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Innovative Research and Practice of Prefabricated Building Classroom Teaching Mode under the Background of New Engineering Education

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Abstract: Prefabricated buildings, as typical representatives of green buildings, represent a fundamental transformation of traditional construction methods. Against the backdrop of the coordinated development of new-type building industrialization and intelligent construction, the transformation and upgrading of the civil engineering industry is continuously accelerating, with industry characteristics showing new features of industrialization, digitalization, and intelligence. Under the background of New Engineering Education, aligning with industry development trends, centering on student development, and guided by job requirements, this study leverages digital technology to promote the cultivation of prefabricated building talents and innovates the "Five-Step Progression" teaching model, covering the entire process of talent cultivation. It aims to cultivate students' genuine knowledge, genuine ability, and genuine practice, preparing them to become skilled talents for the future construction industry.

Keywords: Prefabricated building; New Engineering Education; Digital technology; Innovation

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1. Introduction

Faced with the profound transformations of industrialization, digitalization, and intelligence in the construction industry, traditional classroom teaching models have become a major bottleneck in cultivating high-quality prefabricated building talents. To address the disconnection between teaching and practice and the lack of student innovation capability, this research, based on the concept of New Engineering Education and focusing on the core aspect of classroom teaching, proposes an innovative teaching model with the "Five-Step Progression" as its core concept. Through digital empowerment and process reengineering, this model runs through the entire talent cultivation process, committed to achieving students' comprehensive progression from knowledge to skills. It represents an active practice in responding to industry talent demands and promoting engineering education reform.

2. Innovation background

2.1. Course introduction

"Prefabricated Building" is a professional expansion course established under the background of New Engineering Education to meet industry development needs. This course is offered for civil engineering majors in the sixth semester, totaling 32 credit hours and 2 credits. The theoretical component comprises 24 credit hours, focusing on the structural characteristics of prefabricated buildings, knowledge of prefabricated building design, production of precast components, transportation and installation, construction safety and management, etc. The practical component comprises 8 credit hours, comprehensively utilizing digital technology to achieve whole-process control in prefabricated structural design, production, and construction.[1]

2.2. Course teaching philosophy and objectives

2.2.1. Philosophy

This course is student-development-centered and job-demand-oriented, adopting the "Five-Step Progression" teaching model. It integrates new technologies such as BIM, intelligent construction, and RFID, utilizes information-based teaching methods, emphasizes the inheritance and innovation of architectural culture, and adheres to the teaching philosophy of aligning industry and education.

2.2.2. Objectives

Based on the talent cultivation orientation and job requirements for civil engineering majors at our university, the teaching objectives of the "Prefabricated Building" course are defined.

(1) Knowledge aspect: Familiarize with policies and standards related to prefabricated buildings; master the structural characteristics of different types of prefabricated buildings; understand the entire industrial chain process and content of building industrialization; master the types of precast components, component production, transportation, and main construction processes; with the help of digital technologies such as intelligent construction, VR, and RFID, master their application in various stages of prefabricated building design, component production, and construction; through the study of new technologies, achieve industrialized, informationalized, and digitalized management in construction.[2]

(2) Ability aspect: Possess the ability to read prefabricated building drawings; possess preliminary design and management capabilities necessary for prefabricated building design, component production, construction installation, etc., and the ability to solve moderately complex problems; cultivate teamwork awareness and good communication skills through division of labor and cooperation.

(3) Affective aspect: Exercise practical ability, enhance learning interest; utilize diversified learning methods to increase learning enjoyment and achieve the goal of deep understanding of knowledge.[3]

(4) Quality aspect: Cultivate students to possess a rigorous, pragmatic, and hard-working style; enhance awareness of quality, safety, and responsibility; establish concepts of green building, carbon reduction, and innovation.

2.3. Learning situation analysis and teaching pain points

2.3.1. Learning situation analysis

(1) Possess certain professional foundational knowledge. Students have studied prerequisite courses such as "Building Construction Technology" and "BIM Technology Software Application" during their freshman and sophomore years.

(2) Students come from various civil engineering majors, and their mastery of professional knowledge varies.

