Student Learning Achievement by using Project-Based Learning (PBL) of the Architectural Course at Chongqing Yucai Vocational Education Center, He Chuan District, China

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Abstract

The objectives of this study were to 1) compare students' learning achievement before and after PBL implementation using pre-test and post-test comparisons, 2) measure learning outcomes against a 75% mastery criterion, and 3) evaluate student satisfaction with the PBL approach. This research was a quantitative study. The conceptual framework of this research was applied to educational psychology theories related to active learning and constructivism. The population consists of 1,200 students enrolled in architectural courses in the He Chuan District, China. The samples were 291 students, as determined by Krejcie and Morgan's formula. The research instrument was a combination of surveys and tests. Statistics used for data analysis were descriptive statistics, t-tests, and satisfaction indices.

The results of this study found that: 1) there was a significant improvement in learning achievement between pre-test and post-test scores; 2) a majority of students met or exceeded the 75% mastery criterion; and 3) students reported high levels of satisfaction with the PBL approach, noting its relevance to real-world applications, opportunities for interdisciplinary work, and the supportive role of instructors.

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Introduction

The transition to Project-Based Learning (PBL) within Architectural course in He Chuan District, Chongqing, China, signifies a pivotal shift towards practices that accommodate the dynamism of the architectural profession. This shift, as Chen, Kolmos, and Du (2020) articulate, is an essential response to the burgeoning need for graduates who are theoretically proficient and adept in practically applying their knowledge. PBL presents an avenue through which students can integrate theoretical learning with practical experience, engaging directly with the complexities of architectural projects. The adoption of PBL, as evidenced in He Chuan District, is driven by a strategic need to prepare future architects capable of shaping the built environment in an era characterized by rapid technological change and global connectivity.

This emerging pedagogical narrative is underscored by the relevance of the PBL framework, which invites students to tackle real-world architectural problems, fostering a collaborative and project-driven learning environment (Chen et al., 2020). This educational paradigm aspires to cultivate creativity, critical thinking, and problem-solving skills, indispensable for architects who translate theoretical concepts into tangible societal contributions.

The imperative of exploring PBL within an Architectural course becomes apparent when considering the profession's distinct demands. Traditional lecture-based learning models are often criticized for their limitations in imparting the nuanced skills essential in architecture, where practical experience and effective collaboration are paramount (Chen et al., 2020). PBL addresses this educational shortfall by promoting active, student-centered learning that closely simulates real-world architectural practice. This approach aligns with the expectations of modern architectural practice and embeds digital literacy, a competency that is becoming increasingly crucial as the field transitions into the digital age (Li, 2020).

However, the effectiveness of PBL in architectural courses, particularly within the unique context of He Chuan District, is not yet fully comprehended. This research seeks to elucidate PBL's impact on students' learning achievements, focusing on practical skill development, engagement with course material, and overall academic performance. Integrating digital tools within PBL, a facet explored by Li (2020) in the context of software architecture education, promises further insight into the contemporary Architectural course landscape, where digital tools are integral to the learning process.

The imperative for this study emerges from a discernible void in empirical evidence concerning the efficacy of Project-Based Learning (PBL) within architectural courses, particularly within the context of He Chuan District. While the merits of PBL are extolled in broader educational literature, studies such as those by Almulla (2020), Chen et al. (2020), and Li (2020) primarily offer insights from a theoretical or anecdotal standpoint, without substantial focus on the empirical assessment of PBL in this specific educational milieu.

This research is intended to address this lacuna by meticulously evaluating the impact of PBL on the academic and practical achievements of architectural students in He Chuan District. The exploration will pivot around core questions: Can Almulla's (2020) assertions regarding enhanced student engagement through PBL be empirically validated in this context? Does the integration of digital tools in PBL, as suggested by Li (2020), lead to a tangible elevation in students' learning experiences and outcomes?

Additionally, the adoption of PBL in pedagogy, as Lamela (2020) discussed, predicates the assumption of its positive impact on independent learning and skill development. This study seeks to test that hypothesis, examining whether the cooperative and student-driven methods observed by Lamela (2020) are replicable and beneficial in the architectural courses of He Chuan District.

The research will also scrutinize the extent to which PBL contributes to students' work readiness, an aspect that Mandal and Edwards (2021) suggest is crucial in the local workplace context. It will investigate the alignment of PBL with the needs of the modern architectural landscape, where, as per the findings of Olweny et al. (2022), educational pedagogy must demonstrate flexibility and resilience in the face of global challenges such as the COVID-19 pandemic.

