Exploring the Reform Practice of an Integrated BOPPPS and PBL Teaching Model in Professional Courses Under the Guidance of OBE

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Abstract. In response to the challenges faced by the traditional teaching of the specialized course “Transportation Organization,” including outdated content, insufficient student engagement, monotonous teaching methods, and rigid evaluation systems, this study constructs a three-layer integrated teaching model characterized by “macro-level guidance via OBE, meso-level driving via PBL, and micro-level closed-loop instruction via BOPPPS.” This model determines course objectives through “reverse design,” integrates “authentic, complex, and open-ended” transportation projects throughout the entire teaching process, and utilizes the structured six-step BOPPPS framework to ensure the depth and effectiveness of each instructional unit. Through a comparative practice over two complete teaching cycles, the effectiveness was validated using methods such as performance analysis, questionnaires, student interviews, and the extension of learning outcomes. The results indicate that this model significantly improves students' course grades, autonomous learning abilities, teamwork skills, and their capacity to solve complex engineering problems, while also effectively enhancing their professional identity.

Keywords: OBE; BOPPPS; PBL; Integrated Teaching; Transportation Organization

1 Introduction

Currently, global technological innovation is advancing with unprecedented intensity. The deep integration of next-generation information technologies—represented by artificial intelligence, big data, and the Internet of Things—with the transportation sector is giving rise to new business formats and models, such as intelligent transportation, smart logistics, and shared mobility. During the 15th Five-Year Plan period, China’s national strategies, including “Building a Country with Strong Transportation Network,” “New Infrastructure,” and “Carbon Peak and Carbon Neutrality,” will continue to deepen, placing higher demands on the efficiency, resilience, green credentials, and intelligence level of transportation systems. The core driving force behind industry transformation is talent. As a core specialized course for the transporta-

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tion engineering major, “Transportation Organization” aims to cultivate comprehensive professionals capable of applying systems engineering thinking to comprehensively solve practical problems in passenger and freight transportation organization, and possessing the skills for operational management optimization and decision support.

2 Dilemmas of the Traditional Teaching Model and Current Research Status

The traditional teaching model of the “Transportation Organization” course faces the following dilemmas: 1) The teaching content is disconnected from industry frontiers. The update speed of textbooks lags significantly behind the iteration and innovation of industry technologies, resulting in delayed coverage of cutting-edge topics such as real-time dispatching, multi-modal coordination, and intelligent decision-making. 2) The teaching method is teacher-centered, leading to insufficient student engagement and autonomous learning. It becomes difficult for students to develop a deep understanding and flexible application of complex optimization problems in transportation organization. 3) The practical component is weak, with a disconnect between theory and application. Course experiments are mostly confined to verification and demonstration, making it challenging for students to deeply engage in authentic transportation organization decision-making processes. 4) The evaluation method is monolithic, emphasizing knowledge memorization over competency development. Assessment relies heavily on final written examinations, making it difficult to comprehensively and authentically measure students' overall competencies.

In response to these challenges, the educational community both domestically and internationally has explored various advanced teaching philosophies and methods in the field of engineering education. Among these, Outcome-Based Education (OBE) emphasizes the reverse design of curriculum systems guided by students’ final learning outcomes, which has become a core concept in engineering education accreditation and provides a top-level framework for course objective setting and evaluation[1]. Problem/Project-Based Learning (PBL) drives students' active learning through problem-based scenarios, demonstrating significant effectiveness in cultivating students’ problem-solving abilities and autonomous learning skills [2][3]. The BOPPPS effective teaching model, with its clear six-stage structure of Bridge-in, Objective, Pre-assessment, Participatory Learning, Post-assessment, and Summary, along with its emphasis on interactive participation, provides an operational and structured tool for classroom instruction [4]. In recent years, numerous scholars have applied these concepts and teaching methods to the reform of specialized courses. Feng et al. [5] integrated the advantages of online and offline learning through Blended Learning, breaking through time and space constraints while enriching teaching resources and interactive formats. Liu et al. [6] constructed a multi-link blended model of “online platform + theory + experiment + fieldwork” based on OBE and PBL in a geology course, achieving the progressive enhancement of students' abilities from foundational knowledge to professional competencies. Zhang et al. [7] explored an

OBE-oriented integrated model combining PAD (Presentation-Assimilation-Discussion) class and PBL in a quality management course, forming a closed instructional loop. Zhao et al. [8] validated the advantages of combining BOPPPS and PBL in improving academic performance and student satisfaction within a medical course context. Zhang et al. [9] utilized the BOPPPS+PBL model to promote industry-education integration in a food technology course.

