

Development of Project-based Learning (PBL) to Improve the Design Ability of Students in Vocational Education

Xiulian Duan¹ and Thanyaluck Khechornphak²

¹ Master of Education Program, Curriculum and Instruction, Rajabhat Maha Sarakham University, Thailand

² Lecturers from the Faculty of Education, Program in Curriculum and Instruction, Rajabhat Maha Sarakham University, Thailand

¹E-mail: XiulianDuan2568@gmail.com, ORCID ID: <https://orcid.org/0009-0005-0464-8394>

²E-mail: p.pbk13@gmail.com, ORCID ID: <https://orcid.org/0000-0003-0562-5002>

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Abstract

Background and Aims: As China's vocational education system aligns with the 2019-2025 reform mandate emphasizing practical competencies and industry integration, interior design education faces the challenge of preparing students for increasingly complex, technology-mediated design practices. Traditional lecture-based approaches inadequately develop the multidimensional competencies required in contemporary residential design. This experimental study aimed to: (1) develop and validate a Project-Based Learning (PBL) instructional model for residential space design, (2) assess its impact on students' design competencies through pre-post comparison, and (3) evaluate student satisfaction with the PBL approach.

Methodology: Employing a one-group pretest-posttest design, we implemented a five-week PBL intervention with 42 second-year interior design students at Guangdong Huashang Technical School (first semester, 2025). Students completed an authentic residential renovation project. Data collection included validated design competency assessments (pre/post, 100-point scale across five dimensions), expert evaluation of the instructional model (n=3 experts), and student satisfaction surveys (12-item, 5-point Likert scale). Analysis employed paired t-tests and descriptive statistics.

Results: Expert evaluation rated the PBL model at 4.42/5.00 (SD=0.28), indicating high instructional quality. Student design competency scores increased significantly from pretest (M=67.50, SD=9.76) to posttest (M=82.00, SD=8.12), $t(41)=17.24$, $p<.001$, with a large effect size (Cohen's $d=1.60$). Performance gains were most substantial in construction documentation (79.05%) and design presentation (84.88%), with site analysis showing more modest improvement (69.05%). Student satisfaction averaged 4.53/5.00 (SD=0.57).

Conclusion: Structured PBL implementation significantly enhanced vocational students' residential design competencies, particularly in technical execution and presentation skills. However, persistent challenges in preliminary analytical tasks suggest the need for scaffolded instruction in client needs assessment and site evaluation. The model's high student

satisfaction and expert validation support its integration into vocational interior design curricula.

Keywords: Project-Based Learning; Design Competency; Residential Space Design; Vocational Education; Interior Design

Introduction

China's interior design industry has undergone a rapid transformation in recent years, driven by digital visualization technologies, sustainability imperatives, and evolving client expectations for participatory design processes. Yet vocational interior design education—which produces a significant portion of the industry's workforce—has often lagged behind these changes, maintaining lecture-demonstration formats that prioritize technical drawing skills over integrated design thinking (Huang Shujie, 2022). This gap between educational preparation and professional requirements is particularly pressing within China's ongoing vocational education reforms, which emphasize practical competencies and closer industry-university integration (National Vocational Education Reform Implementation Plan, 2019).

Project-Based Learning (PBL) has emerged internationally as a promising pedagogical approach for developing the multidimensional competencies required in contemporary design practice. Unlike traditional instruction that fragments design knowledge into discrete skills, PBL situates learning within authentic, complex problems that mirror professional workflows (Markham, 2024). By engaging students in extended inquiry processes centered on challenging questions or problems, PBL promotes deeper learning through the application of knowledge to real-world contexts (Sang Guoyuan, 2024).

However, most PBL research in design education originates from university settings in Western contexts. Few experimental studies have systematically examined PBL implementation in Chinese vocational colleges, where students typically have different educational backgrounds, shorter program durations, and more direct pathways to industry employment (Li Zhihe, 2020). Moreover, existing studies rarely provide granular documentation of instructional design, making replication and adaptation difficult for vocational educators.

