

## Research on the Heterogeneity of Project-Based Teaching Effectiveness in Higher Vocational Colleges in Henan Province, China

Guoqiang Li<sup>1</sup>, and Sobsun Mahaniyom<sup>2</sup>

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### Abstract

This study examined the implementation effectiveness of Project-Based Learning (PBLE) in higher vocational education using a structural equation modeling (SEM) approach, with emphasis on differences between teachers' and students' perceptions. A quantitative cross-sectional survey was conducted among teachers and students from higher vocational colleges in Henan Province, China. PBLE was conceptualized as a multidimensional construct consisting of Project Task Completion, Team Collaboration Ability, Teacher Guidance Effectiveness, Project Authenticity, Self-Efficacy, and Transferable Professional Competency. The results indicated that PBLE was implemented at a moderate to high level, though significant heterogeneity existed across groups. Project Task Completion and Team Collaboration Ability emerged as strengths, while Project Authenticity and Transferable Professional Competency showed weaker effects. The findings highlight the context-dependent nature of PBLE and emphasize the importance of authentic projects and teacher professional development.

**Keywords:** Project-Based Learning, Vocational Education, Learning Effectiveness, Teacher–Student Differences, Competency Development

### Introduction

Over the past decade, China has promoted the quality upgrading of vocational education under the national strategy of education modernization, emphasizing a shift from knowledge transmission to competency-oriented development through industry–education

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<sup>1, 2\*</sup>Faculty of Education, Shinawatra University, Thailand

Email: 676986057@qq.com<sup>1</sup>, sobsun.m@siu.ac.th<sup>2\*</sup>



integration and school–enterprise collaboration (State Council of the People’s Republic of China, 2019). This direction is consistent with international trends that highlight authentic learning, work-integrated curricula, and transferable competency development to meet labor market demands (Billett, S.,2011; OECD, 2018). Consequently, Project-Based Teaching/Learning (PBT/PBL) has been identified as a core pedagogical approach in vocational education reform. However, despite clear policy support, the implementation effectiveness of PBL remains highly uneven. Prior studies indicate that PBL outcomes vary significantly across institutions, disciplines, teachers, and student groups, depending on curriculum design quality, teacher competence, assessment methods, and learner readiness (Helle, L. et al., 2006; Thomas, J. W., 2000). While some institutions successfully integrate authentic workplace projects and process-oriented assessment, others implement PBL superficially, maintaining lecture-centered instruction and inauthentic projects, which fail to achieve intended competency outcomes (Kokotsaki, D. et al., 2016).

Henan Province, as a major hub of higher vocational education, has actively advanced policies to improve quality and align vocational training with regional industrial needs (Henan Provincial People’s Government, 2019; General Office of Henan Provincial People’s Government, 2024). Nevertheless, disparities in resources, enterprise collaboration, and teacher capacity have resulted in a clear phenomenon of “the same policy, different outcomes,” echoing challenges reported in international vocational education systems (Moodie, G. et al., 2019).

Despite extensive discussion of PBL, systematic regional-level empirical evidence explaining differential outcomes remains limited. Moreover, multidimensional evaluation frameworks capturing key indicators of PBL effectiveness are still insufficient (Bell, S., 2010; Strobel, J. & van Barneveld, A., 2009). Therefore, this study conducts an empirical investigation of PBL effectiveness in higher vocational colleges in Henan Province to address this gap and provide evidence-based support for improving vocational education quality.

## Research Objective

This study aims to examine the effectiveness of Project-Based Learning (PBLE) in higher vocational education and to explain variations in learning outcomes between teachers and students. The study focuses on the implementation of PBLE across multiple dimensions, analyzes differences in teaching and learning effectiveness, and identifies factors influencing



perceptual differences among participants. The findings are intended to provide empirical evidence for improving project-based learning design, supporting context-sensitive instructional practices, and informing effective vocational education policies.