However, existing research that deeply integrates OBE, BOPPPS, and PBL, while clearly delineating their respective functional roles at the macro, meso, and micro levels and their coupling mechanisms, remains relatively scarce. Particularly for engineering courses characterized by strong systematicity, practicality, and interdisciplinarity, such as "Transportation Organization," exploring a teaching model that can closely align with industry demands, stimulate student agency, and deeply integrate theory with practice has become an inevitable choice for enhancing course teaching quality and cultivating high-quality talents capable of adapting to future transportation development.

3 Theoretical Foundation and Construction of the Integrated Model

3.1 Analysis of Core Concepts

3.1.1 OBE: Top-Level Design and Guiding Role.

The core principle of OBE is "reverse design," which proceeds from societal and industrial needs by first defining the competencies that students should demonstrate upon graduation. Based on these defined competencies, educational objectives are then designed, the curriculum system is constructed, teaching content is organized, and instructional activities are implemented. Finally, an evaluation system is established to verify whether the intended outcomes have been achieved. In this integrated model, OBE assumes the guiding role of a "top-level designer": it determines the competency objectives of the course, ensures that subsequent PBL project design and BOPPPS classroom activities remain oriented toward these objectives, and continuously calibrates the instructional direction through the evaluation system.

3.1.2 BOPPPS: The Meticulous Executor of Classroom Teaching.

The BOPPPS model, serving as a closed-loop instructional design framework that emphasizes student participation and teaching effectiveness, provides a clear, structured process for individual classroom teaching units, ensuring interaction and feedback. In this model, BOPPPS acts as the "executor of micro-level classroom teaching." It guarantees that in every teaching unit, students achieve clear objectives, have comprehensible learning status, engage in deep participation, and receive timely feedback, thereby laying a solid micro-foundation for the attainment of overall course goals.

3.1.3 PBL: The Driving Engine and Connecting Link Throughout the Process.
Through this process, they acquire the embedded knowledge and skills while simultaneously developing their autonomous learning and practical problem-solving abilities. In this integrated model, PBL serves as both the "engine driving learning" and the "connecting link for teaching segments." As an engine, it stimulates students' curiosity and intrinsic motivation to learn through carefully designed complex projects originating from authentic industry demand scenarios. As a connecting link, it integrates potentially fragmented knowledge points, practical skills, and course design tasks, achieving an integrated design and seamless cohesion among theoretical teaching, experimental teaching, and practical teaching.

3.2 Construction of the OBE-Oriented Integrated BOPPPS and PBL Model

OBE, BOPPPS, and PBL are not simply superimposed; rather, based on their intrinsic characteristics, they are organically integrated at different levels and segments of the course teaching process, forming a three-dimensional, closed-loop teaching system (as shown in Fig. 1).

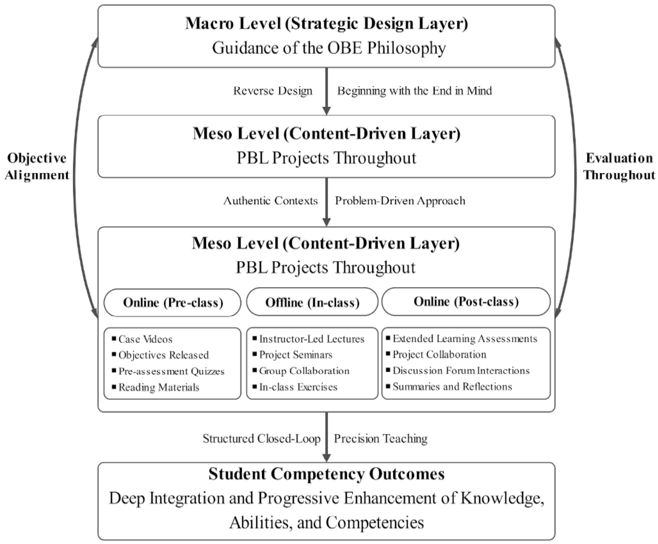


Fig. 1. OBE-Oriented Integrated BOPPPS and PBL Teaching System

3.2.1 Macro Level (Strategic Layer): OBE Guidance.
According to the graduation requirements specified in the talent cultivation program for the transportation engineering major, the specific, observable, and measurable course objectives for "Transportation Organization" are reverse-deduced across the three dimensions of knowledge, ability, and competency. These objectives serve as the overarching guidelines for all activities within the course.