Teaching mode innovation is the core of improving the quality and effectiveness of education. The traditional "cramming" teaching method has been difficult to meet the needs of modern vocational education. As an innovative attempt, the project teaching mode is of great significance in the home space design course of the technical interior design major. (Li Zhihe, 2020)

The project-based learning mode is conducive to cultivating students' vocational skills. (Wu Guang, 2021). Through practical projects, students can intuitively understand the industry

needs and professional standards, and can master relevant skills efficiently. At the same time, this mode can also stimulate students' awareness of innovation and improve their teamwork ability. (Dong Kun, 2019). During the implementation of the project, students need to constantly think, explore, and innovate, and cooperate closely with team members to solve problems, which is extremely beneficial to cultivating the spirit of innovation and collaboration. In addition, the project-based learning mode helps to improve students' comprehensive quality. (Wu Guang, 2021).. In the process of completing the project, students should not only master professional knowledge and skills but also exercise non-technical skills such as communication, organization, coordination, and time management, so as to lay a solid foundation for their future career development.

Many education and industry experts have praised the application of the project-based learning model in the course. They pointed out that this model can skillfully integrate theory and practice, allowing students to improve their professional skills and overall quality, and cultivate their innovation and teamwork ability. (Wu Guang, 2021) Experts emphasize that project-based learning should prioritize: 1) careful project selection that meets instructional objectives and aligns with real needs; and 2) strengthening process management. Monitoring and guiding every step of the project implementation process effectively; and 3) prioritizing objective and fair assessment and evaluation results, taking into account project success and student academic performance (Feng Hui, 2021).

Based on a study of key concepts and principles of project-based learning (PBL), the researcher applied Fang Tao's (2024) concept to the project-based teaching process to develop home design skills for vocational students. This process consisted of four main steps: Step 1: Preparation, to identify project topics based on teaching objectives and interests. Step 2: Teaching, to collaboratively design a project implementation plan and clarify assigned tasks, collect data, and practice. The project plan was adjusted as needed to maximize student practice. Step 3: Presentation and Evaluation, to allow each group of students to present and evaluate their projects, discuss the results together, and receive feedback from the teacher. Step 4: Reflection and Conclusion, to collaboratively reflect on and summarize the project, improve the experiences and lessons learned, and use it as a reference for future teaching.

This study addresses these gaps by developing and experimentally testing a detailed five-week PBL model for residential space design instruction in a Chinese vocational college. We provide comprehensive documentation of the instructional design, quantitatively assess its impact on multiple dimensions of design competency, and examine student reception of the approach. Our findings offer practical guidance for vocational educators seeking to

implement PBL while contributing to theoretical understanding of how PBL functions in vocational versus academic contexts.

Objectives

1. To develop learning activities using Project-based learning (PBL) to improve design ability.
2. To compare the design ability of students studying using Project-based learning (PBL) between pre-test and post-test.
3. To study students' satisfaction with learning activities using Project-based learning (PBL).

Research Hypotheses

Students who participate in the Project-Based Learning residential design course will demonstrate significantly higher design competency scores on the posttest assessment compared to the pretest assessment across all five competency dimensions.

Literature Review

The investigator has studied the literature, textbooks, books, and related studies as follows:

Guangming Daily (2023) noted that the importance of project-based teaching is evident and that traditional subject-based teaching can no longer meet the demands of the modern era. In this context, project-based learning has gained recognition for its focus on helping students tackle complex, unconventional, and challenging real-world problems, thereby fostering higher-order cognitive skills such as communication, collaboration, critical thinking, and innovation. This approach is widely adopted in primary and secondary education. Furthermore, with the growing acceptance of core competencies, educational practices have shifted from a single focus on knowledge acquisition to a more comprehensive and integrated approach centered around these competencies. Project-based learning aligns well with the goal of competency-based education and is now a key component of the national curriculum standards for developing students' core competencies. Additionally, from a motivational standpoint, the projects in project-based learning are derived from real-life issues encountered by students, providing a fresh, engaging, and direct experience that better stimulates students' interest and motivation to learn.

Zhao Qiang (2020). The next step is the implementation plan. During this phase, students work in groups to apply their knowledge and skills to solve real-world problems. Zhang Hong's 2023 research indicates that effective group collaboration can foster

intellectual exchanges among students, enhance their teamwork and communication skills, and improve their ability to tackle complex issues. The final step involves inspection and evaluation, which includes both self-assessment by students and teacher evaluations. Scholar Zhao Qiang, in 2020, argued that a diversified assessment approach can comprehensively and objectively reflect students' learning processes and outcomes. Self-assessment helps students reflect on their learning experiences and identify areas for improvement, while teacher evaluations provide professional guidance and feedback.

