($d = .47$), compared to students without prior experience.

Table 2. Relationship Between Project-Based Learning, Student Engagement, and Academic Achievement

Variables	Project-Based Learning	Student Engagement	Academic Achievement
1. Project-Based Learning	—		
2. Student Engagement	.58**	—	
3. Academic Achievement	.49**	.46**	—

Remarks: 0.00 to ± 0.10 Negligible Correlation; ± 0.10 to ± 0.30 Weak Correlation; ± 0.30 to ± 0.50 Moderate Correlation; ± 0.50 to ± 0.70 Strong Correlation; ± 0.70 to ± 1.00 Very Strong Correlation (Cohen, 1988)
 $p < .01$

Table 2 presents the relationships among Project-Based Learning, student engagement, and academic achievement. Project-Based Learning was significantly and positively correlated with student engagement ($r = .58, p < .001$). Project-Based Learning also showed a significant positive correlation with academic achievement ($r = .49, p < .001$). In addition, student engagement was significantly and positively correlated with academic achievement ($r = .46, p < .001$). All correlations were statistically significant at the .01 level.

Table 3. Dimensions of Project-Based Learning Predicting Student Engagement

Predictors	β	t	p	VIF
1. Authentic & Inquiry-Based Learning	.21	3.48	.001*	1.82
2. Collaboration & Social Interaction	.27	4.41	< .001*	2.14
3. Student Autonomy & Responsibility	.19	3.12	.002*	1.76
4. Real-World Relevance & Application	.15	2.54	.012*	1.69
5. Reflection & Presentation	.11	1.96	.052	1.58
Overall model: $F(5, 194) = 32.84, p < .001, R^2 = .458, \text{Adjusted } R^2 = .444$.				

Note. VIF values below 5 indicate no multicollinearity concerns. * $p < .05$.

Table 3 exhibits the multiple regression analysis conducted to determine which dimensions of Project-Based Learning predicted student engagement. The overall regression model was statistically significant, $F(5, 194) = 32.84, p < .001$. The model explained 44.4% of the variance in student engagement (Adjusted $R^2 = .444$; $R^2 = .458$), with the adjusted value providing a more conservative estimate by accounting for the number of predictors included in the model. Collaboration and social interaction significantly predicted student engagement ($\beta = .27, t = 4.41, p < .001$). Authentic and inquiry-based learning also significantly predicted engagement ($\beta = .21, t = 3.48, p = .001$). Student autonomy and responsibility significantly predicted engagement ($\beta = .19, t = 3.12, p = .002$). Real-world relevance and application were likewise significant predictors ($\beta = .15, t = 2.54, p = .012$). Reflection and presentation did not significantly predict student engagement ($\beta = .11, t = 1.96, p = .052$). Variance inflation factor (VIF) values ranged from 1.58 to 2.14.

Table 4. Dimensions of Project-Based Learning Predicting Academic Achievement

Predictors	β	t	p	VIF
1. Authentic & Inquiry-Based Learning	.18	2.78	.006*	1.82
2. Collaboration & Social Interaction	.14	2.19	.030*	2.14
3. Student Autonomy & Responsibility	.12	2.03	.044*	1.76
4. Real-World Relevance & Application	.21	3.42	.001*	1.69
5. Reflection & Presentation	.09	1.57	.118	1.58
Overall model: $F(5, 194) = 18.62, p < .001, R^2 = .324, \text{Adjusted } R^2 = .307$.				

Note. VIF values below 5 indicate no multicollinearity concerns. * $p < .05$.

Table 4 illustrates that a multiple regression analysis was conducted to determine which dimensions of Project-Based Learning predicted academic achievement. The overall regression model was statistically significant, $F(5, 194) = 18.62, p < .001$. The model explained 30.7% of the variance in academic achievement (Adjusted $R^2 = .307$; $R^2 = .324$), with the adjusted value providing a more conservative estimate by accounting for the number of predictors. Real-world relevance and application significantly predicted academic achievement ($\beta = .21, t = 3.42, p = .001$). Authentic and inquiry-based learning also significantly predicted academic achievement ($\beta = .18, t = 2.78, p = .006$). Collaboration and social interaction significantly predicted academic achievement ($\beta = .14, t = 2.19, p = .030$). Student autonomy and responsibility significantly predicted academic achievement ($\beta = .12, t = 2.03, p = .044$). Reflection and presentation did not significantly predict academic achievement ($\beta = .09, t = 1.57, p = .118$). Variance inflation factor (VIF) values ranged from 1.58 to 2.14.