3.2.2 Meso Level (Tactical Layer): PBL Driving and Integration.

The course objectives are decomposed into several representative authentic projects. These projects cover the core knowledge modules of the course and possess appropriate complexity and openness. Each project is scheduled within a specific teaching period, becoming the central task and contextual background for the teaching activities at that stage.

3.2.3 Micro Level (Operational Layer): BOPPPS Unit-Based Implementation and Blended Online and Online Delivery.

A series of BOPPPS teaching units are designed for the core theoretical knowledge points and practical skills involved in each PBL project. Each unit follows the closed-loop process of “Bridge-in, Objective/Outcome, Pre-assessment, Participatory Learning, Post-assessment, and Summary,” and flexibly adopts a blended online and offline delivery mode.

3.2.4 Continuous Evaluation Throughout the Process.

Based on the OBE philosophy, a multi-faceted evaluation system mapped to the course objectives is established. The evaluation covers all segments, including classroom performance, interim reports during the PBL project process, contributions to group discussions, comprehensive project reports, defense performance, and the final comprehensive assessment. By combining process assessment with summative assessment, the system comprehensively measures students’ attainment levels in knowledge, abilities, and competencies.

4 Practical Application in the "Transportation Organization" Course

4.1 Restructuring of Course Objectives and Content System Based on OBE

A course objective revision team was established, consisting of course instructors, industry experts, and student representatives. Aligning with engineering education accreditation standards, the undergraduate talent cultivation program for the transportation engineering major, and the talent market demands of the intelligent transportation industry, the original course objectives and teaching content of “Transportation Organization” were reviewed and restructured [10].

4.1.1 Reverse Design of Measurable Course Learning Objectives.

Course Objective 1 (Knowledge): Students will be able to describe the fundamental composition and operational principles of transportation systems, as well as the basic theories, methods, and techniques of transportation organization and management; distinguish the technical and economic characteristics and applicable scopes of different transportation modes; and apply core models and algorithms to conduct transportation demand analysis, network planning, operational scheduling, and benefit evaluation.

Course Objective 2 (Ability): Students will be able to employ qualitative and quantitative methods to forecast freight and passenger transportation demand; design appropriate transportation organization schemes and conduct simulations using relevant software; comprehensively evaluate transportation organization schemes in terms of efficiency, cost, reliability, and environmental impact; and collaboratively complete a relatively complex transportation organization project within a team, while demonstrating effective oral and written communication skills.

Course Objective 3 (Competency): Students will be able to cultivate a modern transportation philosophy emphasizing safety, efficiency, sustainability, and intelligence; develop decision-making capabilities under uncertain conditions; and understand the professional ethics and social responsibilities associated with transportation organization.

4.1.2 Restructuring of Modular and Project-Oriented Teaching Content.

The traditional textbook structure, organized by separate chapters for different transportation modes (highway, railway, waterway, aviation), was reconfigured. The content system was restructured around "transportation organization business processes" and "core decision-making problems," resulting in four major modules: Module 1: Foundational Concepts and Demand Analysis. This module covers an introduction to transportation organization and transportation demand forecasting methods. It aligns with the preliminary background analysis phase of the PBL project. Module 2: Scheme Design and Core Techniques. As the core module, this encompasses transportation organization processes and methods, selection and combination of transportation modes, transportation route planning, transportation plan compilation, loading and unloading process organization, and transportation dispatching with real-time control. Each technical element can function as a key sub-problem within the PBL project. Module 3: System Evaluation and Intelligent Evolution. This module includes transportation organization evaluation indicators, service quality evaluation for transportation organization, green logistics and low-carbon transportation, and multimodal transport. It corresponds to the evaluation and extended innovation components of the PBL project.Module 4: Comprehensive Practice and Cutting-Edge Topics. This module integrates applications through course design and transportation simulation projects, while introducing cutting-edge topics through seminars on the application of big data and artificial intelligence in transportation organization.

