

The Anomalous Correlation: Examining Project-Based Learning's Impact on Final Examination Performance

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Abstract: *Project-Based Learning (PBL) is widely recognised as a transformative educational approach, offering solutions to challenges posed by traditional teaching methods. Its benefits have been extensively documented within the education sector. However, despite its acclaim, studies have revealed a tenuous link between PBL and students' final examination performance. Hence, this research aims to assess the impact of PBL on final examination results, employing a mixed-methods approach. The study involved 173 participants enrolled in Introduction to Statistics for Built Environment at CFSIIUM. Data collection encompassed final examination scores and peer assessment surveys, which were analysed using Pearson's Correlation Coefficients. Thematic analysis was employed to interpret qualitative insights from peer assessments. The findings reveal a weak positive correlation ($r = 0.207$, $p = 0.006$) between PBL implementation and final examination performance. Thematic analysis of the challenges associated with PBL, including issues with student participation and commitment, communication, task management and quality control, timing and availability sheds light on factors influencing individual outcomes. While PBL holds promise for enhancing students' performance and fostering experiential learning and knowledge retention, strategic planning and careful consideration are imperative for maximizing its benefits and mitigating potential drawbacks. These insights are expected to inform pedagogical strategies and driving enhancements in PBL-driven learning experiences.*

Keywords: Project-Based Learning, Final Examination Performance

1. Introduction

The field of education is dynamic and constantly adapting to incorporate new methods and technologies to improve student engagement, comprehension, and overall achievement. Educational strategies are continually refined to create more impactful and personalized learning experiences, focusing on enhancing student outcomes across diverse learning environments. Project-based learning (PBL) has attracted considerable interest among various educational innovations due to its emphasis on experiential learning that centers around the students. PBL encourages students to engage in real-world projects that require critical thinking, collaboration, and problem-solving (Korkem et al., 2024; Fadhil et al., 2021; Firmansyah et al., 2022). PBL has been proven to enhance student learning outcomes compared to traditional teaching methods (Mahasneh & Alwan, 2018). It positively affects the professional abilities, perspectives, and personal lives of science and engineering graduates

over the long term (Heinricher et al., 2013; Fitriawati, 2023). The level of impact is affected by various factors, including geography, subject area, group size, and project duration (Zhang and Ma, 2023). Despite the widely recognized advantages of PBL supported by academic research, the impact of PBL on traditional academic metrics, such as final examination performance, remains an area of considerable debate. In addition, the results in this area are often varied and occasionally contradictory, reflecting the complexity of assessing PBL's effectiveness in conventional academic settings. On one hand, some studies have demonstrated that PBL can lead to notable improvements in student test scores and overall academic achievement (Fatmawati and Zulyanty, 2022; Yamil et al., 2022).

These findings suggest that PBL's hands-on, interactive approach may enhance students' understanding and application of knowledge. On the other hand, other research by Zhang and Ma (2023) presents more modest or inconclusive results, indicating that the benefits of PBL might not always translate into higher examination scores. This disparity in findings highlights the complexity of evaluating PBL's effectiveness and underscores the need for further investigation to understand the conditions under which PBL is most beneficial.

A mixed methods approach was employed to achieve the research goals, combining quantitative analysis of examination scores with qualitative evaluations of project experiences. This research examines the correlation between PBL and students' performance in final examinations. The primary goal is to determine if students who engage in PBL demonstrate improved examination results compared to those who do not participate in the project. Specifically, the aim is to identify anomalous correlations or unusual patterns that might emerge from the data. By examining these dimensions, a comprehensive understanding of PBL's impact on academic performance can be achieved. The results of this research will provide valuable insights for instructors, curriculum developers, and policymakers as they work to improve teaching methods and enhance educational practices. Ultimately, this research will contribute to the ongoing discussion regarding the effectiveness of modern educational approaches and their alignment with traditional assessment standards. Understanding how PBL influences final examination performance can help inform future educational practices and ensure that innovative teaching methods effectively support student success.

