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Project-Based Approach as Methodology to Improve Academic Performance of Medical School Students Within the Research Line Teaching Course: A Quasi-Experimental Study

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ABSTRACT

Background and Aims: Traditional teaching methods in medical education often fail to engage students or foster critical research skills required for evidence-based medicine. Project-based learning (PBL) is widely recognized for promoting active learning and improving academic performance, although its application in research-focused medical courses remains under-explored, especially in low-resource settings. This study aimed to evaluate the effectiveness of PBL in enhancing academic performance and originality compared to traditional literature review-based assessments.

Methods: A quasi-experimental study was conducted between March 11, 2024 and May 31, 2024, with 179 twelfth-semester medical students divided into two groups: the experimental group (PBL approach, $n = 108$) and the control group (literature review-based approach, $n = 71$). Students in the PBL group completed the full research cycle, including topic selection, data collection, analysis, research paper formulation, while the control group focused on synthesizing existing literature. Academic performance (course grades) and originality (Turnitin similarity percentage) were measured. Data were analyzed using descriptive statistics and independent samples t-tests, with a significance threshold of $p < 0.01$.

Results: The PBL group demonstrated significantly higher academic performance (mean: 82.5, median: 85) compared to the control group (mean: 66.5, median: 63.75; $t(177) = -20.53$, $p < 0.01$). Similarly, originality improved significantly in the PBL group, with lower similarity scores (mean: 4.17%, median: 4.5%) than the control group (mean: 12.62%, median: 13%, $t(177) = 13.74$, $p < 0.01$). Variability in academic performance was slightly higher in the PBL group (standard deviation: 5.80 vs. 4.81), reflecting the individualized nature of PBL.

Conclusion: This study confirms that PBL significantly enhances academic performance and fosters originality among medical students, particularly in research-focused courses. The findings underscore the potential of PBL as a transformative approach to medical education, addressing gaps in traditional methods while aligning with global trends in evidence-based practice and academic integrity. PBL is recommended as an adaptable and effective strategy, especially in resource-limited educational settings.

1 | Introduction

The need for innovative educational approaches in medical schools is increasingly evident, as traditional teaching methods often fail to engage students and enhance their academic performance [1]. Research skills are essential for medical students, not only for their academic success but also for their future professional practice. Evidence-based medicine (EBM) requires medical professionals to acquire, critically evaluate, and apply the most reliable research evidence in clinical work [2]. Engaging in research activities, such as conducting research projects during medical training, equips students with essential skills for EBM.

Project-based learning (PBL) is widely recognized for its ability to promote active learning and improve academic performance [3]. Despite its success in various educational fields, its role in medical education, particularly in research-focused courses, remains underexplored [4–6]. Recent studies further emphasize the benefits of PBL in medical education, highlighting its contribution role to critical thinking, collaboration, and practical research skills [7–9]. For example, PBL has been shown to foster deeper learning and higher knowledge retention in medical students compared to lecture-based approaches [9]. Additionally, integrating PBL into educational curricula enhances research capabilities and improves students' ability to engage in independent scientific inquiry [10, 11]. Studies have also demonstrated that PBL improves student engagement, critical analysis skills, and the practical application of theoretical knowledge [12]. While the overall effectiveness of PBL has been widely documented, its application in specific contexts, such as research-focused courses, and its role in addressing challenges like originality and academic performance, requires further investigation. Moreover, in low-resource settings, PBL implementation faces barriers such as limited faculty training, inadequate infrastructure, and insufficient mentorship quality. This study aims to evaluate these nuanced aspects of PBL, focusing on its potential to bridge gaps in fostering research skills and integrity among medical students. Unlike traditional literature review-based assessments that emphasize passive learning [13], PBL actively engages students, fostering originality and deeper comprehension [14]. With increasing global emphasis on research integrity, particularly in the era of technology-driven education [15] this study provides a timely evaluation of PBL's effectiveness in fostering essential research skills among medical students. Thus, this study aims to evaluate the impact of a PBL approach on academic performance and originality among medical students, demonstrating its effectiveness in promoting deeper understanding and critical engagement in research-focused courses. To guide this study, the following research questions were formulated:

Research Question 1—How does the PBL approach affect academic performance in research-focused medical courses compared to the literature review-based approach?