4.2 Cross-Stage Project Design Based on PBL

Two to three major PBL projects spanning the entire semester were designed. These projects were primarily derived from authentic optimization requirements of transportation management departments and transport enterprises, faculty-led horizontal research projects, problem statements from national logistics design competitions, and adaptations of classic academic case studies. This study presents the project "Optimization Design of Transportation Organization for an Urban Scenic Area" as an illustrative example, with the following design specifications:

4.2.1 Project Background.

Students are provided with data pertaining to the road network surrounding a specific urban scenic area, public transportation facilities, static traffic facilities, traffic operation data, as well as identified problems including inadequate supporting facilities, difficulties in traffic order management caused by overcrowding during peak passenger flow periods, and insufficient parking supply and guidance mechanisms.

4.2.2 Overall Project Task.

Working in groups, students are required to design transportation organization optimization schemes encompassing regional road network construction, parking facility design, public transportation optimization (including conventional buses, customized buses, shared bicycles, etc.*)*, regional traffic organization optimization, and traffic management countermeasures.

4.2.3 Project Decomposition and Cross-Stage Integration (as Shown in Fig. 2)

Stage 1 (Theory-Driven Instruction): During BOPPPS instructional units covering topics such as "Transportation Demand Forecasting," "Public Transportation Operation Organization," and "Road Passenger Transportation Organization," the project problem serves as a bridge-in activity and a case study for classroom discussions. Students are required to complete forecasts of scenic area passenger flow and parking demand, as well as analyses of transportation mode choice behavior.

Stage 2 (PBL Classroom Integration): Group discussions are conducted with detailed task allocation. The group leader decomposes the overall project task into subtasks, and group members, based on their respective subtask assignments, design transportation organization optimization schemes for specific problems, producing documented outcomes that include both textual descriptions and graphical illustrations.

Stage 3 (Course Design Consolidation): Each group consolidates the analytical results from previous stages to formulate a comprehensive optimization design proposal, followed by presentation sessions for sharing and peer review. Finally, the instructor provides summary remarks and facilitates reflective discussions on the completed work.

a) Group Discussion b) Proposal Presentation c) Instructor Feedback

Fig. 2. Classroom Implementation Photos of the PBL Approach

Table 1. Example of the Diversified Whole-Process Evaluation System for the "Transportation Organization" Course

<table>
<tr><td colspan="3">Course Objectives</td><td>Goal 1: Knowledge Goal</td><td>Goal 2: Competence Goal</td><td>Goal 2: Literacy Goal</td><td>Total</td></tr>
<tr><td colspan="3">Specific Description of Goals</td><td>Elaborate the basic principles of transportation organization, distinguish technical characteristics, and apply core models.</td><td>Be capable of conducting demand forecasting, designing transportation organization schemes, performing simulation, conducting comprehensive evaluation, and possessing the ability of team collaboration.</td><td>Establish the concept of sustainable development of modern transportation, the overall concept of coordination and win-win results, and the sense of responsibility that prioritizes safety.</td><td></td></tr>
<tr><td rowspan="3">Assessment Method (Percentage)</td><td rowspan="3">Process Assessment Score</td><td>After-class Assignments</td><td>5%</td><td>12%</td><td>3%</td><td rowspan="3">60%</td></tr>
<tr><td>Classroom Performance/In-class Tests</td><td>5%</td><td>8%</td><td>2%</td></tr>
<tr><td>PBL Projects</td><td>2%</td><td>15%</td><td>8%</td></tr>
<tr><td></td><td colspan="2">Summative Assessment Score</td><td>8%</td><td>25%</td><td>7%</td><td>40%</td></tr>
<tr><td colspan="3">Key Observation Points for Scoring</td><td>Accuracy rate of online quizzes and standardization of homework; classroom Q&A and exercises; accuracy of theoretical citations in project reports; scores of final objective questions.</td><td>Assignment completion quality; Depth of case analysis; Needs identification, scheme design, team division of labor and contributions in project reports; Score on comprehensive application questions in the final examination.</td><td>Value judgments in classroom discussions and PBL project discussions; considerations of sustainability and a sense of responsibility in project schemes; value orientations in final case analysis.</td><td rowspan="2"></td></tr>
<tr><td colspan="3">Considerations for Weight Setting</td><td>Foundational knowledge serves as the basis for competency development.</td><td>PBL projects and comprehensive applications function as the primary vehicle.</td><td>Literacy is internalized in the learning process.</td></tr>
</table>

4.3 Design of Blended Classroom Teaching Units Based on BOPPPS

Taking the public transportation network planning and optimization design component involved in the PBL project "Optimization Design of Transportation Organization for an Urban Scenic Area" as an example, this study illustrates the implementation of a BOPPPS-based blended teaching unit centered on the core knowledge point "Public Transportation Operation Organization" in the "Transportation Organization" course.