Sang Guoyuan (2024) notes that project-based learning (PBL), a student-centered teaching model, has its theoretical roots in the 'learning by doing' concept proposed by American philosopher John Dewey. Dewey (1938) emphasized that education should promote knowledge construction through practical activities, which forms the core theoretical foundation of PBL. Contemporary scholar Sang Guoyuan (2024) further identified six key elements of PBL: authenticity (the project context is closely tied to real-world scenarios), inquiry (encouraging students to actively explore solutions to problems), collaboration (tasks are completed in teams), interdisciplinary integration (integrating knowledge from multiple fields), process orientation (focusing on the entire project implementation process), and diversified evaluation.

Kavaloski, V. (2021). In project teaching, the setting of project objectives is the starting point of project design. It should be closely related to the teaching objectives, while taking into account the actual situation and subject characteristics of the students. The objectives of the project should be clear, operable, and evaluable, which can guide students to complete specific learning tasks and achieve the expected learning effect. Integration of teaching content. Project design needs to be integrated around the teaching content to ensure the close integration of the project and the course content. Teachers should select appropriate teaching content according to the project objectives and integrate it into the project, so that students can master relevant knowledge and skills in the process of completing the project. The integration of teaching content should pay attention to the systematization and coherence of knowledge and avoid the fragmentation of knowledge.

Jonassen, D.H. (1999). Constructivism emphasizes that learning occurs in specific contexts, where students actively engage in the learning process. Learning goals are achieved through social interaction and knowledge sharing. Project-based learning creates real-world learning scenarios for students, enabling them to actively participate in discussions, exchanges, and practical activities as they work in groups on projects. In the project implementation of the family space design course, students collaborate in groups to explore design solutions, share ideas and experiences, and actively construct new knowledge based on their existing knowledge and experience, thereby internalizing knowledge and enhancing

their skills.

Conceptual Framework

Based on research textbooks, books, and literary works, it is determined that the use of project-based learning methods in the teaching process can improve students' overall performance. Therefore, the investigators will summarize these research ideas as follows.

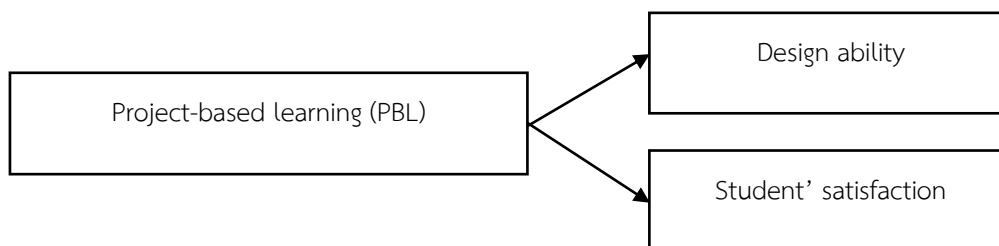


Figure 1 Conceptual Framework

Methodology

This research used an experimental design in the form of experimental research (Experimental Research), One Group Pretest-Posttest Design, and One Group Posttest Only Design (Paisan Worakam, 2021).

random	group	Test first	Experimental thing	Test after
-	E	O ₁	X	O ₂

When E means Experimental group

O₁ means measuring variables before experimenting

X means giving an experiment

O₂ means measuring variables after the experiment

Project-based learning implementation and process data collection

1) Teaching arrangement: This course will last for 5 weeks, with 4 hours per week, a total of 20 hours. In the teaching process, the project-based learning mode is introduced, with the actual home space design project as the carrier, to guide students to complete the whole process from project research, scheme design, effect drawing, to scheme display.

2) Process data collection: In each class, teachers record students' participation, group cooperation performance, and other conditions through classroom observation. At the same time, the online learning platform is used to record the students' learning track, including the number of logins, the browsing time of learning resources, homework submission, and other

data. This process data can reflect the students' investment and learning status in the course learning process.