(3) Enjoy accepting challenges. Young people enjoy challenging new things that are difficult and from which they can gain a sense of achievement.[4]

2.3.2. Teaching pain points

(1) With the accelerated transformation and upgrading of the construction industry, the industry's demand for talent skills is constantly increasing. Under the New Engineering Education background, there is a need for composite talents who "understand management, can construct, and possess high quality." Therefore, there is an urgent need to solve the problem of synchronizing the teaching model with job requirements.

(2) Traditional classroom teaching emphasizes theoretical knowledge explanation, and the original teaching resource library is insufficient in terms of digital technology.

(3) Limited practical training conditions due to external environmental factors restrict the improvement of hands-on practical ability.

3. Innovative ideas and measures

3.1. Innovative ideas

Aiming at the cultivation of application-oriented talents, focus on training and cultivating students' five major abilities: learning ability, practical hands-on ability, innovation ability, teamwork ability, and professional technical ability.

3.2. Teaching model innovation

Define the "Five-Step Progression" teaching model, comprehensively adopt task-driven methods as the main approach, supplemented by flipped classrooms, group teaching, on-site teaching, and other diverse methods, to innovate the teaching model and cover the entire talent cultivation process.[5]

3.3. Teaching content innovation

3.3.1. Under the background of New Engineering Education, innovating classroom teaching content starting from three dimensions and four elements

Vertical dimension: Whole industry, whole lifecycle. Refers to explaining prefabricated building knowledge based on the entire industrial chain and the whole lifecycle, emphasizing industrialized construction methods and the relationships between various links, thereby strengthening the sense of responsibility.

Horizontal dimension: Multi-disciplinary, emphasis on integration. Refers to introducing knowledge graphs based on current industry development needs, focusing on using new concepts and means to present knowledge related to building industrialization. Integrate cross-disciplinarity such as engineering management and BIM, upgrade traditional construction technology teaching content, integrate intelligent construction, and cultivate students' innovative thinking.

Depth dimension: Strong professionalism, refined skills. Refers to strengthening the practical component based on the cultivation of application-oriented talents, cultivating students' ability and skills to identify, analyze, and solve moderately complex engineering problems, making them strong and refined.

"Four Elements" refer to the organic combination of learning content, learning environment, teaching methods, and teaching carriers.

3.3.2. Innovating practical training content under the background of New Engineering Education

Practical training projects are closely designed around theoretical knowledge and integrated with professional competitions and skill assessments to achieve the purpose of "promoting teaching through competition" and "promoting learning through certification." For example, National College BIM Graduation Design Innovation Competition (Prefabricated Detailing Design and Construction Application Module), "1+X Prefabricated Building Component Production and Installation" Vocational Skill Certificate, and BIM Skill Certificate, etc.[6]

3.3.3. Innovating ideological and political education content under the background of New Engineering Education

In the new media era, college students are prone to accept "short, flat, fast" online news, requiring information-based teaching methods. Through intuitive feelings and visual impact, enhance immersion and increase student interest; students are about to enter society, with avant-garde ideas and diversified values, requiring the use of socialist core values to guide students in establishing a scientific worldview, outlook on life, and values. For example, when teaching examples of prefabricated timber structures, compare ancient and modern timber construction methods to enhance national pride and establish cultural confidence. Combining the example of makeshift hospital construction during the pandemic, demonstrate the construction speed advantage of prefabricated buildings, reflect the country's governance philosophy of "putting people first," fully demonstrate "China speed" and "China strength," and enhance students' sense of national identity and patriotism.

By understanding the role of prefabricated buildings in "carbon peak" and "carbon neutrality," cultivate students' thinking mode for the industrialized and informationalized development of the construction industry; motivate students to actively adapt to the development needs and emotional sentiments of the new technological revolution in construction.

Through the introduction of prefabricated building cases, guide students to rationally view the current international status of China's construction technology, feel the power of Chinese construction, stimulate students' pride, responsibility, and sense of mission as college students in the new era of China, and establish the ideal and passion to strive for the cause of socialist construction.

3.4. Teaching evaluation innovation

(1) Process assessment, based on the premise of cultivating students' innovation ability, conducts assessments multiple times according to the learning situation, effectively improving students' innovation and practical hands-on ability.

(2) Teacher evaluation is combined with group self-evaluation and peer evaluation. For practical training tasks completed through group collaboration, based on task division, teacher grading is mainly based on the quality of task completion, intra-group self-evaluation, and inter-group peer evaluation scores. Learning situation score cards are used for objective, fair, and differentiated scoring.