1) Bridge-in: By presenting issues such as the limited number of bus routes serving the scenic area, tourist complaints regarding low public transportation mode share, and Baidu heat maps during peak periods at the scenic area, the core question is introduced: "optimizing network planning and operation organization does not rely on intuition or experience."

2) Objectives: Upon completion of this lesson, students are expected to achieve the following competencies: 1*)* Describe the characteristics of different network patterns, including trunk lines, regular lines, and feeder lines; 2*)* Apply the "point-line-area" hierarchical model to conduct network optimization; 3*)* Preliminarily analyze simple cases using the conceptual approaches of the "route-by-route method" and the "system optimization method."

3) Pre-assessment: Three multiple-choice questions are released through the learning management platform to assess students' foundational knowledge.

4) Participatory Learning: 1*)* Focused Instruction: The instructor delivers concise lectures on core concepts of network patterns and hierarchy, network evaluation indicators, and public transportation operation organization models. 2*)* Group Activity: Students attempt to plan a new route using manual methods or simple drawing tools by applying the "route-by-route method," and provide justifications for their design. Groups engage in mutual questioning and evaluation of each other's proposals. 3*)* Guided Advancement: The instructor introduces the concept of the "system optimization method" and guides students to contemplate the progression from "manual experience-based approaches" to "model-based optimization."

5) Post-assessment: Given a new simplified scenario and two predetermined optimization schemes, students are asked to quickly select the superior scheme and briefly explain their reasoning.

6) Summary: The instructor summarizes the advantages, disadvantages, and applicable scenarios of both optimization methods.

4.4 Construction of a Diversified Whole-Process Evaluation System

In contrast to traditional isolated and summative teaching evaluation, this study constructs a diversified process-oriented evaluation system featuring the deep integration of the three-layer OBE-PBL-BOPPPS framework. Evaluation is repositioned as a core feedback mechanism embedded throughout the entire teaching process, driving learning improvement and directly verifying the achievement of final outcomes. This system comprehensively assesses students' mastery of foundational knowledge, application of knowledge points, practical problem-solving abilities, teamwork skills, as well as their comprehensive capabilities in autonomous learning and practical innovation. The entire assessment framework consists of two main components: process assessment and summative assessment, accounting for 60% and 40% respectively. The larger proportion allocated to process assessment reflects the industry market demand for practical competencies. Each assessment item is graded on a percentage scale, with specific evaluation indicators and weighting factors presented in Table 1. Furthermore, the content design of each assessment item establishes a complete mapping to the formulated course objectives, thereby satisfying the requirement for quantifiable evaluation while simultaneously achieving a transformation of the assessment system from emphasizing scores, final examinations, and individual performance to emphasizing outcomes, processes, and the integration of both team and individual performance.

5 Analysis of Teaching Practice Effectiveness

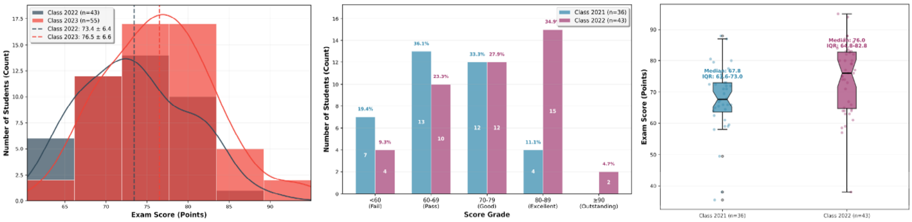
To verify the effectiveness of the model, a cluster sampling method was adopted, using natural class groupings as units to select two classes from two complete teaching cycles of the transportation engineering major at our university for comparative teaching practice. Specifically, Class 1 of Grade 2021 (36 students) from the transportation engineering major in the second semester of the 2023-2024 academic year served as the control group, receiving a traditional lecture-based model supplemented by in-class case practices. Class 1 of Grade 2022 (43 students) from the transportation engineering major in the second semester of the 2024-2025 academic year served as the experimental group, receiving the integrated teaching model proposed in this study. Both classes were taught by the same team of instructors, covered the same core content from identical textbooks, and had the same total instructional hours.