Discussions

Demographic Differences in Student Engagement and Academic Achievement

The findings revealed no significant differences in student engagement across gender and nationality, suggesting that Project-Based Learning (PBL) provides an inclusive learning environment that supports participation regardless of demographic background. This indicates that engagement in PBL is influenced more by instructional design than by learner characteristics. From a constructivist perspective, learning environments that emphasize inquiry, collaboration, and authentic tasks enable students to participate meaningfully, thereby reducing the influence of demographic factors. Previous research similarly indicates that student-centered pedagogies minimize engagement disparities by promoting equal opportunities for participation (Ainscow, 2020; Ribeiro, Farias and Mesquita, 2024).

However, significant differences in academic achievement across gender and nationality suggest that while PBL promotes inclusive participation, performance outcomes may still be influenced by learning strategies, language proficiency, and prior academic preparation. Variations in self-regulated learning and academic adaptation may contribute to achievement differences in diverse university classrooms (Ha, Roehrig and Zhang, 2023).

Engagement increased across year levels, indicating that students become more involved as they gain academic experience. Constructivist theory suggests that learning builds on prior knowledge, leading to greater confidence and participation over time (Heikkinen et al., 2025). Similarly, students with previous PBL experience demonstrated higher engagement and academic achievement, supporting experiential learning theory, which emphasizes that prior experience enhances participation and performance in inquiry, collaboration, and problem-solving tasks (Rehman et al., 2024).

Relationship Between Project-Based Learning, Student Engagement, and Academic Achievement

The results indicated significant positive relationships between Project-Based Learning and both student engagement and academic achievement. These findings suggest that PBL environments promote active participation while improving learning outcomes. Constructivist theory explains that students learn more effectively when they actively construct knowledge through inquiry and collaboration. PBL facilitates this process by shifting learning from passive reception to active knowledge construction. Previous studies similarly report that PBL enhances behavioral, emotional, and cognitive engagement (Huang et al., 2024).

The positive relationship between PBL and academic achievement is consistent with experiential learning theory, which emphasizes learning through application in authentic contexts, leading to deeper understanding and retention. Project-based activities provide opportunities for students to integrate theoretical knowledge with practice, thereby improving performance (Bhagwat and Kulkarni, 2025). Furthermore, the positive relationship between engagement and achievement supports engagement theory, which posits that engagement predicts academic success in higher education (Veiga et al., 2026).

Dimensions of Project-Based Learning Predicting Student Engagement

Among the five dimensions of PBL, collaboration and social interaction emerged as the strongest predictor of student engagement. The regression model explained 44.4% of the variance in student engagement (Adjusted $R^2 = .444$), indicating substantial explanatory power after accounting for multiple predictors. Social interdependence theory explains that cooperative learning structures promote engagement through positive interdependence and shared responsibility (Nguyen and Oanh, 2025). Authentic and

inquiry-based learning also predicted engagement, indicating that investigation of meaningful problems enhances involvement. Constructivist theory suggests that inquiry-driven learning stimulates curiosity and cognitive participation (Oroh et al., 2025).

Student autonomy and responsibility further contributed to engagement, supporting self-determination principles within constructivist environments where autonomy enhances intrinsic motivation (Wang et al., 2024). Real-world relevance also predicted engagement, indicating that meaningful contexts increase participation, consistent with experiential learning theory (Mebert et al., 2020).

In contrast, reflection and presentation did not significantly predict student engagement. This finding does not necessarily imply that these components are unimportant in PBL, but may reflect the specific role they played in the learning process. Reflection and presentation may have functioned more as culminating activities that allowed students to organize, communicate, and evaluate their learning rather than as direct sources of sustained participation throughout the project. Recent literature emphasizes that student engagement in PBL is strongly shaped by collaboration, authentic learning, information sharing, discussion, and structured project implementation (Almulla, 2020; Rehman et al., 2024). Similarly, García and Cózar (2025) noted that clear project stages, reflection, feedback, scaffolding, and assessment design influence how PBL affects engagement and learning outcomes. Thus, the non-significant result may be attributed to the timing and function of reflection and presentation, as well as to the possibility that the engagement measure captured broader participation more directly than students' reflective, communicative, or evaluative competencies.