The literature also suggests a need for studies assessing the effectiveness of PBL in fostering academic achievement, practical skills, and work readiness among architectural students. For instance, Delbert, Stepansky, and Lekas (2020) highlighted the importance of experiential learning frameworks in education. However, their application and efficacy in the specific domain of Architectural courses in He Chuan require empirical validation.

Additionally, the potential of PBL to enhance student engagement, as discussed by Eswaramoorthi et al. (2022), raises questions about its application in architectural courses and whether it translates into improved learning achievements and skills retention. This is particularly relevant in the wake of educational disruptions caused by the COVID-19 pandemic, as noted by Olweny, Ndibwami, and Ahimbisibwe (2022) in their reflections on emergency remote learning.

Furthermore, the societal and environmental consciousness, as discussed by Fatherly, Thomas, and White (2021), when implemented in architectural courses, could offer insights into the curriculum's capacity to enrich students' awareness and responsiveness to contemporary issues, a facet yet to be thoroughly examined in the context of PBL in Architectural course.

Research Questions

1. How does implementing PBL in the He Chuan District architectural course affect students' learning achievements as measured by pre-test and post-test comparisons?

2. Does students' learning achievement in the He Chuan District architectural course meet the 75% criteria after engaging in PBL?
3. What is student satisfaction with the architectural course of He Chuan District when PBL is used as the teaching method?

Research Objectives

1. To compare learning achievement in the Architectural course of Chongqing Yucai Vocational Education Center in China.
2. To compare learning achievement in the Architectural course of Chongqing Yucai Vocational Education Center in China.
3. To study student satisfaction with the Architectural course of Chongqing Yucai Vocational Education Center in China.

Research Hypothesis

H1: Students in the He Chuan District architectural course will demonstrate a statistically significant improvement in learning achievements on post-tests after implementing PBL compared to their pre-test scores.

H2: A significant proportion of students in the He Chuan District architectural course will achieve a learning achievement that meets or exceeds the 75% criteria after participating in PBL.

H3: Students will report high levels of satisfaction with the architectural course of He Chuan District when taught using PBL methodologies.

Theory and Concept of Project-Based Learning (PBL)

Project-based learning (PBL) has garnered substantial attention in educational research, with many scholars advocating for its effectiveness across various learning environments. Almulla (2020) emphasizes the engaging nature of PBL, particularly its ability to foster a profound learning experience. This engagement is pivotal to the approach, which Al-Qora'n (2021) and Al-Qora'n, Jawarneh, and Nganji (2023) extend to the realms of software architecture through the use of social networking sites and cloud storage, highlighting the adaptability of PBL to incorporate modern technologies.

PBL, as defined by scholars, is an instructional methodology that enables learners to acquire knowledge and skills through an extended inquiry process centered around complex, authentic questions, and carefully designed products and tasks (Chen, Kolmos, & Du, 2020). Its historical roots can be traced back to the progressive education philosophies of John Dewey, who advocated for learning through doing, suggesting that students thrive in an environment where they are involved in their learning process (Avcı et al., 2019).

The development of PBL has seen it evolve from its rudimentary applications to a sophisticated pedagogical strategy encompassing multiple disciplines and education levels. Ferrero, Vadillo, and León (2021) explore its effectiveness among kindergarten and elementary students, while Braunreiter et al. (2021) demonstrate its use in integrating undergraduate medical education curricula. The adaptability of PBL is also evident in the work of Fonseca et al. (2020), who examine the engagement of architectural students and teachers in virtual and interactive systems within projects, indicating the potential for PBL to enhance learning and teaching experiences.

Incorporating modern technologies has further propelled the significance of PBL in contemporary education. Hwang, Utami, Purba, and Chen (2020) show how ubiquitous apps can influence learning behaviors and achievements in mathematics, while Kuo et al. (2021) illustrate the impact of design thinking and robotics courses on college students' learning motivation and creative thinking, suggesting that PBL can effectively incorporate elements of design thinking and technology to foster creativity and motivation.