### Research Scope

This study investigates the effectiveness of Project-Based Learning (PBLE) in higher vocational education by examining teachers' and students' perceptions across six core dimensions: Project Task Completion, Team Collaboration Ability, Teacher Guidance Effectiveness, Project Authenticity, Self-Efficacy, and Transferable Professional Competency. Comparative analyses are conducted across teacher and student groups to explain heterogeneity in learning effectiveness.

The study was conducted in higher vocational colleges in Henan Province, China, during 2024–2025, with data primarily collected in 2025. The sample comprised approximately 200 teachers and 400–500 students selected using stratified and convenience sampling methods to ensure representativeness and analytical validity.

### Review of Literature and Concepts

Project-Based Learning (PBL) has been widely recognized as an effective pedagogical approach in vocational and professional education, particularly for promoting competency-oriented learning and bridging the gap between academic instruction and workplace practice. Grounded in constructivist learning theory, PBL emphasizes active learning through authentic tasks, collaboration, and contextualized problem-solving, enabling learners to construct knowledge through real-world experiences rather than passively acquiring knowledge (Thomas, J. W., 2000; Hmelo-Silver, C. E., 2004). In higher vocational education, PBL has increasingly been adopted to enhance students' employability, practical skills, and transferable competencies required in dynamic labor markets (Billett, S., 2011).

Recent studies suggest that the effectiveness of PBL should be conceptualized as a multidimensional construct that integrates both learning processes and learning outcomes. Rather than relying solely on final products or academic achievement, scholars highlight the importance of examining students' task engagement, collaboration quality, instructional support, and authentic learning contexts when evaluating PBL effectiveness (Martanto, R., 2022; Shi, Y., 2024). Empirical research further identifies several key dimensions influencing PBL



outcomes, including Project Task Completion, Team Collaboration Ability, Teacher Guidance Effectiveness, Project Authenticity, Self-Efficacy, and Transferable Professional Competency (Bandura, A., 1997; Bell, S., 2010; Strobel, J. & van Barneveld, A., 2009).

Based on this synthesis, this study conceptualizes Project-Based Learning Effectiveness (PBLE) as a multidimensional framework encompassing these six interrelated components, which collectively reflect both the process-oriented and outcome-oriented aspects of project-based learning in higher vocational education. This framework provides a theoretical foundation for systematically examining variations in PBL effectiveness among teachers and students.

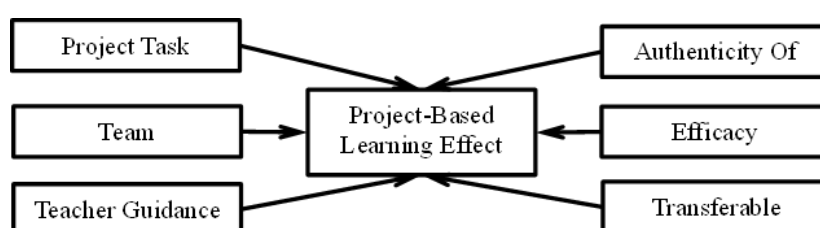


Figure 1. Theoretical Framework Model of this Study.

## Research Methodology

This study employed a quantitative, cross-sectional research design to examine the effectiveness of Project-Based Learning Effectiveness (PBLE) and to compare perceptions between teachers and students in higher vocational education in Henan Province, China.

The population consisted of teachers involved in project-based instruction and students enrolled in project-based courses. Using stratified and convenience sampling, the final sample included approximately 200 teachers and 400–500 students, which was adequate for statistical group comparison.

PBLE was operationalized as a multidimensional construct comprising six dimensions: Project Task Completion, Team Collaboration Ability, Teacher Guidance Effectiveness, Project Authenticity, Self-Efficacy, and Transferable Professional Competency. Background variables of teachers and students were used to examine group differences.

Data were collected in 2025 through online and onsite questionnaires. Descriptive statistics, reliability analysis, independent-samples t-tests, and one-way ANOVA were employed to analyze PBLE implementation and perceptual differences between groups.