Research Question 2—Does the PBL approach enhance originality, as measured by similarity scores, compared to the literature review-based approach?

Considering these research questions the following hypothesis were proposed:

Hypothesis 1. *Students engaged in the PBL approach will achieve significantly higher academic performance scores than those using the literature review-based approach.*

Hypothesis 2. *Students in the PBL group will produce research papers with significantly lower similarity scores* (*indicating higher originality*) *compared to the literature review group.*

This study is grounded in constructivist learning theory, which posits that learners actively construct knowledge through meaningful interactions with their environment [3, 16]. PBL aligns with this framework by emphasizing real-world problem-solving and active engagement, allowing students to develop a deeper understanding of the subject matter [1, 7]. Additionally, the study draws on self-determination theory (SDT), which highlights the importance of autonomy, competence, and relatedness in fostering intrinsic motivation and higher engagement. This theoretical foundation supports the premise that PBL enhances academic performance and originality in research-focused medical education.

2 | Materials and Methods

2.1 | Study Design

This quasi-experimental study aims to address the gap in understanding the effectiveness of PBL in research-focused medical courses. It evaluates whether PBL enhances academic performance and promotes originality compared to traditional literature review-based assessments. The study was conducted between March 11, 2024 and May 31, 2024, involving two groups of twelfth-semester students in a single-step medical curriculum.

2.2 | Subjects' Characteristics

A total of 179 students participated, with 71 students in the control group (literature review-based approach) and 108 students in the experimental groups (PBL approach). All students had similar educational backgrounds, having completed courses such as “Academic Writing,” “Introduction to Medical Research,” “Critical Thinking,” and “Biostatistics and Scientific Report.” Additionally, all participants were enrolled in clinical subjects and had exposure to basic and diagnostic sciences, clinical environments, and clinical reasoning sessions.

2.3 | Study Intervention

The intervention was designed to incorporate PBL principles for students in the experimental group. The intervention steps included:

2.4 | Topic Selection and Problem Formulation

Students in the PBL group selected healthcare topics relevant to clinical practice. Faculty mentors guided them in refining research questions and hypotheses based on current medical

research trends. In contrast, the literature review group followed a structured approach, focusing on synthesizing existing literature under faculty supervision.

2.5 | Study Design and Proposal Development

PBL group students designed the full research cycle, including methodologies, data collection plans, and analysis strategies. This stage involved workshops on research methods, data analysis, and ethical considerations. Mentors provided feedback to ensure projects adhered to academic and ethical standards.

2.6 | Data Collection and Analysis

PBL students collected data through clinical observations, surveys, or systematic literature reviews. They used statistical tools, such as SPSS, for data analysis and interpretation. Literature review students gathered and synthesized secondary data, following structured guidelines provided by mentors. Both groups submitted structured research papers while adhering to academic integrity standards. Turnitin software was used to evaluate originality, with a maximum allowable similarity threshold of 20%.

2.7 | Workshops and Trainings

All students participated in interactive workshops on academic writing, research integrity, and critical analysis of results. These workshops ensured consistency in training for both groups.

2.8 | Outcome Measures

The study assessed: (a) academic performance, measured through course grades assigned to research papers; (b) originality, evaluated by Turnitin similarity percentages.

2.9 | Statistical Analysis

Descriptive and inferential statistics were used to analyse the collected data. Mean, median, and standard deviations summarized performance and similarity indices. Shapiro-Wilk test confirmed normal data distribution in both groups. An independent samples t-test compared the means of academic performance and originality (similarity scores) between the control and experimental groups. A p-value of < 0.01 was considered statistically significant, confirming the effectiveness of the PBL approach.

2.10 | Ethical Considerations

Ethical clearance was obtained from the Bioethics International Committee of the Petre Shotadze Tbilisi Medical Academy (identification code: 20240503/01, Tbilisi, Georgia). All procedures adhered to the Helsinki Declaration of 1975, revised in 2013. Participants received comprehensive study information and provided written informed consent before inclusion.