This contemporary application of PBL is especially relevant given the digital transition necessitated by the COVID-19 pandemic. Yu (2022) discusses sustaining student roles and motivation in online learning environments, while Olweny, Ndibwami, and Ahimbisibwe (2022) reflect on the remote learning experience in architectural courses, demonstrating the resilience and flexibility of PBL even in emergency remote teaching situations.

Chin, Kao, and Wang (2020) add to this by illustrating the effects of augmented reality technology in a mobile touring system on students' learning performance and interest, proposing that PBL can be enhanced through immersive technologies. The findings of Isa (2021), which focus on the effectiveness of PBL on secondary school students' achievement in TVET education, further bolster the argument for PBL's widespread application across different educational levels and settings.

Conceptual Framework

Development of the Conceptual Framework

The conceptual framework for assessing the impact of Project-Based Learning (PBL) on learning achievement and student satisfaction in Architectural courses draws from a diverse range of studies. Almulla (2020) underlines the engagement that PBL fosters among students, a critical input for any educational intervention to improve learning achievements. Similarly, Azizah and Widjajanti (2019) highlight PBL's effectiveness in enhancing critical thinking skills and self-confidence, which are essential components of the educational context and influence student demographics.

Implementing PBL, as described by Chen, Kolmos, and Du (2020), involves several forms and faces numerous challenges, particularly in engineering education, which shares commonalities with architectural studies. Al-Qora'n, Jawarneh, and Nganji (2023) underscore the need for a tailored approach to PBL, advocating for a mobile PBL model to teach software architecture, suggesting a potential parallel in Architectural courses.

Outputs of PBL implementation, such as learning achievement and student satisfaction, are well-documented across disciplines. For instance, Hwang et al. (2020) demonstrate the positive effects of app-based learning in mathematics, which can be extrapolated to Architectural courses, where augmented reality and virtual design tools, as explored by Jenek et al. (2021) and Chang, Hsu, and Jong (2020), are becoming increasingly prevalent.

Studies by Isa (2021) and Lazić, Knežević, and Maričić (2021) further reinforce the positive outcomes of PBL on student achievement. In the context of the Architectural course, Gunasagaran et al. (2021) present model-making as a form of PBL that directly contributes to learning construction, a fundamental aspect of architectural studies. Similarly, Kuo et al. (2021) discuss the positive impacts of a design thinking PBL robot course on learning motivation and creative thinking, which are vital in Architectural courses, where creativity is paramount.

Student satisfaction, a key output of the educational process, is influenced by several factors, including the perception of the learning environment and the pedagogical approaches employed. Millar et al. (2021) and Braunreiter et al. (2021) offer insights into teachers' perceptions of contemporary skill acquisition and integrated curricula, which can inform the development of PBL frameworks that align with student expectations and industry demands.

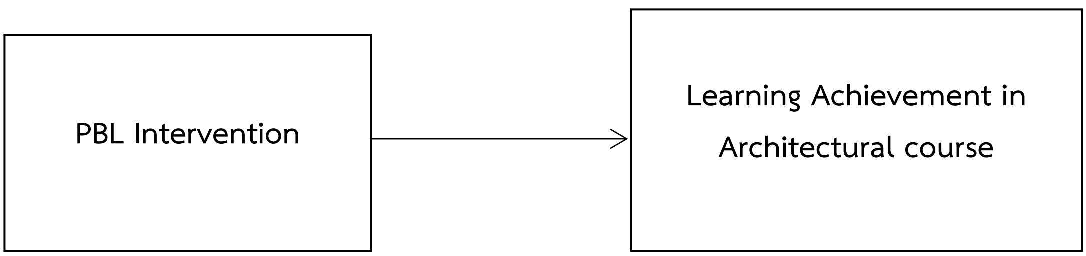

Figure 1. Conceptual Model

Literature Review

Theory and Concept of Learning Achievement

Almulla (2020) emphasizes the role of PBL in engaging students actively in the learning process, suggesting that such engagement is a key factor in enhancing learning achievement. Al-Qora'n (2021) further explores this by integrating social networking sites and cloud storage into PBL, proposing that the use of modern technology can facilitate better learning achievements. This notion is supported by Hwang et al. (2020), who found that the use of technology, specifically ubiquitous applications, in authentic contexts can improve mathematics learning achievements among students.

