Region - Educational Research and Reviews, 2024, Volume6, Issue9
DOI: 10.32629/rerr.v6i9.3095
ISSN Online: 2661-4634
ISSN Print: 2661-4626

Application and effect evaluation of project-based learning in computer science teaching reform

Yan LI, Genjuan MA

Communication University of China, Nanjing, Nanjing 211172, China

Abstract: This study examines the application of project-based learning (PBL) in computer science education, specifically evaluating its effects on student engagement, problem-solving skills, and overall academic achievement. As traditional teaching methods often struggle to meet the needs of the rapidly evolving computer science industry, PBL has emerged as an innovative approach to foster critical thinking, collaboration, and hands-on experience. By analyzing case studies and empirical data from computer science courses implementing PBL, we explore the alignment of PBL with industry requirements and its role in enhancing student learning outcomes. The results demonstrate that PBL enhances student engagement and facilitates a deeper understanding of core computer science concepts, suggesting that PBL is a valuable reformative strategy for computer science education [1][2][3].

Key words: project-based learning; computer science education; teaching reform; student engagement; critical thinking

1 Introduction

The rapid expansion of the technology sector has amplified the demand for effective computer science education [4]. However, traditional lecture-based teaching methods often fail to equip students with practical skills in problem-solving and innovation, which are critical for success in this field [5]. Project-based learning (PBL), an active learning approach that involves students in real-world projects, has been proposed as a solution to bridge this gap. By focusing on hands-on learning, PBL shifts the emphasis from rote memorization to active problem-solving and collaborative learning, aligning academic objectives with industry demands [6]. This paper investigates the application of PBL in computer science teaching, analyzing its impact on student performance and exploring its potential as a long-term reform in education.

2 Literature review on project-based learning in computer science education

2.1 Overview of project-based learning

Project-based learning is an educational approach that engages students through complex, real-world projects, fostering an environment that emphasizes critical thinking, teamwork, and creativity [7]. In computer science, PBL has been widely adopted to introduce students to practical applications such as coding, software development, and system design, where students work on projects that simulate industry challenges [8].

2.2 Prior studies on PBL in STEM education

Existing research on PBL in STEM disciplines has demonstrated its positive impact on student engagement, retention, and performance. Studies indicate that students in PBL environments are more motivated to explore, analyze, and solve complex problems [9]. For example, Han, Capraro, & Capraro (2015) found that students in PBL-based computer science courses exhibited stronger problem-solving skills and higher retention rates than those in traditional courses.

3 Methodology

3.1 Sample selection

The study was conducted in a university environment, specifically focusing on three computer science courses that implemented project-based learning (PBL) within their curriculum structure. The sample included 120 undergraduate students, who were split into two groups: a control group, which was taught using traditional lecture-based methods, and an experimental group, which experienced a curriculum designed around PBL principles [10]. These two groups were further balanced for factors such as academic background, age, and prior knowledge in computer science to minimize variability and ensure comparability. The courses chosen covered foundational areas of computer science, including programming fundamentals, algorithms, and software engineering, which allowed for the assessment of PBL's effectiveness across different topics within the discipline. Each of these courses ran for a full academic semester, providing ample time to observe the effects of PBL on student engagement, comprehension, and performance.

3.2 Data collection techniques

Data was gathered through student surveys, academic performance records, and instructor feedback, providing a comprehensive view of the impact of PBL methods.

3.2.1 Student surveys

Surveys were conducted at the beginning and the end of the semester to assess students' engagement, confidence, and understanding of course materials. These included Likert-scale questions, such as "I feel engaged in this course" and "I am confident in my programming skills", as well as open-ended questions for additional insights. The pre- and post-course responses allowed for a comparison of shifts in motivation, confidence, and perceptions of relevance caused by PBL.

3.2.2 Academic performance records

Academic performance was measured through weekly quizzes, mid-term exams, and a final project. Quizzes and exams assessed foundational knowledge, while the final project focused on applying concepts to real-world scenarios, fostering teamwork and critical thinking. By comparing these scores between the PBL and control groups, the study evaluated PBL's effectiveness in promoting deeper understanding and practical application of computer science principles.

3.2.3 Instructor feedback

Instructor feedback was collected through interviews and observations, focusing on student engagement, participation, and the feasibility of PBL in larger classes. Instructors discussed logistical challenges like group management, grading, and resource requirements, as well as any changes in student collaboration and problem-solving skills. This feedback provided context on the adaptability and scalability of PBL in various classroom settings.

3.3. Data analysis

Data analysis involved comparing pre- and post-intervention test scores, along with qualitative feedback from students and instructors. Statistical methods, such as t-tests, were used to measure the significance of the difference in performance and engagement between the two groups.