3 | Results

The study evaluated the effectiveness of the PBL approach compared to the traditional literature review-based assessment in a cohort of 179 twelfth-semester medical students. The students were divided into two groups: the control groups ($n = 71$), which followed a literature review-based assessment approach, and the experimental groups ($n = 108$), which engaged in the PBL methodology. The primary outcomes measured were academic performance (course grades) and originality (similarity percentages assessed via Turnitin).

Students in the experimental group demonstrated significantly higher academic performance than those in the control group (Table 1). The mean academic performance score for the PBL group was 82.5, with a median of 85, compared to the control group's mean score of 66.5 and a median of 63.75. This improvement was statistically significant ($t(177) = -20.53$, $p < 0.01$). This substantial difference suggests that the PBL approach fosters deeper engagement, critical thinkings, and practical understanding, ultimately enabling students to achieve better academic outcomes.

The originality of research papers, as measured by similarity percentages, showed significant improvement in the PBL group (Table 2). The mean similarity percentage in the control group was 12.62%, with a median of 13%, indicating moderate originality. In contrast, the PBL group achieved a mean similarity score of 4.17% and a median of 4.5%, reflecting a higher level of originality and critical engagement with research tasks. The difference was statistically significant ($t(177) = 13.74$, $p < 0.01$). These findings highlight the effectiveness of the PBL approach in fostering independent thought and promoting original contributions to academic research. Compared to the structured and guided literature review method, PBL encourages students to critically engage with research material and develop their analytical skills.

The variability in scores, as reflected by the standard deviations, was slightly higher in the PBL group for academic performance (5.80 vs. 4.81), although lower for originality (2.48 vs. 5.48). This suggests that while PBL allows for individualized outcomes, it fosters more consistent originality in research outputs. These

TABLE 1 | Academic performance.

Academic performance	Control group ($n = 71$)	Experimental group ($n = 108$)
Mean	66.5	82.5
Median	63.75	85
Standard deviation	4.81	5.80

TABLE 2 | Originality, similarity % defined by Turnitin.

Originality (similarity % defined by Turnitin)	Control group ($n = 71$)	Experimental group ($n = 108$)
Mean (%)	12.62	4.17
Median (%)	13	4.5
Standard deviation (%)	5.48	2.48

findings indicate that the flexibility of PBL supports diverse academic performance levels, enabling students to engage with research tasks at their own pace while maintaining high standards of originality.

4 | Discussion

The results of this study confirm the hypotheses, demonstrating that PBL significantly enhances both academic performance and originality compared to traditional literature review-based methods. While statistical significance is evident, the practical implications of these findings provide valuable insights for medical education. This aligns with broader literature, which highlights the effectiveness of PBL in promoting active learning, deeper engagement, and practical application of knowledge in medical education [7, 8, 16, 17].

4.1 | Impact on Academic Performance

Students in the experimental group achieved significantly higher academic performance (mean: 82.5, median: 85) compared to the control group (mean: 66.5, median: 63.75). This supports Hypothesis 1, indicating that students engaged in PBL outperform those using the literature review-based approach. The improvement in academic performance reflects PBL's ability to immerse students in the learning process, encouraging critical thinking and active problem-solving [7, 8, 16]. These findings align with recent studies emphasizing how PBL fosters knowledge retention, enhances motivation, and supports the development of research competencies [9, 10]. Unlike prior studies [4, 5], which reported inconsistent academic benefits of PBL in medical education due to variability in faculty engagement, our findings suggest that structured mentorship and targeted faculty training significantly enhance PBL's effectiveness. This underscores the importance of proper implementation strategies to maximize its impact on student outcomes. To translate these findings into real-world applications, structured PBL sessions can improve student engagement and self-directed learning [18]. For example, medical schools that integrate PBL-based research training may see enhanced student participation, stronger analytical reasoning, and better application of EBM in clinical settings.

4.2 | Enhancement of Originality

The PBL approach significantly reduced the similarity percentage of submitted research papers (mean: 4.17%, median: 4.5%) compared to the literature review-based group (mean: 12.62%, median: 13%). This validates Hypothesis 2, confirming PBL's effectiveness in fostering originality. By engaging in the full research cycle—from topic selection to data analysis—students in the PBL group were better equipped to critically evaluate and synthesize information rather than merely reproduce existing content. These findings contrast with prior research [14, 15], which suggested that medical students often struggle with originality due to reliance on secondary sources. Our study shows that integrating PBL with structured research methodologies encourages independent inquiry and minimizes plagiarism risks, reinforcing academic integrity.