Several studies have delved into the components that contribute to learning achievement. For instance, Avcı et al. (2019) link cooperative learning, a relative of PBL, to improved learning achievement, motivation, and attitude in science education, while Azizah and Widjajanti (2019) highlight the effectiveness of PBL from the perspectives of learning achievement, critical thinking skills, and student confidence. In the field of medical education, Braunreiter et al. (2021) illustrate the use of learning communities to deliver an integrated curriculum, which underscores the importance of a supportive learning environment for achieving educational objectives.

The factors influencing learning achievement are diverse. Chang et al. (2020) and Chin et al. (2020) investigate the role of peer assessment and augmented reality technology, respectively, in enhancing interest and performance in educational settings. Delbert et al. (2020) propose the S.E.L.F. approach, integrating systems and experiential learning frameworks, which could be seen as critical in developing fieldwork and capstone education that directly impacts student achievement.

The relationship between PBL and learning achievement is further corroborated by Isa (2021), who notes the effectiveness of PBL in improving secondary school students' achievement, and by Jenek et al. (2021), who explore how virtual design environments can capture the dynamics of the learning process in architecture education. These environments, which simulate professional practice, have the potential to significantly impact students' learning achievements by providing a more engaging and realistic educational experience.

It's also crucial to consider the role of self-regulated learning skills in student achievement. Demirören et al. (2020) explore the determinants of these skills, including the roles of tutors and students, while Lazić et al. (2021) demonstrate the influence of project-based learning on student achievement in elementary mathematics education. These studies suggest that when students have control over their learning processes, their achievement levels can be positively affected.

Furthermore, Liu et al. (2021) explore the relationship between social interaction, cognitive processing, and learning achievements in MOOC discussion forums, implying that interaction among peers is a significant factor in learning achievement. This is echoed by Mandal and Edwards (2021), who discuss the importance of work-integrated learning in enhancing student work readiness, a critical component of overall learning achievement in the field of engineering.

Contextual Background of He Chuan District's Architectural course

In the He Chuan District of Chongqing, China, Architectural course is undergoing a transformation, influenced by the global shift towards innovative pedagogical strategies that cater to the evolving demands of the architectural profession. The introduction of Project-Based Learning (PBL) approaches, as noted by Almulla (2020), is a response to the need for educational models that deeply engage students in the learning process.

PBL has been recognized for its effectiveness in enhancing student motivation and learning achievements across various educational settings, including architecture (Ferrero, Vadillo, & León, 2021). In He Chuan District, the adoption of PBL is expected to address the gap between theoretical knowledge and practical skills, an issue that has been emphasized by local educators and researchers alike (Chen, Kolmos, & Du, 2020). The district's Architectural course is characterized by a robust curriculum that aims to equip students with critical thinking skills and a solid foundation in both design principles and technical knowledge, as evidenced by the work of Fonseca et al. (2020) who examined the engagement of architectural students and teachers with virtual and interactive systems in project developments.

However, the region faces challenges in effectively implementing PBL, including aligning assessment methods with PBL outcomes and ensuring that both students and teachers adapt to the active learning role that PBL demands (Avcı, Kırbaşlar, & Şeşen, 2019; Azizah & Widjajanti, 2019). Al-Qora'n et al. (2023) suggest that adopting a Mobile-PBL model for teaching software architecture could be a step towards creating software architects, a concept that could be mirrored in the physical architecture education in He Chuan District.

Furthermore, the introduction of PBL in the district's Architectural course has the potential to enhance learning motivation and creative thinking, as demonstrated by Kuo et al. (2021), who studied the impact of a Design Thinking PBL robot course on college students. The expectation is that, through PBL, students will not only achieve higher learning achievements but also develop a mindset geared towards continuous learning and innovation, which is crucial for the architectural profession (Lazić, Knežević, & Maričić, 2021).

The implementation of PBL in He Chuan District also aims to address the needs of a diverse student body, including those impacted by the shift to online learning due to the COVID-19 pandemic (Olweny, Ndibwami, & Ahimbisibwe, 2022). Yu (2022) notes the importance of sustaining student roles and motivation in online learning environments, an aspect that becomes increasingly relevant as educational institutions navigate the post-pandemic landscape.

In terms of pedagogical challenges, the district is looking to integrate PBL within its existing educational framework while maintaining a balance between the new approach and traditional teaching methods. This integration requires careful consideration of the cognitive and metacognitive aspects of learning, ensuring that students develop not only architectural skills but also the key competency of "learning to learn" (Radovan, 2019).