2. Methodology

This correlational research sought to investigate the relationship between students' performance on a group project, designed as a Project-Based Learning (PBL) activity, and their final examination scores in the Introduction to Statistics for Built Environment course. The research was conducted among 173 students who were enrolled in the course, which is part of the curriculum for Architecture and Environmental Design foundation students at the CFS IIUM. The group project, which served as one of the continuous assessments for the course, was designed to assess the students' understanding of conducting basic statistical studies. It encompassed various aspects of the syllabus, including identifying problems and issues related to the built environment and architecture around the CFS IIUM campus, designing a study, presenting and analysing data, and concluding with recommendations. Data for the research was collected from primary sources of existing end-of-semester examination scores.

To analyse the data, Pearson's Correlation Coefficient was utilized to examine the strength and direction of the relationship between the student's scores on the PBL and their final examination scores. This statistical method allowed for the quantification of the potential impact of the project on the student's performance in the final examination. In addition to the quantitative

analysis, a qualitative component was included in the study. A voluntary survey was administered to the students who took the course during the specific semester. The survey aimed to gather insights into the challenges associated with PBL, such as issues with student participation, commitment, and group dynamics. The data collected from the survey was analysed using thematic analysis, a method that involves identifying, analysing, and reporting patterns (themes) within the qualitative data. The 6 steps of coding proposed by Braun and Clarke (2019) used in this study to explore the major themes regarding the impact of PBL and examination scores is presented in Figure 1.

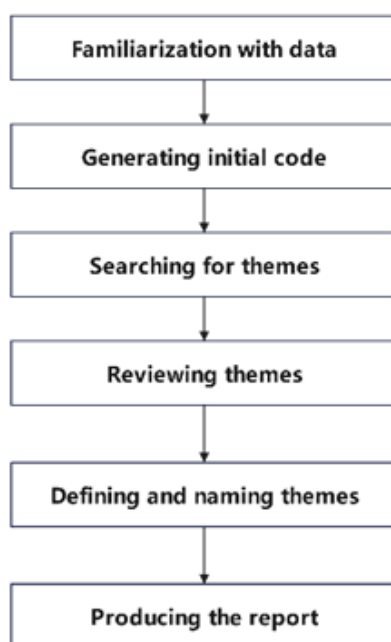


Figure 1: Thematic analysis steps adapted from Braun and Clarke (2019).

3. Results and Discussions

This study employs a mixed-methods approach, using correlation analysis and thematic analysis to examine the impact of PBL on students' examination scores. The correlation analysis results are shown in Table 1.

Table 1: Pearson's coefficient between PBL and final examination scores

	n	r	p-value
Final examination score	173	0.201	0.006

The Pearson correlation coefficient (r) of 0.207, with a p-value of 0.006, indicates a statistically significant positive correlation between students' PBL scores and final examination scores. However, the correlation is weak, suggesting that while there is a tendency for higher PBL scores to be associated with higher final examination scores, the relationship is not strong. This is supported by a study done by Li et al. (2021) to map the correlation between different types of assessments with students' final examination scores which reveals that the correlation between PBL and final examination score is weak compared to the correlation between assignment and term test with final examination score. This weak correlation can be attributed to several challenges inherent in PBL that may affect its effectiveness as a predictor of student performance in examinations. This also suggests that group work assessment is less effective in predicting students' final examination performance, in compared to individual assessment.

This is supported by various studies (Li et al., 2021; Hafeez, 2022) for which the key issues resulting in its weak correlation include variability in individual contributions within group projects, differences in student's learning styles and engagement levels, and disparities in technical and practical skills. Additionally, subjective assessment criteria in PBL and misalignment of learning objectives with the assessment design further weaken this relationship. External factors, such as insufficient instructor preparedness and ineffective monitoring, exacerbate these challenges.

In delving in-depth exploration of the challenges present, a thematic analysis was carried out to support the quantitative data findings. This analysis explores the challenges faced by students in carrying out PBL group projects.