3) Post-teaching test. After completing all the teaching content, the students will have the second test. The test questions were consistent with the pre-teaching test in terms of difficulty and knowledge coverage. Students' mastery of home space design knowledge was tested again; the test results before and after teaching were compared, and the effect of project-based learning on students' knowledge mastery was evaluated.

4) Evaluation of student works. Collect the home space design works completed by students in the process of project teaching, and score and evaluate the students' works from multiple dimensions such as site analysis and customer needs, floor plan design, construction plan design, construction drawing design, renderings design, design results typesetting and report, with a full score of 100 points. Through the work evaluation, students' ability to apply knowledge and skills in project practice, as well as the development of innovative thinking

5) Survey of student satisfaction. After the course, students were asked to fill out the satisfaction questionnaire on project-based learning courses in home space design. The questionnaire covers the satisfaction evaluation of teaching content, teaching methods, teacher guidance, learning harvest, and other aspects, in the form of a Likert level 5 scale. In addition, open-ended questions were set up to collect students' comments and suggestions on the course. Through the questionnaire survey, we can understand the students' subjective feelings about the course and provide direction for course improvement.

The collected pre-teaching test results, post-teaching test results, evaluation scores of students' works, classroom observation records, online learning platform data, and questionnaire survey data were sorted out, classified, and summarized according to individual students to ensure the accuracy and integrity of the data. SPSS and other spreadsheet software were used to establish the database, input, and to preliminarily organize the data for subsequent analysis.

Results

Development and Validation of the PBL Model

Three content experts evaluated the PBL instructional model using a 5-point Likert scale across six dimensions. The model received a mean rating of 4.42 (SD=0.28), indicating high quality. Ratings ranged from 4.17 (feasibility of implementation) to 4.67 (alignment with objectives). Expert feedback highlighted strengths in the authentic project scenario and structured progression, while noting concerns about time constraints for detailed construction drawings.

Impact on Design Competency

Table 1 presents the pre-post comparison of overall design competency scores.

Table 1 Paired t-test Results for Design Competency Scores

Test	n	Full Score	M	SD	t	df	p	Cohen's d
Pretest	42	100	67.50	9.76	17.24	41	<.001	1.60
Posttest	42	100	82.00	8.12				

The increase of 14.5 points represents a statistically significant and large effect ($d=1.60$). The reduction in standard deviation from 9.76 to 8.12 suggests the intervention reduced performance variability.

Table 2 shows posttest performance across the five competency dimensions.

Table 2 Posttest Performance by Competency Dimension

Dimension	Possible Score	Total Score	Percentage	Performance Level
1. Site Analysis & Client Needs	20	580	69.05%	Medium
2. Spatial Planning & Floor Plan	20	630	75.00%	Good
3. Technical Documentation	20	664	79.05%	Good
4. Digital Visualization	20	704	83.81%	Good
5. Professional Presentation	20	713	84.88%	Good

Performance was highest on Professional Presentation (84.88%) and lowest on Site Analysis (69.05%), suggesting students found analytical tasks more challenging than technical execution and presentation tasks.

Student Satisfaction

Overall satisfaction with the PBL approach was high ($M=4.53$, $SD=0.57$). The highest-rated items concerned instructor feedback on work obstacles ($M=4.64$) and peer collaboration ($M=4.62$). The lowest-rated item, though still positive, concerned integrating knowledge to solve complex problems ($M=4.33$).

Discussion

Quality of the Instructional Model

The mean expert evaluation scores ($M = 4.42/5.00$) show that the overall quality of the proposed PBL instructional model is relatively high. When analyzed across different dimensions, several interesting details emerge. The aspect of alignment with the learning objectives received the highest score ($M = 4.67$), reflecting the experts' judgment that the instructional model was well-structured and pedagogically sound. However, the dimension of feasibility of implementation had the lowest mean score ($M = 4.17$), indicating that the implementation of PBL is still a challenging task in vocational education. This is not surprising, as our experts also noted that using authentic, project-based learning in VET can be resource-intensive in terms of time, organizational support, and facilities. It is also important to note that many vocational programs in China are only 3–4 contact hours per week, and conducting authentic, interdisciplinary, PBL activities in this setting may be extremely difficult (Li Zhihe, 2020).