5.1 Quantitative Analysis of Effectiveness

5.1.1 Comparison of Academic Performance.

As shown in Fig. 3 and Table 2, the mean final course score of the experimental class (Grade 2022, Class 1) was 74.44, while that of the control class (Grade 2021, Class 1) was 67.53, representing an increase of 6.91 points in the experimental class. The independent samples t-test results revealed a statistically significant difference ($t = -3.0247$, $p = 0.0034 < 0.01$), leading to the rejection of the null hypothesis that "there is no difference in the mean scores between the two classes" at the 0.01 significance level. This indicates a highly significant difference in the "Transportation Organization" course examination scores between the two classes, with the difference not attributable to chance factors. The 95% confidence interval [2.23, 11.59] does not contain zero, confirming the stability of this difference. Regarding score distribution, the proportion of students achieving excellence (scores ≥ 80) in the experimental class was 39.53%, substantially higher than the 11.11% in the control class. It is evident from these core indicators of final academic performance that the experimental class significantly outperformed the control class. Additionally, effect size analysis using

Cohen's d as the effect size measure yielded Cohen's d = 0.6832, indicating a medium effect size. This demonstrates that the 6.91-point difference in mean scores between the experimental and control classes is not only statistically significant but also pedagogically meaningful, suggesting that this difference can have a substantial impact on students' mastery of the course content and their subsequent learning.



a) Histogram of Score Distribution

b) Comparison of Score Distribution by Performance Level

c) Boxplot Comparison of Scores

Fig. 3. Comparative Analysis of Academic Performance Between Experimental Class and Control Class

5.1.2 Self-Assessment Questionnaire on Competencies.

Upon completion of the course, an anonymous questionnaire survey was conducted using a self-developed "Course Learning Experience and Competency Self-Assessment Questionnaire." Questions were posed across five dimensions: theoretical knowledge application, professional software proficiency, teamwork capability, professional interest stimulation, and assessment fairness. Each dimension contained 3-5 questions aligned with the course objectives, totaling 20 items, and utilized a five-point Likert scale (1 = strongly disagree, 5 = strongly agree). The comparative results are shown in Fig. 4. It can be observed that, particularly in the dimensions of teamwork capability and professional interest stimulation, the integrated teaching model enhanced students' motivation for active learning.

Table 2. Comparison of Core Academic Performance Indicators Between Experimental Class and Control Class

Comparison Indicators	Class 1 Grade 2021	Class 1 Grade 2022	Difference
Mean Score	67.53	74.44	+6.91
Median	67.75	76.00	+8.25
Failure Rate	19.44%	9.30%	-10.14%
Excellence Rate (≥80)	11.11%	39.53%	+28.42%
Distinction Rate (≥90)	0.00%	4.70%	+4.70%
Maximum Score	88.0	95.0	+7.0

5.2 Qualitative Analysis of Effectiveness

5.2.1 Student Interview Feedback.

To gain deeper insights into students' actual experiences and perceived benefits from the curriculum reform, the teaching team conducted sampled interviews with students from the experimental class using a semi-structured interview protocol. Core questions addressed students' perceptions of the integrated model, identification of the most challenging and rewarding components, and self-assessments of changes in their competencies. Based on the criteria of covering different performance tiers and diverse roles assumed in the PBL projects, 12 students were sampled from the 43 students in the experimental class for in-depth interviews. Student A stated: "Previously, I thought transportation organization was just about memorizing content and solving problems—very tedious. Now, through working on the scenic area transportation organization project, I feel that every knowledge point has come alive. I understand where they are applied and how to use them, which gives me a great sense of achievement." Student B remarked: "There were some conflicts in group work at the beginning, but to complete the project, we had to divide tasks, discuss, and compromise. During the final defense, our group collaborated very well, and I think this is more important than simply achieving high scores."