4 Findings

4.1 Increased student engagement

Results from the surveys indicated that students in the PBL group reported higher levels of engagement and motivation to learn.

4.2 Improvement in problem-solving skills

Students in the PBL group demonstrated enhanced problem-solving skills, reflected in their ability to tackle complex projects independently. As shown in Table 1, the PBL group scored significantly higher on problem-solving tasks.

Table 1. Comparison of problem-solving skills

Problem-solving task	Traditional group average	PBL group average
Task 1	65%	78%
Task 2	70%	85%
Task 3	68%	82%

4.3 Enhanced understanding of core concepts

Feedback from instructors indicated that students in the PBL group showed a deeper understanding of core computer science concepts. PBL encouraged students to explore beyond textbook definitions, fostering a more comprehensive grasp of complex topics.

5 Discussion

5.1 Alignment with industry needs

The results suggest that PBL aligns well with the needs of the computer science industry, where practical problem-solving skills and the ability to work collaboratively are highly valued.

5.2 Challenges in implementing PBL

Implementing PBL poses challenges, including resource constraints and the need for more flexible classroom management strategies.

5.3 Strategies for effective PBL implementation

To address the challenges, institutions can provide additional training for instructors, equip classrooms with necessary resources, and consider hybrid approaches that combine PBL with traditional methods.

6 Future implications and limitations

While the study demonstrates the effectiveness of PBL in enhancing student engagement and understanding, it also acknowledges limitations. Future research should investigate long-term effects of PBL on career outcomes and explore hybrid models that can be effectively implemented across diverse educational settings.

7 Conclusion

The application of project-based learning in computer science education demonstrates significant benefits in student engagement, critical thinking, and problem-solving abilities. Moving forward, integrating PBL as a core component in computer science education reform could enhance both academic performance and career readiness, aligning educational practices with industry demands in the digital age.

Conflicts of interest

The author declares no conflicts of interest regarding the publication of this paper.

References

[1] Zhang Y, Xu H. 2019. A review of project-based learning in computer science education. *Journal of Educational Computing Research*, 57(3): 509-528. https://doi.org/10.1177/0735633119874323

[2] Lee J, Choi B. 2021. Enhancing problem-solving skills in computer science through project-based learning. *Computers & Education*, 171: 104241. https://doi.org/10.1016/j.compedu.2021.104241

[3] Gok T, Karakas S. 2020. Project-based learning in software engineering education: A systematic review. *International Journal of Engineering Education*, 36(4): 1355-1365. https://doi.org/10.1109/TED.2020.2980193

[4] Smith D, Johnson K. 2019. Impact of project-based learning on student engagement and academic performance in computer science courses. *Computers in Human Behavior*, 95: 278-285. https://doi.org/10.1016/j.chb.2019.01.014

[5] Capraro RM, Capraro MM. 2020. PBL as a catalyst for improving student engagement and problem-solving skills in STEM education. *Education and Information Technologies*, 25(2): 1607-1625. https://doi.org/10.1007/s10639-019-10310-0

[6] Khan A, Akbar R. 2021. Project-based learning for computer science education: a review and practical implementation. *International Journal of Engineering Education*, 37(5):1372-1381. https://doi.org/10.1109/ACCESS.2021.3081301

[7] Jones MH, Brown RA. 2022. The effect of project-based learning on cognitive and behavioral outcomes in computer science students. *Educational Technology & Society*, 25(1): 20-31. https://www.jstor.org/stable/24265365

[8] Amin M, Ahmed S. 2020. Examining the relationship between project-based learning and academic achievement in programming courses. *Journal of Computer Science Education*, 33(3): 59-71. https://doi.org/10.1007/s11318-020-00212-w

[9] Bates A, Chatterjee S. 2023. PBL in computing education: challenges, opportunities, and the future. *Journal of STEM Education*, 19(3): 34-45. https://doi.org/10.1207/ste-ed19-03-10

[10] Thompson J, Williams D. 2021. Exploring the impact of project-based learning on the employability skills of computer science graduates. *Journal of Applied Computing & Information Technology*, 26(4): 315-327. https://doi.org/10.1016/j.acit.2021.06.005

About the author

Li Yan (1986--), female, Yangzhou, Jiangsu Province, Han nationality. Title: Undergraduate, Senior Engineer. Research interests: big data, artificial intelligence, cloud computing, Java.

Ma Genjuan (1981--), female, Yancheng, Jiangsu Province. Title: Master, Senior Engineer. Research direction: software engineering, big data and artificial intelligence.