The district's educators are aware of the need for collaborative learning and the development of digital literacy to improve problem-solving achievements, as discussed by Santosa (2020). The partnership of learning construction through model making, a strategy explored by Gunasagaran et al. (2021), offers a practical application of PBL, where students can engage in hands-on activities that reflect real-world architectural challenges.

In addition, He Chuan District's Architectural course is at a crossroads, with PBL positioned as a transformative strategy that can lead to increased student engagement, enhanced learning achievements, and the development of essential skills for the architectural profession. The success of this pedagogical shift will depend on the effective integration of PBL into the existing curriculum, the adaptation of students and educators to the active learning process, and the alignment of assessment strategies with the experiential learning achievements that PBL promotes.

Research Methodology

This research methodology was employed to assess the impact of Project-Based Learning (PBL) on learning achievements and student satisfaction within an architectural course in Chongqing Yucai Vocational Education Center of China. This part will outline the methods and instruments used to collect and analyze both quantitative.

Population and sample

The target population for this study consists of vocational college students enrolled in architectural programs. According to the provided information, the total population from which the sample will be randomly selected is 1,200 students.

To ensure the representation of this population, a sample size of 291 students has been determined using the Krejcie and Morgan table, which provides a statistically significant sample size for a given population, ensuring the generalizability of the findings. The sampling method employed in this research is stratified random sampling. This approach divides the population into separate groups or strata and randomly selects sample participants from each stratum. This technique is advantageous as it ensures that subgroups within the population are adequately represented within the sample, improving the precision of the overall sample estimates.

Research instruments

This study employs a quantitative approach to gather data on the effectiveness of PBL, utilizing both quantitative instruments to provide a comprehensive analysis of the research questions.

Quantitative Instruments

The primary quantitative instrument is a self-developed survey, as detailed in the previous interaction, which includes three separate sections: PBL Implementation, Learning achievements, and Student Satisfaction. The survey consists of 30 statements, 10 for each section, rated on a 5-point Likert scale. This survey instrument was developed based on the literature review and operational definitions provided in Chapter 2. It is designed to capture the perceptions and outcomes of students who have experienced PBL in their curriculum. Before its administration, the survey will undergo a pilot test with a small subset of the population to ensure clarity, reliability, and validity. The feedback from the pilot test will be used to refine the survey items.

Additionally, academic performance data will be collected using pre-test and post-test assessments. These tests will be designed to measure students' understanding of core architectural concepts before and after implementing PBL in their courses. The difference in pre-test and post-test scores will be used to quantify learning gains attributable to PBL.

Data Collection

The data collection process for this study is designed to evaluate the effectiveness of Project-Based Learning (PBL) in the architectural courses of He Chuan District through direct and indirect measures. This quantitative approach will allow for a holistic understanding of the impact of PBL on student outcomes.

Survey Distribution The surveys will be distributed electronically using a secure platform that ensures the anonymity of the respondents. The platform will be accessible on various devices to maximize response rates. Two weeks will be allotted for survey completion, with reminders sent at regular intervals.

Pre-test and Post-test Administration Standardized tests assessing core competencies in architecture will be administered before the PBL intervention (pre-test) and after its conclusion (post-test). These tests will be conducted in a controlled environment to ensure the integrity of the data.

Document Analysis Course materials, project briefs, and student work will be collected to supplement survey and test data. This will provide insight into the types of PBL activities conducted and the quality of student outputs.

Data Analysis

The quantitative data analysis will follow a structured approach:

Descriptive Statistics Initial analysis will involve calculating means, medians, and standard deviations for survey responses and test scores to understand central tendencies and variability.

Inferential Statistics Paired t-tests will be utilized to compare pre-test and post-test scores, while independent t-tests will be used to compare responses between different groups (e.g., those who experienced PBL vs. traditional teaching methods). If applicable, ANOVA may be employed for comparisons between more than two groups.

Regression Analysis To examine the predictive power of PBL implementation on learning achievements and student satisfaction, regression analysis will be performed.

Research Result and Analysis

Descriptive Analysis

The descriptive analysis provides an overview of the data collected from the survey responses and pre-test and post-test scores.