Ethical principles were strictly observed, including voluntary participation, informed consent, and confidentiality of respondents' data.

## Research Results

### 1. Overall Implementation of Project-Based Learning

The results show that Project-Based Learning (PBL) has been widely adopted in higher vocational colleges in Henan Province; however, the level of implementation effectiveness varies across institutions. Descriptive results indicate that overall Project-Based Learning Effectiveness (PBLE) was perceived at a moderate to relatively high level. Among the six PBLE dimensions, Project Task Completion (PTC) and Team Collaboration Ability (TCA) were consistently rated higher, indicating that structured task execution and collaborative learning are the most evident strengths of project-based teaching. In contrast, Project Authenticity (PA) and Transferable Professional Competency (TPC) were rated comparatively lower, suggesting limitations in aligning classroom projects with real-world professional contexts

### 2. Structural Characteristics of Teacher and Student Groups

The sample structure analysis confirms substantial diversity among both teacher and student respondents, providing a reliable basis for comparative analysis. Teachers differed in terms of gender, age, professional title, and educational background, while students varied across gender, geographic origin, major categories, and part-time or social practice experience. This structural diversity supports the study's objective of examining heterogeneity in PBLE perceptions and outcomes across different background characteristics.

### 3. Differences in PBLE Perceptions among Teachers

Comparative analyses revealed meaningful differences in PBLE perceptions among teacher groups. Teachers holding higher professional titles and advanced academic qualifications reported significantly higher levels of Teacher Guidance Effectiveness (TGE) and Project Authenticity (PA). In addition, teachers with industry-related experience demonstrated more positive evaluations of collaborative learning processes and competency development. These results indicate that teachers' professional background and experiential capital play an important role in shaping the effectiveness of project-based teaching implementation.

### 4. Differences in PBLE Experiences among Student Groups

Significant differences in PBLE perceptions were also identified among student groups. Students with part-time work or social practice experience reported higher levels of Self-



Efficacy (SE) and Transferable Professional Competency (TPC) than those without such experience. Differences were further observed across major categories, with students in engineering and design-related programs reporting stronger project authenticity and collaboration experiences than students in management-oriented programs. These findings highlight the influence of prior experiential learning and disciplinary context on project-based learning outcomes.

### **5. Comparative Perceptions between Teachers and Students**

A comparative analysis between teacher and student groups revealed notable perceptual discrepancies across several PBLE dimensions. Teachers generally rated Teacher Guidance Effectiveness (TGE) and Project Authenticity (PA) more positively than students, whereas students expressed lower confidence in the extent to which project-based learning supported transferable professional competency development. This gap suggests a misalignment between instructional intentions and learner experiences, reflecting differences in evaluative perspectives between the teaching and learning sides.

### **6. Summary of PBLE Heterogeneity**

Overall, the results confirm that PBLE outcomes are structurally heterogeneous across teachers, students, disciplines, and experiential backgrounds. While project-based learning demonstrates clear strengths in enhancing task completion and teamwork, its effectiveness in fostering authentic learning experiences and transferable professional competencies remains uneven. These findings underscore the need for differentiated instructional strategies, enhanced teacher professional development, and stronger integration of authentic industry projects to improve the consistency and quality of project-based learning implementation.



**Table 1** Integrated Statistical Results of Project-Based Learning Effectiveness (PBLE)

PBLE Dimension	Group	N	Mean	SD	t / F	P-value	Interpretation
Project Task Completion (PTC)	Teachers	198	4.12	0.54	t = 2.87	.004*	Teachers rated PTC higher
	Students	462	3.98	0.61			
Team Collaboration Ability (TCA)	Teachers	198	4.05	0.57	t = 1.94	.053	No significant difference
	Students	462	3.97	0.63			
Teacher Guidance Effectiveness (TGE)	Teachers	198	4.18	0.51	t = 5.42	<.001**	Teachers perceived higher guidance
	Students	462	3.72	0.66			
Project Authenticity (PA)	Teachers	198	3.89	0.58	t = 4.11	<.001**	Perceptual gap identified
	Students	462	3.45	0.70			
Self-Efficacy (SE)	Students (with practice)	231	4.01	0.59	F = 9.36	.002*	Practice experience effect
	Students (no practice)	231	3.68	0.65			
Transferable Professional Competency (TPC)	Teachers	198	3.92	0.56	t = 6.08	<.001**	Students are less confident in transfer
	Students	462	3.34	0.71			