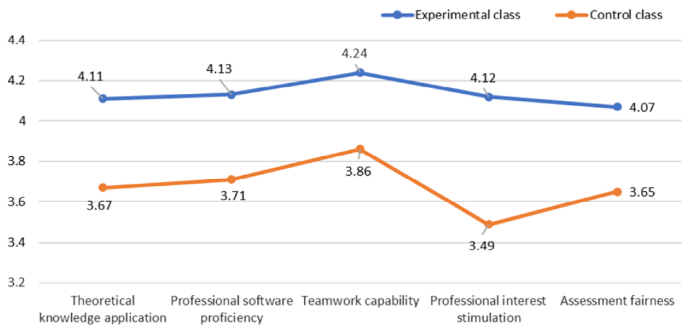


Fig. 4. Comparison of Questionnaire Survey Data Between the Experimental Class and the Control Class

5.2.2 Project Outcomes and Extended Effects.

The quality of PBL project outcomes in the experimental class was generally high, with some proposals demonstrating notable innovation. Notably, two groups, inspired by their project achievements and after further refinement, achieved significant recognition. One group participated in the annual "Guangxi University Students Innovation and Entrepreneurship Training Program" and received national-level project funding of 20,000 RMB. The other group participated in the "National 3D Digital Innovation Design Competition" and won second prize. Furthermore, influenced by the enhanced interest in this course, 23.4% of students in the experimental class ultimately chose research directions related to transportation organization for their graduation theses, compared to 15.32% in the control class, demonstrating a marked increase in students selecting transportation organization-related research topics for their subsequent graduation projects.

5.3 Implementation Challenges and Resource Support

The in-depth implementation of the OBE-oriented integrated BOPPPS and PBL teaching model also presents certain challenges. One significant issue is the substantial increase in instructor workload. During the initial implementation, curriculum restructuring activities—including objective formulation and mapping, PBL project design, and BOPPPS unit development—required approximately two to three times the time investment of traditional lesson preparation. Throughout the teaching process, the high-frequency process-oriented evaluation and guidance added an average of four to five hours of weekly workload. Additionally, resource requirements are considerable, necessitating the collection and screening of authentic project cases from transportation enterprises, secondary project design, and substantial support from industry collaboration channels. Therefore, to promote the sustainability and scalability of this model, the course team will continuously iterate the teaching content and progressively refine the following aspects: 1) Development of standardized templates, including three-layer integrated teaching design templates, PBL project task specification templates, and BOPPPS lesson plan templates, thereby lowering the threshold for course design. 2) Collaborative construction and sharing of a teaching resource repository, including authentic PBL project case libraries, micro-lecture video libraries, and evaluation indicator databases, supporting instructors in on-demand selection and continuous updating. 3) Optimization of teaching support structures and technological platforms, fully utilizing online teaching platforms (such as Chaoxing Xuexitong) to construct course resource repositories and establish online project collaboration and communication platforms. 4) Pursuit of institutional support, incorporating the workload of in-depth teaching reform into performance evaluation and recognizing it as significant teaching achievement.

6 Conclusion

In response to the need for teaching reform in the “Transportation Organization” course, this study constructs an OBE-oriented integrated teaching model combining BOPPPS and PBL. This model employs OBE as strategic guidance, PBL as tactical driving force and integration, and BOPPPS for meticulous implementation, while integrating theoretical instruction, experimentation, and practice through blended online and offline approaches, thereby establishing a diversified whole-process evaluation system. Practical results demonstrate that this model effectively enhances students’ academic performance and active learning engagement, significantly strengthens students’ practical capabilities in solving complex engineering problems, teamwork skills, and innovative awareness, and stimulates students' professional learning interest and career identity. However, as an emerging teaching model, certain limitations exist. First, regarding internal validity, although the study employed a quasiexperimental design and conducted equivalence tests for BOPPPS pre-assessments, it could not completely control for potential confounding factors such as motivational differences between cohorts and students' individual extracurricular time investment. Second, regarding external validity, the study was validated only within a single institution and specific major, with a limited sample size. Consequently, the generalizability of this model across different disciplines, class sizes, and institutional educational philosophies remains to be verified. Furthermore, regarding evaluation instruments, the study primarily relied on self-developed questionnaires and qualitative interview analysis; future research could introduce more standardized quantitative assessment tools for more precise measurement. Looking forward, future work may explore the integration of artificial intelligence tools to assist in personalized learning path planning and project process management, and promote the interconnected reform of this integrated teaching model across the transportation engineering curriculum cluster, thereby providing solid course teaching support for cultivating innovative talents capable of meeting the strategic demands of a transportation powerhouse.

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