



# Teaching Reform Practice for Cultivating Applied Talents in Emerging Engineering Fields Driven by the OBE+PBL Dual-Track Approach: A Case Study of the Prefabricated Concrete Structure Course

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**Abstract.** Prefabricated construction will have a profound impact on driving the transformation of the construction industry. Cultivating applied talents in emerging engineering fields with expertise and skills in prefabricated construction has become a crucial task for civil engineering programs in universities. As a core course in the prefabricated building direction, the course of prefabricated concrete structures has strong practicality, which makes it difficult for the traditional teaching mode to effectively combine theory with practice. To explore more practical and efficient teaching methods, we integrated the OBE and PBL concepts and implemented reforms in terms of teaching objectives, curriculum content, assessment methods, and teaching methodologies. Practice has demonstrated that the OBE+PBL dual-track driven teaching approach effectively integrates theory and practice, holding significant value in cultivating application-oriented talents for emerging engineering disciplines who can adapt to industrial transformations in the new era.

**Keywords:** OBE + PBL, New Engineering Education, application-oriented talents, prefabricated concrete structures, teaching reform.

## 1 Introduction

The *14th Five-Year Plan* (2021) of China underscores the need to strengthen the development of emerging engineering disciplines and promote the cultivation of application-oriented talents, aiming to align with the requirements of technological advancement and industrial transformation in the new age<sup>[1]</sup>.

China's real estate sector is undergoing a critical phase of transformation<sup>[2]</sup>. Prefabricated building structures, with their advantages of superior quality, high efficiency, and environmental benefits, are poised to drive the industrialization and green transformation of the construction sector. This shift, however, demands a substantial workforce equipped with specialized knowledge and skills in prefabricated technologies. To address this need, the author's institution has introduced the course *Prefabricated Concrete Structures*, which integrates traditional concrete structure design with emerging

prefabrication techniques. As a highly practice-oriented course, conventional lecture-based teaching struggles to bridge theory and practice effectively. Thus, exploring more practical and efficient pedagogical methods is imperative to better nurture application-oriented talents in emerging engineering fields suited to industrial transformation.

Against this backdrop, this study combines the principles of OBE and PBL to explore innovative teaching reforms in the *Prefabricated Concrete Structures* course.

## 2 Course Overview and Key Reform Points

Prefabricated concrete structures is one of the core specialized courses in the prefabricated building discipline of civil engineering. Building upon traditional cast-in-place concrete structures and guided by current codes and standards, this course elaborates on the design concepts, methods, and practical applications of prefabricated concrete structures, serving as a highly practical professional technical course.

The course faces several instructional challenges, specifically manifested in the following aspects:

1. Novel Content and Limited Teaching Resources, Instructors must compile and organize teaching content from diverse resources.

2. Content Overload vs. Insufficient Class Hours: The course is required to integrate content from two subjects—*Concrete Structure Design* and *Prefabricated Concrete Design*—but is allocated only the class hours of a single course, leading to an overall shortage of instructional time.

3. High Prerequisite Knowledge Demands and Abstract Theory: Students' less-than-ideal grasp of course knowledge such as structural mechanics leads to a lack of confidence and diminished motivation.

4. Disconnect Between Theory and Practice: While the course emphasizes practical application, students tend to rely on rote memorization and struggle to apply theoretical knowledge to practical scenarios.

5. Single Assessment Method: The current evaluation system relies heavily on attendance, homework, and final exams, failing to comprehensively assess the achievement of competency-based learning objectives.

## 3 Connotation and Applicability Analysis of OBE and PBL

Outcome-Based Education (OBE), proposed by American educator Spady, is a student-centered educational philosophy that prioritizes the final learning outcomes of students<sup>[3,4]</sup>. It focuses on outcome orientation, emphasizes the achievement of learning outcomes through systematic assessment and feedback mechanisms to meet curriculum and program objectives.

Problem-Based Learning (PBL) is a constructivist teaching methodology that emphasizes learning through solving authentic or complex problems, fostering student initiative and practical abilities. Through inquiry-driven approaches, it cultivates students' capacity to apply knowledge to address actual challenges, thereby enhancing comprehensive competencies<sup>[5-6]</sup>.

Both methodologies are student-centered, aligning with contemporary educational philosophies. Moreover, they complement each other in teaching and learning: OBE provides a structured framework, clarifying learning outcomes and assessment criteria. OBE guides the design of PBL problems. OBE's assessment mechanisms provide feedback to refine learning strategies in PBL. PBL offers concrete pedagogical strategies, operationalizes OBE's outcomes by translating theoretical knowledge into practical application.