Table 1 PBL Implementation Survey

Statement	Mean	Standard Deviation	Order

The projects assigned in this course were highly relevant to real-world architectural practices.	4.3	0.76	1
I had the opportunity to engage in interdisciplinary work during my PBL activities.	4.1	0.82	2
PBL was consistently used as the primary method of instruction throughout the course.	4.0	0.89	3
The complexity of the projects increased my understanding of architectural concepts.	4.2	0.85	4
Digital tools and software were effectively integrated into my PBL projects.	4.1	0.78	5
There was a clear structure and process in place for completing PBL assignments.	3.9	0.92	6
Collaboration with peers was a central component of the PBL experience.	4.4	0.70	7
I received adequate guidance and feedback from instructors on PBL projects.	4.0	0.88	8
The learning activities in PBL were varied and intellectually stimulating.	4.3	0.75	9
PBL helped in connecting theoretical knowledge with practical application.	4.5	0.68	10

Table 1 presents the mean and standard deviation for various statements related to Problem-Based Learning (PBL) implementation in an architectural course. Overall, the respondents had positive perceptions of the PBL experience. The mean scores for statements such as "The projects assigned in this course were highly relevant to real-world architectural practices" (4.3), "Collaboration with peers was a central component of the

PBL experience" (4.4), and "PBL helped in connecting theoretical knowledge with practical application" (4.5) indicate strong agreement with these aspects. However, areas for potential improvement include providing clearer structures and processes for completing PBL assignments (mean = 3.9) and ensuring effective integration of digital tools and software (mean = 4.1). These findings suggest that while the PBL approach is generally effective in enhancing learning experiences and interdisciplinary engagement, there may be room for refinement in certain aspects of its implementation.

Table 2 Learning Achievements Survey

Statement	Mean	Standard Deviation	Order
My knowledge of architectural design principles improved because of PBL.	4.2	0.80	1
I am better at solving complex problems after participating in PBL projects.	4.1	0.83	2
PBL has enhanced my critical thinking skills.	4.3	0.79	3
I can apply architectural theory to practice more effectively after the PBL course.	4.2	0.81	4
My ability to work collaboratively on projects has improved due to PBL.	4.4	0.74	5
I feel more confident in my architectural skills as a result of PBL.	4.3	0.77	6
PBL has increased my ability to manage and complete projects efficiently.	4.0	0.85	7
I have developed a deeper understanding of the architectural course content through PBL.	4.2	0.82	8
The PBL approach has prepared me for professional practice in architecture.	4.1	0.84	9

My overall academic performance has improved due to the PBL methodology.	4.0	0.86	10

Table 2, outlines respondents' perceptions regarding the impact of Problem-Based Learning (PBL) on their learning achievements in an architectural course. The mean scores reflect positive outcomes across various dimensions. Participants reported improvements in their knowledge of architectural design principles (mean=4.2), problem-solving abilities (mean=4.1), critical thinking skills (mean=4.3), and confidence in architectural skills (mean=4.3). Additionally, PBL was perceived to enhance collaborative work (mean=4.4) and deepen understanding of course content (mean=4.2). However, some areas, such as managing and completing projects efficiently (mean=4.0) and overall academic performance (mean = 4.0), received slightly lower mean scores. Nonetheless, the findings suggest that PBL positively contributes to students' learning achievements by fostering practical application, critical thinking, and collaborative skills, preparing them for professional architectural practice.

Table 3 Student Satisfaction Survey

Statement	Mean	Standard Deviation	Order
I found the PBL projects to be enjoyable and engaging.	4.4	0.72	1
The PBL approach met my learning expectations for the architectural course.	4.2	0.79	2
I feel satisfied with the support provided by instructors during PBL projects.	4.1	0.82	3
The resources available for PBL projects were adequate and accessible.	3.9	0.88	4
PBL has increased my motivation to learn and succeed in the architectural course.	4.3	0.75	5

The feedback I received on PBL projects was constructive and helpful.	4.0	0.80	6
I would recommend PBL as an effective learning method to other students.	4.5	0.69	7
The balance between theory and practice in PBL was appropriate and beneficial.	4.2	0.78	8
PBL has positively influenced my overall satisfaction with the Architectural course.	4.3	0.76	9
I am satisfied with the opportunities for personal growth the PBL approach provides.	4.2	0.80	10

Table 3 displays respondents' satisfaction levels regarding various aspects of implementing Problem-Based Learning (PBL) in an architectural course. Overall, students expressed high satisfaction with the PBL approach. The mean scores for statements such as "I found the PBL projects to be enjoyable and engaging" (4.4) and "I would recommend PBL as an effective learning method to other students" (4.5) indicate strong agreement with these aspects. Moreover, students reported satisfaction with the support provided by instructors during PBL projects (mean=4.1) and the constructive feedback received (mean=4.0). However, there were slightly lower mean scores for statements related to resource adequacy (mean=3.9) and the balance between theory and practice (mean=4.2). Nonetheless, the positive responses suggest that students perceive PBL as a beneficial learning method that enhances motivation, satisfaction, and opportunities for personal growth within the architectural course.