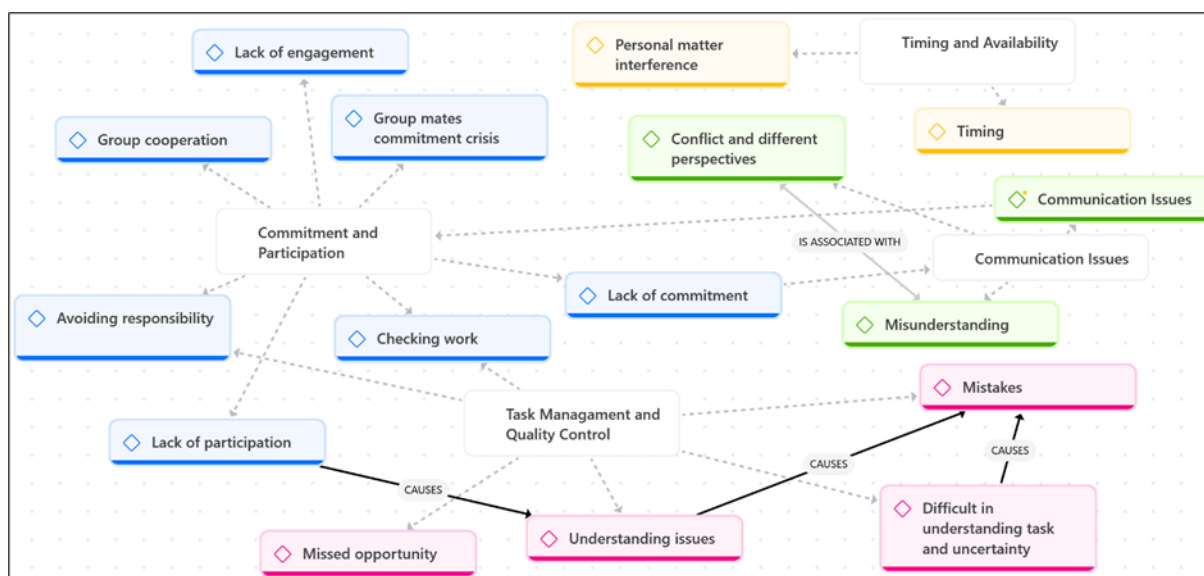


Figure 2: A thematic map on challenges of PBL ran by atlas. ti.

The analysis is based on qualitative responses from students through a voluntary survey, highlighting four main themes (challenges): Communication Issues, Commitment and Participation, Task Management and Quality Control, and Timing and Availability, which is shown in the thematic map in Figure 2. The highlighted challenges faced by students are recorded and discussed as follows.

Challenge 1: Communication Issues

Students frequently reported problems with communication within their groups. One respondent mentioned, "We just do our work and rarely discuss," indicating a lack of collaborative communication. Another respondent noted, "Miscommunication, misunderstanding, and solo rider," highlighting how poor communication leads to misunderstandings and isolation in group tasks. These issues are exacerbated by differing perspectives, as one student said, "Different ways of thinking might be why we argue a lot." Poor communication among group members can lead to misunderstandings, delays, and incomplete tasks as supported in other studies (Shamsiah et al., 2021; Hafeez, 2022). If communication issues persist, tasks may not be completed on time or maybe of poor quality, affecting the overall project outcome and potentially lowering scores on the final examination. Poor communication within groups, as evidenced by misunderstandings and isolation, disrupts collaboration and reduces the quality of project outcomes. This impacts the depth of learning, leaving students less prepared for final examination, and resulting in a weaker correlation value.

Challenge 2: Commitment and Participation

A significant number of students expressed concerns about the lack of commitment and participation from their group members. For example, "Group mates don't give commitment and are not serious when doing their work" and "Not all group members cooperate." Another detailed response described a member who "avoids meeting by giving various reasons" and contributes minimally to the project, illustrating the frustration caused by unequal participation. Varied levels of commitment among group members can lead to uneven workload distribution and a lack of engagement to support group work, as corroborated in recent research done by Meng et al. (2023) and Shamsiah et al. (2021). Less committed students may contribute less to the project, leading to incomplete tasks or lower-quality work. This can affect both the project grade and their understanding of the subject matter, impacting final examination scores negatively. Unequal participation creates an imbalance in workload and engagement. Students who contribute minimally are likely to gain less subject mastery, affecting their ability to perform well in the final examination. This inconsistency dilutes the predictive strength of PBL scores for final examination performance.