Therefore, by combining the two approaches, we can fully leverage their respective strengths, thereby holistically enhancing students' comprehensive competencies in practice.

To cultivate applied talents in emerging engineering disciplines, the precast concrete structures course requires students to master theoretical knowledge and apply it to solve practical engineering problems, thereby bridging the gap between theory and practice. During the teaching process, the OBE (Outcome-Based Education) and PBL (Problem-Based Learning) concepts are integrated: First, clear teaching objectives are set based on OBE to define curriculum content and establish a comprehensive assessment mechanism. Subsequently, leveraging the OBE-defined objectives, PBL methodologies are employed to incorporate real-world engineering challenges into instruction, thereby enhancing students' practical application capabilities.

## **4 Implementation of Teaching Reform Based on OBE+PBL**

### **4.1 Defining Course Objectives**

Based on the OBE philosophy, and integrating industry needs, professional training goals, and course characteristics, the course objectives are defined with a student-centered approach.

1. Knowledge Objectives: Students are required to master the concept of precast concrete structures; the types and fundamental requirements of commonly used materials; the classification and general layout principles of precast concrete structural systems; the design methods of precast reinforced concrete composite floor system; the design methods of monolithic precast concrete frame structures; the design approaches and key considerations of monolithic precast concrete shear wall structures; and the design methods for splitting and connecting common precast components.

2. Skill Objectives: Students should develop the ability to comprehensively apply knowledge for analyzing and designing prefabricated concrete structures, solving practical engineering problems, and integrating theory with practice; the ability to research, acquire information, and pursue lifelong learning; and preliminary capabilities in scientific research, and technological innovation.

3. Ethical and Quality Objectives: Cultivate patriotism and national pride; strengthen professional confidence, learning motivation, and the belief in contributing to society through technology; foster professional ethics, dedication, and a craftsman spirit of excellence; develop teamwork, integrity, and a sense of responsibility; inspire innovation in materials, technologies, and processes for prefabricated structures.

## 4.2 Restructuring Teaching Content

Based on the OBE philosophy and aligned with the course objectives, adjustments have been made to the curriculum considering the foundational knowledge of students at our university. Relevant knowledge on cast-in-place concrete structure has been incorporated into the course. This integration bridges traditional cast-in-place concrete and pre-cast concrete structures, fostering a more comprehensive knowledge system for students. To optimize content delivery, portions of Chapter 7 have been interwoven into Chapter 4, Chapter 5, and Chapter 6.

Additionally, due to expanding curriculum content and limited class hours, we removed the construction-related content from the textbook. The freed-up class time is reallocated to reinforce cast-in-place concrete structure design knowledge. To fulfill OBE's ideological-political and competency development goals, the course integrates ideological-political case studies and cutting-edge engineering knowledge. Table 1 highlights selected ideological-political elements incorporated into the curriculum.

**Table 1.** Table Curriculum Ideological and Political Elements.

Teaching Content	Font size and style
Introduction	National policies and "super projects" to inspire pride and innovation.
Features	Quotes from <i>The Book of Changes</i> to emphasize teamwork.
Materials	Innovative materials to stimulate creativity.
Frame Design	Cultivating craftsmanship and lifelong learning.

Based on the PBL concept, the teaching process integrates actual engineering projects with course content to enhance students' practical application capabilities. For instance, in the first class session, students receive architectural drawings of the college office building and are required to learn how to complete a full prefabricated concrete structure design based on these drawings throughout the semester. When teaching Chapter 4 on composite slab design, a floor system design project is assigned beforehand. Similarly, before covering Chapter 5 on frame structure design, students are given a real-world frame structure design project. The instruction combines theoretical explanations with guided project implementation, enabling students to understand how to apply acquired knowledge to complete projects. Figure 1 illustrates the teaching arrangement integrating OBE and PBL methodologies.

## 4.3 Reform of Teaching Methods

To address students' weak foundational knowledge and low learning motivation, we have reformed teaching methodologies. A transfer teaching method is adopted to facilitate comparative learning between cast-in-situ structures and prefabricated structures. Digital tools like Rain Classroom are utilized to manage and optimize teaching content, processes, and outcomes.

In alignment with the PBL philosophy, the course emphasizes an inverted classroom model. Students are first presented with real-world problems, followed by targeted

knowledge delivery, encouraging self-directed and inquiry-based learning to deepen understanding. Digital models of prefabricated concrete structures are created, and virtual simulation technology is utilized for visual demonstrations, helping students grasp complex concepts.