At the same time, in our study, we were able to use scaffolding approaches to contextualize the six main elements of PBL outlined by Sang Guoyuan (2024)—authenticity, inquiry, collaboration, interdisciplinary integration, process orientation, and diversified evaluation—for vocational education and novice learners.

Competency Development

The significant improvement in design competency ($t=17.24$, $p<.001$, $d=1.60$) aligns with international research on PBL's effectiveness in developing applied skills (Yanti & Pratiwi, 2020). However, the differential effectiveness across dimensions provides crucial insight: while technical and presentational skills showed strong improvement (79.05-84.88%), analytical competencies (site analysis at 69.05%) improved more modestly. This pattern suggests authentic projects may be more effective for developing applied, procedural competencies than for building abstract, diagnostic reasoning skills—a finding consistent with expertise development literature indicating pattern recognition develops later than procedural skills (Dreyfus & Dreyfus, 1986).

The reduction in performance variability (SD decreased from 9.76 to 8.12) suggests the PBL intervention had an equalizing effect, potentially benefiting lower-performing students more than higher performers. This aligns with social constructivist predictions that peer collaboration provides scaffolding for struggling learners (Vygotsky, 1978).

Student Satisfaction

High student satisfaction ($M=4.53$) affirms PBL's motivational benefits in vocational education, where engagement is a persistent challenge. Students particularly valued peer collaboration and instructor feedback—social dimensions of learning that traditional formats

underutilize. Notably, the item directly addressing PBL's core purpose—integrating knowledge to solve complex problems—received the lowest mean rating ($M=4.33$). While still positive, this suggests students may not have fully recognized the interdisciplinary integration occurring or found the integrative demands particularly challenging.

Limitations

Several limitations qualify these findings. The one-group pretest-posttest design without a control group limits causal inference; observed improvements might partly reflect factors other than PBL specifically. The single-site, single-instructor implementation raises questions about generalizability. The five-week intervention provides no evidence about long-term retention or transfer to professional contexts. The convenience sample from one institution may not represent vocational students across China's diverse regions.

Conclusion

This study demonstrates that structured PBL implementation can significantly enhance vocational students' residential design competencies, with particular effectiveness in technical execution and presentation skills. The expert-validated instructional model provides a replicable framework for vocational educators, while the identification of persistent challenges in analytical tasks offers crucial guidance for implementation refinement.

The findings have several implications for practice. Vocational interior design programs implementing PBL should: (1) invest additional instructional time in scaffolding site analysis and needs assessment; (2) ensure adequate time for peer collaboration and structured feedback; (3) prepare instructors in facilitation skills; and (4) explicitly highlight interdisciplinary connections to help students recognize knowledge integration.

For policy, this study provides empirical evidence supporting PBL as a pedagogy aligned with China's vocational education reform goals. However, successful implementation requires institutional support through modified teaching load structures, professional development, and facility investments.

Future research should address this study's limitations through controlled comparison designs, longitudinal tracking into professional practice, multi-site replications, and investigation of how to specifically strengthen analytical competencies within PBL frameworks. As AI increasingly influences design practice, research should also examine how PBL can develop uniquely human competencies that complement technological capabilities.

Recommendation

For Instructors

1. Front-load analytical skill development with explicit instruction in site analysis frameworks before project launch.
2. Provide differentiated scaffolding through extension tasks for high-performers and additional supports for struggling students.
3. Make interdisciplinary connections explicit through reflective prompts that help students recognize knowledge integration.
4. Leverage high student satisfaction with collaboration through structured peer critique protocols.

For Curriculum Designers

1. Sequence PBL experiences across the program with increasing complexity and decreasing scaffolding.
2. Integrate contemporary professional competencies (sustainability, digital tools, AI applications) into PBL projects.
3. Balance PBL with complementary instructional approaches for analytical skill development.

For Administrators

1. Provide professional development in PBL facilitation skills for instructors.
2. Modify workload structures to recognize the intensive nature of PBL facilitation.
3. Invest in industry-standard software, equipment, and facilities to support authentic projects.

For Researchers

1. Conduct controlled comparison studies with randomized or matched-group designs.
2. Investigate the mechanisms through which PBL develops different competency dimensions.
3. Examine long-term transfer of PBL-developed competencies to professional practice.
4. Explore cultural adaptations of PBL for Chinese educational contexts

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