Challenge 3: Task Management and Quality Control

Ineffective task handling leads to incomplete or substandard projects, limiting students' understanding of key concepts. Poor project execution translates to weaker preparation for the examination, further reducing the strength of the correlation. One student noted, "Missed an important question for the questionnaire," pointing to oversight issues. Another respondent highlighted the lack of quality control, "Everyone should check each other's work, not just do their part." Ineffective task management can result in missed deadlines, scope creep, and poor-quality deliverables. If tasks are not managed effectively, the project may not meet expectations or address all required criteria. Shamsiah et al. (2021) noted that, despite discussions within groups, individual students may still find it difficult to comprehend ideas, concepts, and problems at the same level as other members. This can lead to lower project grades and insufficient preparation for topics covered in the final examination, consequently. This challenge highlights the need for effective facilitation and support to ensure all students can engage with and understand the material.

Challenge 4: Timing and Availability

Coordinating meeting times and managing personal commitments posed significant challenges. Scheduling conflicts hinder consistent collaboration and progress. This often results in rushed or incomplete work, preventing students from fully engaging with or understanding the material. Consequently, their examination performance suffers, weakening the correlation. Students mentioned difficulty in finding common meeting times due to personal obligations, such as "There are times when we can't meet up because some of us are either going out for outings or meeting their family." This theme underscores the impact of personal schedules on group project timelines. Conflicting schedules and availability issues can make it challenging for group members to meet and collaborate regularly, as indicated in Hafeez (2022). Limited availability can hinder progress on the project, delay feedback loops, and lead to rushed or incomplete work. As a result, students may not fully grasp the material covered in the project, affecting their performance on the final examination.

Interconnected Challenges

The thematic analysis also mapped out interconnected challenges, which means that one issue from the challenge can exacerbate another, in which, these issues are interlinked—communication problems exacerbate task management failures, which in turn affect participation and timing. This compounding effect disrupts learning outcomes, making PBL

less effective in predicting examination performance. For example, communication problems can lead to poor task management, which in turn can affect commitment and participation. This interconnectedness can have negative impacts on students' learning and final examination preparation and scores.

Based on the identified challenges, this research found that PBL can lead to an incomplete understanding of concepts, difficulty in applying knowledge, and inadequate individual preparation due to over-reliance on peers. Additionally, this approach may also limit practice with traditional examination questions, potentially hindering examination performance. The impact on final examination scores varies; students who are highly engaged and committed tend to achieve better understanding and perform well in both PBL assessments and examinations. In contrast, students with inconsistent participation may struggle with comprehension and achieve lower examination scores, despite potentially high group performance in PBL. This variability suggests that while PBL can enhance learning for some, it may also pose challenges for others, emphasizing the need for balanced assessment strategies that integrate both PBL and traditional methods. Thus, the following paragraphs discuss strategies and tips to effectively implement PBL, aiming to address these challenges and optimize learning outcomes

Recommended Strategies and Implementation Tips for Effective PBL

By incorporating strategies, instructors can create a more equitable and participatory PBL environment that encourages all students to contribute and commit to the group's work, ultimately leading to a stronger correlation between PBL scores and final examination scores. While PBL holds promise for enhancing students' performance and fostering experiential learning and knowledge retention, strategic planning and careful consideration are imperative for maximizing its benefits and mitigating potential drawbacks. Studies have shown that instructors may deliver clear explanations of rubrics and expected outcomes (Pang et al., 2021), monitor groups' milestones and progress with valuable feedback (Tai and Yuen, 2023), make peer evaluation part of the whole assessment, and require reflective journals as well as role rotation during presentations may improve the effective implementation of PBL (Meng et al., 2023) as presented in Table 2.