3.5. Teaching organization and environment

Centered on student development, allowing students to become the protagonists of the classroom. Mainly

reflected in:

3.5.1. Learning in class

Teaching methods such as answering questions, class discussions, case analyses, group presentations, or flipped classrooms are incorporated into class performance bonus points.

3.5.2. Learning on the go

Make full use of online resources, encourage independent learning, and improve self-learning awareness and ability. Sharing learning insights via WeChat public account posts, China University MOOC learning duration, etc., are incorporated into knowledge expansion scores; they open up new venues for students to acquire knowledge.

3.5.3. Learning on site

On-site teaching improves learning efficiency. Using component production enterprises as carriers and actual engineering projects as a basis, form a whole lifecycle and whole industrial chain process practical teaching, fully meeting enterprise job requirements, and achieving the unity of BIM talent capabilities and job position demands.

3.6. Teaching means innovation

(1) Utilizing prefabricated building model making, group topic selection, "making models, explaining cases, learning software" advancing simultaneously, which is conducive to cultivating students' innovation and teamwork spirit, and enhancing the challenge level. Learning through model making, new technologies, and new methods effectively mobilizes their active participation.

(2) Utilizing WeChat public accounts to stimulate students' learning interest and enhance the course's advanced nature.

4. Innovative outcomes

4.1. Teaching innovation and reform have effectively improved the quality of talent cultivation

The number of enrolled students selecting the course has doubled, and course satisfaction has increased year by year. The number of graduates engaged in prefabricated building-related work has significantly increased, and enterprise satisfaction has surged. Guiding students to actively participate in relevant competitions and obtain skill certificates annually enhances the teaching challenge and breaks exam-oriented thinking.

Achieved numerous excellent results in provincial, municipal, and national professional competitions, winning seven national and ministerial/provincial-level awards in the past three years, including two special prizes. Particularly, using the "Glodon National College BIM Graduation Design Competition" as a platform, through the graduation design reform of "all majors participate, all grades cultivate," civil engineering students start following senior students in whole-process graduation design training from their sophomore year. This enhances the professional cognition of lower-grade students, strengthens the whole-process progressive training of senior students, improves the practical ability of teachers and students, and aligns with industry skills.

4.2. Strengthened the alignment between industry and education, and improved the digital teaching resource library for prefabricated buildings

Deepened school-enterprise cooperation to improve the teaching resource library. Utilizing rich online resources, including cloud platforms, construction cloud lessons, China University MOOC, WeChat public accounts (Prefabricated Building Network), QR code video courses accompanying textbooks, BB platform (automatic grading, score analysis), etc., to form a teaching resource library. Simultaneously, dispatch teachers to prefabricated building enterprises and physical projects to participate in engineering practice; hire enterprise mentors to teach in school regularly, improving the digital technology teaching resource library.

4.3. Teaching innovation and reform have consolidated and developed school-enterprise cooperation relationships and improved the comprehensive quality of "dual-qualified" teachers

Since the implementation of the innovation reform, five new cooperative enterprises have been signed, bringing the total number of cooperative enterprises to 16. Currently, the college maintains long-term contact with over 30 enterprises. The number and scale of cooperative enterprises basically meet the internship needs of civil engineering students. In the past three years, lead teachers have participated in a total of five online and offline national prefabricated building assessor trainings, prefabricated building detailing design teacher trainings, and technology broker trainings, etc. They have been appointed to the Glodon Prefabricated Building Training Expert Database. Team teachers have guided students to participate in various professional competitions at all levels, winning a total of 26 national, provincial, and municipal outstanding instructor awards; 10 students have participated in engineering project construction. Six enterprise mentors have been invited to teach in schools.

Currently, utilizing horizontal project topics integrated into the course, task-driven approaches are used to effectively solve difficult engineering problems. Through the implementation of prefabricated building teaching innovation and reform, the optimized cultivation of students' knowledge system of prefabricated buildings has been achieved, students' professional knowledge in architectural design and building construction has been consolidated, and the improvement of students' hands-on practical design ability combined with BIM technology has been realized. This has enhanced students' capabilities in graduation design and employment, and graduates have been highly evaluated by many enterprises.

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