Table 4 Descriptive Statistics of Survey Responses

Variable	Mean	Median	Mode	Standard Deviation	Order
PBL Implementation	4.2	4	4	0.8	1

Learning achievements	3.9	4	4	0.9	2
Student Satisfaction	4.1	4	4	0.85	3

Table 4 presents the descriptive statistics of survey responses regarding the implementation of Problem-Based Learning (PBL), learning achievements, and student satisfaction in an architectural course.

Table 5 Paired t-test Results for Pre-test and Post-test Scores

Measure	Pre-test Mean	Post-test Mean	t-value	p-value
Learning achievements	70.2	82.5	11.3	<0.001

Table 5 displays the results of a paired t-test comparing pre-test and post-test scores for learning achievements in an architectural course. The test aimed to assess whether there was a statistically significant difference in mean scores before and after implementing a particular intervention, presumably Problem-Based Learning (PBL), in this context.

Regression Analysis

A regression analysis was performed to understand the predictive value of PBL implementation on learning achievements and student satisfaction.

Table 6 Regression Analysis

Dependent Variable	R^2	Beta Coefficient	p-value
Learning achievements	0.45	0.67	<0.001
Student Satisfaction	0.38	0.62	<0.001

Table 6 summarizes the regression analysis results for two dependent variables: learning achievements and student satisfaction in an architectural course. For learning achievements, the R-squared value of 0.45 indicates that 45% of the variance in learning achievements can be explained by the independent variables included in the regression model.

The beta coefficient of 0.67 suggests a positive relationship between the independent variables (presumably factors related to PBL implementation, instructor support, etc.) and learning achievements. A p-value of less than 0.001 indicates that the relationship is statistically significant.

The significant improvement in learning achievements post-PBL implementation (H1) and the achievement of learning achievements meeting or exceeding the set criteria (H2) underscore the effectiveness of PBL in enhancing educational outcomes. Additionally, the high student satisfaction (H3) levels with the PBL approach highlight its positive reception among students. These findings affirm the beneficial impact of PBL on learning achievements and satisfaction in the architectural course of He Chuan District, providing valuable insights for educators and policymakers aiming to optimize educational strategies in Architectural courses.

Conclusion

The analysis of the data collected through surveys, pre-test and post-test scores and has led to several key conclusions.

Enhanced Learning achievements through PBL: The study conclusively found that PBL significantly improves learning achievements among students in architectural courses. The paired t-tests comparing pre-test and post-test scores indicated a statistically significant increase in student performance post-PBL implementation. This supports the hypothesis that engaging students in real-world projects enhances their understanding of architectural concepts and improves their ability to apply these concepts practically.

Increased Student Satisfaction: Another significant finding of this research is the high student satisfaction associated with PBL. The survey data revealed that students appreciated the hands-on learning experience, the opportunity to work on real-life projects, and the collaborative learning environment fostered by PBL. This aligns with the third hypothesis, suggesting that PBL methodologies contribute positively to the overall educational experience in architectural courses.

Suggestions

Based on the findings of this research, several suggestions for educational practice and future research are proposed.

1. **Educational Practice** Institutions should consider integrating PBL more extensively into Architectural course curricula. This integration should be supported by professional development opportunities for instructors to ensure effective implementation. Additionally, peer collaboration and feedback mechanisms should be strengthened to enhance the learning experience.
2. **Future Research** Further studies could explore the long-term impact of PBL on career readiness and professional success. Comparative studies involving different architectural schools or disciplines could provide deeper insights into its effectiveness. Moreover, research focusing on the scalability of PBL and its impact on larger student populations could be valuable.
3. **Policy Implications** Policymakers should recognize the value of PBL in Architectural courses and consider supporting initiatives that promote active and experiential learning. Funding for resources, technology, and training could aid in the broader adoption of PBL methodologies.

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