4.3 | Contextual Relevance and Novelty

While PBL is well-documented as an effective pedagogical method, its application in research-focused medical courses remains underexplored, particularly in low-resource settings. This study demonstrates that PBL can be successfully implemented even in resource-limited environments. Through structured mentorship and targeted workshops, the PBL approach addressed challenges such as limited infrastructure and variability in faculty expertize. This adaptability makes PBL a viable strategy for advancing medical education globally, especially in contexts where traditional methods fall short [4, 5]. Unlike previous studies [7, 19], which highlighted difficulties in adapting PBL to resource-limited settings due to a lack of faculty support, our results suggest that with targeted training and structured implementation PBL can be successfully applied even in low-resource environments. This challenges prior assumptions that PBL is only feasible in well-funded institutions.

4.4 | Alignment With Theoretical Frameworks

This study's findings align with constructivist learning theory, which posits that learners construct knowledge through active engagement and meaningful interactions with their environment [1, 3]. PBL's emphasis on real-world problem-solving supports this framework, enabling students to develop a deeper understanding of research concepts and methodologies. Additionally, the study draws on SDT, which highlights the importance of autonomy, competence, and relatedness in fostering intrinsic motivation. By giving students control over their research projects and providing consistent mentorship, PBL created a learning environment that supports these psychological needs, enhancing engagement and outcomes [7, 16].

4.5 | Variability in Outcomes

The variability observed in academic performance (standard deviation: 5.80 for PBL vs. 4.81 for the control group) reflects

the individualized nature of PBL. Unlike standardized assessments, PBL encourages independent inquiry and personalized contributions, resulting in a broader range of outcomes [6]. Despite this variability, the overall gains highlight PBL's strength in fostering critical thinking and student autonomy—key attributes for future medical professionals and researchers [12, 19, 20]. Unlike studies that raised concerns about the variability of PBL effectiveness across different student groups [21], our findings indicate that structured mentorship and a well-designed PBL framework can ensure consistent academic benefits.

4.6 | Challenges and Limitations

Implementing PBL requires careful planning, faculty training, and adequate infrastructure to support student performance. Challenges such as time constraints, resource limitations, and variability in mentorship quality must be addressed to maximize PBL's potential [19, 21]. While this study provides valuable insights, its short duration and cross-sectional design limit the ability to assess long-term impacts. Future research should examine whether PBL-driven improvements in academic performance and originality persist over time and explore how best to scale PBL in diverse educational settings.

5 | Conclusion

This study confirms that PBL improves academic performance and fosters originality among medical students. The enhanced engagement, critical thinking, and research skills observed in the PBL group demonstrate its potential as an effective pedagogical approach in medical education. Given these benefits, integrating PBL into medical curricula, particularly in low-resource settings, is strongly recommended. Our study provides evidence that structured faculty training and mentorship enable its successful implementation in diverse educational contexts. Medical educators should consider adopting PBL methodologies to enhance student engagement, originality, and evidence-based research practices. By emphasizing active learning and research integrity, PBL aligns with global educational priorities and prepares students for the evolving demands of medical practice and research.

Author Contributions

E.K. and M.Z. performed activities. I.A. made statistical analysis. All authors reviewed the manuscript. All authors have read and approved the final version of the manuscript. Corresponding author has full access to all of the data in this study and takes complete responsibility for the integrity of the data and the accuracy of the data analysis.

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Ethics Statement

Ethical clearance was secured from the Bioethics International Committee of the Petre Shotadze Tbilisi Medical Academy (identification code: 20240503/01, Tbilisi, Georgia). All procedures adhered to the Helsinki Declaration of 1975, revised in 2013.

Consent

All participants received comprehensive study information and provided written informed consent before inclusion.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The authors have nothing to report.

Transparency Statement

The lead author Ekaterina Kldiashvili affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

Declaration of Generative AI and AI-Assisted Technologies

During the preparation of this paper the authors used ChatGPT (https://chat.openai.com/) for stylistic purpose, checking grammar and spelling. After using this tool the authors reviewed and edited the content, they take full responsibility for the content of the publication.

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