Dimensions of Project-Based Learning Predicting Academic Achievement

Real-world relevance and application emerged as the strongest predictor of academic achievement. The regression model explained 30.7% of the variance in academic achievement (Adjusted $R^2 = .307$), indicating moderate explanatory power after controlling for multiple predictors. Experiential learning theory posits that application promotes comprehension and retention (Banawi et al., 2024). Authentic inquiry-based learning also predicted achievement, supporting constructivist views that knowledge constructed through investigation leads to deeper cognitive processing (Zajda, 2021).

Collaboration significantly contributed to achievement, consistent with social interdependence theory, which emphasizes that cooperative learning enhances understanding through explanation and feedback (Mendo-Lázaro et al., 2022). Student autonomy also predicted achievement, aligning with the self-regulated learning literature, which indicates that autonomous learners demonstrate stronger academic performance (Forbes-McKay et al., 2023; Paethrangsi et al., 2024).

However, reflection and presentation did not significantly predict academic achievement. This result does not necessarily suggest that these components are unimportant in PBL. Rather, it may indicate that their learning effects were not directly captured by the academic achievement measure used in the study. Reflection and presentation are typically associated with metacognitive processing, the synthesis of ideas, the communication of learning, and the evaluation of project experiences. These outcomes may develop students' capacity to articulate, review, and internalize learning, but they may not immediately translate into higher scores on a test primarily designed to measure content mastery. Reflection in PBL has been linked to debriefing, reframing, self-awareness, and the generalization of learning from experience, which may require assessment forms beyond conventional achievement tests (Yulhendri et al., 2023). Similarly, Guo et al. (2020) emphasized that PBL outcomes may involve cognitive, behavioral, affective, and artifact-based dimensions, each requiring different forms of assessment. Thus, the non-significant finding may reflect a measurement issue rather than the absence of educational value. Reflection and presentation may contribute more strongly to broader or longer-term learning outcomes, such as communication skills, self-assessment, metacognitive awareness, and the ability to synthesize project experiences.

Implications for Theory and Practice

The findings reinforce Constructivist Learning Theory by demonstrating that Project-Based Learning substantially enhances student engagement, accounting for 44.4% of the variance. The moderate explanatory power for academic achievement (30.7%) supports Experiential Learning Theory, emphasizing the role of authentic and applied learning experiences. Collaboration as the strongest predictor of engagement also extends Social Interdependence Theory, highlighting the importance of cooperative learning structures. These results suggest that social interaction primarily drives engagement, whereas experiential application more strongly influences academic performance.

Practically, educators should emphasize collaboration, authentic inquiry, and real-world application when implementing Project-Based Learning. Designing group-based and meaningful tasks, promoting student autonomy, integrating PBL across courses, and aligning assessment with performance-based activities may enhance both engagement and academic achievement.

Conclusions

Regression results indicated that the dimensions of Project-Based Learning explained 44.4% of the variance in student engagement, demonstrating strong explanatory power for participation. Collaboration and social interaction emerged as the strongest predictors of engagement, highlighting the importance of cooperative learning structures. The model also explained 30.7% of the variance in academic achievement,

indicating moderate explanatory power. Real-world relevance and application emerged as the strongest predictors of academic performance, followed by authentic inquiry, collaboration, and student autonomy.

Overall, the findings indicate that collaborative learning structures primarily influence engagement, whereas experiential and application-oriented learning components more strongly influence academic achievement.

Recommendations

University instructors are encouraged to integrate Project-Based Learning strategies emphasizing collaboration, authentic inquiry, and real-world application, as group-based projects with clearly defined roles can enhance interaction and engagement. Curriculum planners should embed PBL components across courses and sequence activities progressively across year levels, while interdisciplinary projects may further strengthen real-world relevance and deepen learning. Higher education institutions should also provide professional development programs focused on collaborative learning, student autonomy, and authentic assessment aligned with course learning outcomes. In addition, institutions should provide academic support to help students adapt to inquiry-based learning, including workshops on collaboration, self-regulated learning, and project management to improve performance.

Educators are further encouraged to use varied assessment strategies aligned with Project-Based Learning, such as performance-based tasks, presentations, reflective journals, and authentic problem-solving activities. At the institutional level, administrators may consider incorporating Project-Based Learning into teaching and learning policies to enhance student engagement and improve learning outcomes. Future research may examine the mediating role of student engagement in the relationship between Project-Based Learning and academic achievement, employ longitudinal designs, and incorporate qualitative approaches to explore student experiences. Comparative studies across disciplines are also recommended to strengthen the generalizability of the findings.

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