As shown in Table 1, significant differences were found between teachers and students in several dimensions of Project-Based Learning Effectiveness (PBLE). Teachers reported higher levels of Project Task Completion ( $t = 2.87, p = .004$ ), Teacher Guidance Effectiveness ( $t = 5.42, p < .001$ ), Project Authenticity ( $t = 4.11, p < .001$ ), and Transferable Professional Competency ( $t = 6.08, p < .001$ ) than students. No significant difference was observed in Team Collaboration Ability ( $p = .053$ ).

A significant difference in Self-Efficacy was found among student groups based on practice experience ( $F = 9.36, p = .002$ ), with students who had part-time or social practice



experience reporting higher self-efficacy. Overall, these results indicate clear heterogeneity in PBLE perceptions between teachers and students and across learner backgrounds.

**Table 2** Integrated Summary of Project-Based Learning Effectiveness (PBLE) Results

Dimension / Aspect	PBLE Component	Key Findings	Group Differences	Overall Interpretation
Overall PBLE Effectiveness	PBLE (overall)	PBLE was implemented at a moderate to relatively high level across institutions	Varied across teachers, students, and institutions	PBLE is widely adopted but uneven in effectiveness
Learning Process	Project Task Completion (PTC)	Task completion was perceived as one of the strongest aspects of PBLE	Higher among experienced teachers and students with practice experience	Structured project tasks support learning effectiveness
	Team Collaboration Ability (TCA)	Collaboration and teamwork were generally evaluated positively	Stronger in engineering and design-related programs	Collaborative learning is a key strength of PBLE
Instructional Support	Teacher Guidance Effectiveness (TGE)	Teachers rated guidance effectiveness higher than students	Differences by teacher professional title and education level	A perceptual gap exists between teachers and students
Learning Context	Project Authenticity (PA)	The authenticity of projects received comparatively lower evaluations	Higher in institutions with industry collaboration	Limited real-world integration constrains PBLE's impact
Learner Psychology	Self-Efficacy (SE)	Moderate levels of learner confidence were reported	Higher among students with part-time or social practice experience	Prior experience enhances PBLE engagement
Learning Outcomes	Transferable Professional Competency (TPC)	Competency transfer was perceived as relatively weak	Students rated TPC lower than teachers	The transfer from the classroom to the workplace remains insufficient
Teacher Group Differences	Background characteristics	Professional title, education, and industry experience influenced PBLE perceptions	Senior and industry-experienced teachers reported higher PBLE	Teacher capacity is a key determinant of PBLE quality



Dimension / Aspect	PBLE Component	Key Findings	Group Differences	Overall Interpretation
Student Group Differences	Background characteristics	Discipline and practice experience affected PBLE outcomes	Practice-experienced students showed higher SE and TPC	Experiential learning strengthens PBLE effectiveness
Teacher-Student Comparison	Cognitive perception	Teachers consistently rated PBLE dimensions higher than students	Largest gaps in TGE, PA, and TPC	Misalignment between teaching intentions and learning experiences
Overall Heterogeneity	Cross-group analysis	PBLE outcomes are structurally heterogeneous	Differences across roles, disciplines, and experience levels	Differentiated strategies are required for effective PBLE implementation

## Conclusion, Discussion, Suggestion

### Conclusion

This study investigated the effectiveness of Project-Based Learning (PBLE) in higher vocational education by examining teachers' and students' perceptions across six core dimensions: Project Task Completion, Team Collaboration Ability, Teacher Guidance Effectiveness, Project Authenticity, Self-Efficacy, and Transferable Professional Competency. The findings indicate that while project-based learning has been widely implemented under unified national and regional policies, its effectiveness is not uniform but demonstrates clear heterogeneity across teacher and student groups.