Table 2: Recommended Strategies and Implementation Tips for Effective Project-Based Learning (PBL)

Recommended Strategy	Implementation Tips
Delivery of clear expectation of outcome	Instructors to deliver expected outcomes may be in the form of rubric explanations and samples of completed projects to all groups and students. Define how the assessment will be carried out e.g. group assessment and individual assessment. Clear rubrics, project samples, and defined assessment methods, enhances group project performance by setting clear expectations, ensuring accountability, and motivating active participation for higher-quality outcomes.
Group project milestones	Instructors to monitor project milestones and progress for all groups. Outline interim checkpoints (dates or weeks) and the list of progress required at each checkpoint. This will help to reduce timing issues by keeping students on track, ensuring timely task completion, and preventing delays caused by scheduling conflicts. This fosters better time management, promotes steady progress, and reduces the risk of rushed work.
Peer evaluation	Instructors may implement a structured self and peer assessment process where students evaluate their contribution and that of their group members based on predefined criteria (e.g., attendance, participation, preparation, problem-solving skills). A structured self and peer assessment process may address free-riders and uneven commitment by fostering accountability, fair work distribution, improved engagement, and collaboration skills, and providing instructors with actionable insights to ensure balanced participation.

Observation and feedback by instructors	Instructors to observe and provide prompt feedback along the process of groups' preparation in completing the project. The observation and prompt feedback throughout the project preparation process helps improve group work by guiding students, addressing issues early, and ensuring high-quality contributions, leading to better collaboration and project outcomes.
Individual reflective journals	<p>Instructors may conduct individual reflective journals or exit tickets to all students, where each student or group members write their reflection on their group's progress, as well as an understanding of the whole process taking place in the completion of the project. Journals should include what they learned, their contributions to the group, challenges faced, and how they overcame them, which will later be graded and be part of the whole assessment scores.</p> <p>By having students reflect on their contributions, challenges faced, and learning outcomes, instructors gain valuable insights into individual progress and group dynamics. This strategy promotes self-awareness, reinforces learning, and helps identify areas where students may need additional support. Additionally, grading these reflections as part of the overall assessment ensures that students take the process seriously, enhancing both personal accountability and deeper engagement with the project.</p>
Group presentation & role rotations	Instructors may assign each task to all group members, instead of the group members choosing by themselves. During the group presentation, instructors may select the presenter to present parts from the presentation randomly and may conduct role rotation, to avoid having the same student or group member present only the task they did for the project, rather than to understand the project completely. By assigning tasks and using random presentation roles ensure equitable participation, enhance understanding, and allow instructors to monitor performance, commitment, and group dynamics effectively.

4. Conclusion

PBL aims to enhance learning through hands-on projects, but challenges in communication, commitment, task management, and timing can detract from its effectiveness. If these issues persist throughout the project, students may not fully comprehend the subject matter covered in the project, leading to lower scores on the final examination. Conversely, effective management of these factors can enhance learning outcomes, ensuring students are well-prepared for the final examination by reinforcing understanding through practical application and collaboration.

This research contributes to the theoretical understanding of PBL by highlighting the impact of specific challenges on learning outcomes. It extends existing theories on PBL by demonstrating how communication commitment, task management, and timing can influence both project performance and examination results. This research suggests that while PBL can be a powerful pedagogical approach, its effectiveness is contingent upon the effective management of these challenges. Practically, the results of this research can be utilized to enhance project-based educational practices and raise awareness, leading to improvements in learning quality.

Additionally, future studies should explore how different types of PBL (e.g., individual vs. group-based) or other forms of assessment influence final examination performance. Investigating whether individual PBL tasks yield stronger correlations with examination success compared to group-based approaches or analysing the effectiveness of PBL alongside traditional assessments like tests or quizzes, could provide deeper insights. This understanding would help refine PBL implementation strategies, optimize assessment designs, and develop interventions tailored to address specific challenges, ultimately improving student learning outcomes and academic success.

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