Various methods such as inter-group competitions, drumbeat passing, random roll calls, error-spotting games, quick-response quizzes, group discussions, and student presentations are used in the classroom to increase student engagement, stimulate interest and innovation, and enhance critical thinking skills.

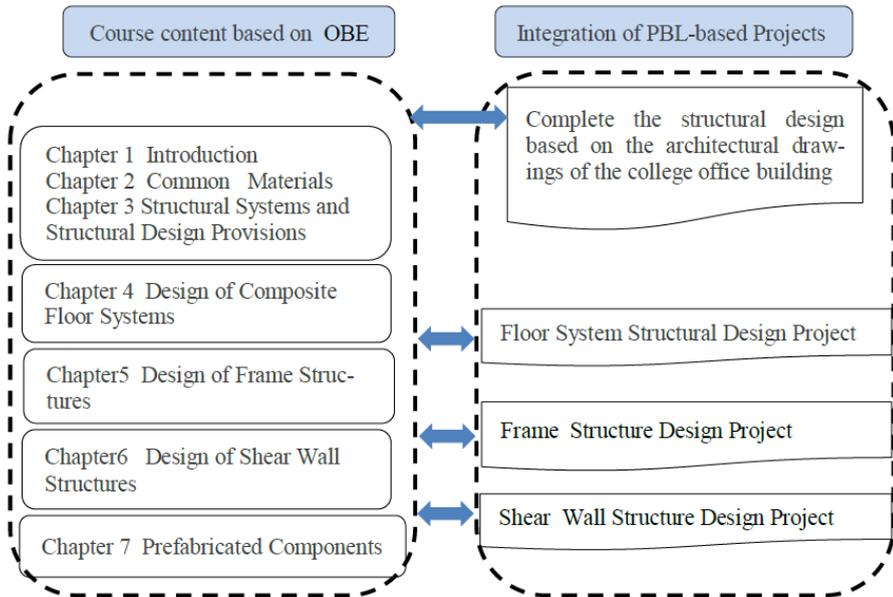


Fig. 1. Curriculum Arrangement under the OBE + PBL Model.

#### 4.4 Reform of Teaching Evaluation

To comprehensively assess students' mastery of knowledge, skills, and attitudes, the traditional "one-exam-determines-all" approach has been abandoned. The weight of final exam scores in the overall grade has been reduced, while process-oriented assessments have been strengthened. Indicators such as pre-class preparation, in-class participation, classroom discussions, attendance, homework, and post-class surveys are now incorporated into the grading system. This allows for a better understanding of students' learning progress throughout the course and enables timely adjustments to teaching strategies based on their performance.

To reflect the higher-order and challenging nature of assignments, some more difficult tasks are included as advanced homework (e.g., targeted case studies, or research tasks). These aim to cultivate students' ability to solve complex engineering problems and expand their knowledge of cutting-edge disciplines.

In classroom assessments, practical skill evaluations have been incorporated. For instance, when teaching Chapter 3, students are tasked with observing campus

buildings, selecting a structure of interest to draft its structural floor plan, analyzing the strengths and weaknesses of its layout using theoretical knowledge, and presenting their findings in class. This approach cultivates comprehensive competencies including the ability to connect theory with practice, critical thinking, and communication skills.

## 5 Conclusion

Over the past five years, the author has conducted four iterations of teaching reform in the *Prefabricated Concrete Structures* course. In the latest teaching cycle, grounded in a dual-track OBE+PBL-driven model, the course increasingly integrated real-world projects while adopting diversified teaching methodologies and assessment mechanisms. Feedback from post-course student surveys, classroom observations, academic performance evaluations, peer assessments, and competition achievements indicates significant improvements in classroom engagement. Students demonstrated enhanced self-directed learning, practical application, creativity, teamwork, and communication skills. Notably, participants achieved outstanding results in structural design and modeling competitions, including securing first place nationally in the prefabricated structure design category at the 2nd Yingjian Cup National Intelligent Building Design Competition.

It can be seen that for the practice-oriented *Prefabricated Concrete Structures* course, the exploration of a dual-track teaching model driven by OBE+PBL integration has achieved a deep convergence of theoretical knowledge and engineering practice. Such an approach holds significant value in cultivating application-oriented talents equipped with both a solid theoretical foundation and exceptional practical capabilities.

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