Overall, project-based learning shows relatively strong performance in task completion and collaborative learning. However, notable weaknesses remain in project authenticity and the transferability of professional competencies. Moreover, perceptual discrepancies between teachers and students were evident, particularly regarding instructional guidance and competency transfer, suggesting a misalignment between teaching intentions and learning experiences. These results confirm that the effectiveness of project-based learning depends not only on policy adoption but also on contextualized implementation and learner engagement.

### Discussion

The results of this study align with prior research indicating that project-based learning is inherently multidimensional and context-dependent (Thomas, J. W., 2000; Strobel, J. & van



Barneveld, A., 2009). The relatively high ratings for task completion and collaboration suggest that PBL is effective in structuring learning activities and promoting teamwork, which is consistent with constructivist learning theory emphasizing active and social learning processes (Hmelo-Silver, C. E., 2004).

However, the comparatively lower evaluations of project authenticity and transferable professional competency reflect limitations frequently reported in vocational education research. When projects are insufficiently connected to real workplace contexts, students may struggle to perceive the relevance of learning outcomes to professional practice (Billett, S., 2011; Shi, Y., 2024). This finding supports previous studies that highlight authentic industry engagement as a critical determinant of successful PBL implementation.

The perceptual gap between teachers and students further echoes concerns raised in the literature regarding instructional misalignment. Teachers may overestimate the effectiveness of their guidance and project design, while students evaluate learning outcomes based on perceived applicability and personal confidence (Ettington, D. R., 2002; Bell, S., 2010). Additionally, the higher self-efficacy reported by students with social or work experience reinforces Bandura, A. (1997) assertion that mastery experiences play a central role in shaping learners' confidence and engagement.

Taken together, these findings suggest that the heterogeneity of PBLE outcomes is shaped by a combination of instructional design quality, teacher professional capacity, and students' experiential backgrounds. Addressing these factors is essential for improving the consistency and depth of project-based learning in higher vocational education.

## Knowledge of Research

This study contributes to vocational education research by conceptualizing Project-Based Learning Effectiveness (PBLE) as a multidimensional construct encompassing six interrelated dimensions, thereby extending prior studies that relied on limited outcome indicators. Empirically, the findings reveal significant heterogeneity in PBLE outcomes across teacher characteristics, student backgrounds, and disciplinary contexts, challenging the assumption that uniform policy implementation leads to consistent teaching effectiveness. Methodologically, the study proposes a replicable measurement framework for evaluating PBLE at institutional and regional levels. By providing region-specific evidence from Henan



Province, this research offers both theoretical refinement and practical insights for improving the quality and sustainability of project-based learning in higher vocational education.

## Suggestions and Implications

Based on the findings, several practical and policy-oriented suggestions are proposed:

### Enhancing Project Authenticity

Vocational colleges should strengthen collaboration with industry partners to integrate real-world projects into curricula, ensuring that project tasks reflect authentic professional contexts and current industry needs.

### Strengthening Teacher Professional Development

Targeted training programs should be provided to enhance teachers' competencies in project design, facilitation, and formative assessment, particularly for instructors with limited industry experience.

### Implementing Differentiated Instructional Strategies

Given the diverse backgrounds of students, project-based learning should be adapted to varying levels of prior knowledge and experience, with additional scaffolding for students with weaker foundations.

### Improving Evaluation and Feedback Mechanisms

Institutions should adopt process-oriented and multidimensional assessment frameworks to capture better students' learning trajectories, competency development, and growth in self-efficacy.

### Supporting Regional and Policy-Level Optimization

Policymakers should consider regional disparities in resources and institutional capacity when promoting project-based learning, shifting from uniform policy mandates to context-sensitive implementation strategies.

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