Journal of International Education and Development
2025, VOL. 9, NO. 2, 48-50
DOI: 10.47297/wspiedWSP2516-250011.20250902

Intelligent Interactive Teaching Reform and Exploration for Civil Engineering Professional Courses

Lin Chi, Bin Liao, Xulu Wang, Chenlong Qiang, Chenghao Liu

School of Environment and Architecture, University of Shanghai for Science and Technology, Shanghai, 200093, China

ABSTRACT
In response to the strategic demand for cultivating undergraduates in intelligent building and construction in China, and in conjunction with the "Smart+" national strategy and the development opportunities of the construction industry in the new era, this paper delves into the practical exploration of intelligent online virtual interactive teaching in civil engineering courses. It summarizes and proposes a series of effective strategies to overcome teaching dilemmas. These strategies aim to lay a solid foundation for subsequent specialized course learning, thereby enhancing students' ability to apply basic theoretical knowledge and their capacity to solve complex engineering problems. Furthermore, they aim to promote the establishment of a scientific and reasonable curriculum system and teaching standards.

KEYWORDS
Civil Engineering; Online Virtual Interactive Teaching; Teaching Reform

1 Introduction

The discipline of civil engineering closely aligns with the national strategic layout of science and technology and the demand for local economic development, striving to cultivate high-quality, innovative, and applied undergraduates with modern civil engineering competencies who are suited to industry development. However, the current undergraduate cultivation model for civil engineering cannot fully meet the requirements for future technical undergraduates, and the teacher-centered teaching model still persists. Against the backdrop of engineering education accreditation in the new era, there is an urgent need to transform teaching ideas, optimize teaching designs, adjust teaching functions, improve teaching models, reshape curriculum systems, and establish long-term continuous improvement mechanisms. These efforts are aimed at cultivating civil engineering undergraduates with interdisciplinary knowledge and innovative consciousness in intelligent construction.

2 Objectives for the Construction of Intelligent Online Virtual Interactive Teaching

2.1 Building a New undergraduate Cultivation System for Civil Engineering Courses Centered on Intelligent Construction

In response to the strategic demand for cultivating undergraduates in intelligent building and construction in China, and in conjunction with the "Smart+" national strategy and the development trends of the construction industry, teachers adhere to the undergraduate cultivation characteristics of "strong fundamentals, emphasis on practice, rigorous processes, and pursuit of innovation." We deepen the educational philosophy of "student-centered, ability cultivation-driven." The aim is to cultivate composite undergraduates with both natural scientific knowledge and humanistic literacy related to intelligent building and construction. These undergraduates should master the basic and cutting-edge theories, methods, and technical tools of intelligent building and construction, possess an open and compatible knowledge structure, solid engineering practice abilities, and a broad international perspective. Additionally, these undergraduates should have firm beliefs, good moral character, be adept at communication and expression, value team collaboration, shoulder social responsibility, adhere to professional ethics, and be able to lead the future development of intelligent building design and construction and related fields.

2.2 Establishing an "Integrated Curriculum" System for Smart Buildings and Smart Cities

A comprehensive and three-dimensional curriculum system, comprising university-wide core courses, modular core courses, and elective courses, focuses on cultivating core competencies through "design-oriented course clusters" and "practical teaching components" under the new engineering paradigm[2]. This system integrates classic architectural core courses such as architectural principles, architectural history, architectural technology, and professional ethics. It also encompasses modular core course clusters that cover interdisciplinary frontier courses such as computational design, artificial intelligence, smart construction, and project management, complemented by an elective course system.

3 Exploring a New Path for Reform in Civil Engineering Education through Practical Teaching

New requirements are proposed for civil engineering-related knowledge. On the one hand, students must possess the mathematical, natural science, engineering fundamentals, and professional knowledge necessary to solve complex engineering problems. On the other hand, they must be able to apply these knowledge to solve such problems. The former is a requirement for knowledge structure, while the latter is a requirement for knowledge application.

4 Measures for the Construction of Intelligent Online Virtual Interactive Teaching

4.1 An Internship/Experimental Teaching System Combining Virtual and Real Elements

Leveraging the strengths of the civil engineering discipline, an internship and experimental teaching philosophy has been formulated, seamlessly integrating practical training with theoretical instruction, and placing equal emphasis on knowledge acquisition, skill development, and fostering an innovative mindset. Utilizing enterprise and university civil engineering experimental teaching demonstration centers, a progressive experimental teaching system has been established, spanning from basic demonstrative experiments to comprehensive and design-focused experiments, and transitioning from fundamental principle-based experiments to those rooted in engineering practice, as well as from teaching experiments to research experiments[3].

Building on the virtual simulation experimental teaching demonstration platform for civil engineering, and adhering to the principle of "combining virtual and real elements, complementing each other, and prioritizing reality when feasible, " virtual internship and experimental projects have been developed. These projects evolve from professional cognition to professional learning, and ultimately to engineering and research, encompassing virtual reality-based projects for foundational knowledge, virtual-real integrated projects for professional applications, and virtual simulation-based projects for research and innovation.

This approach addresses challenges such as the monotonous nature of engineering structures, incomplete construction processes, and the inability to visualize internal structures in traditional internships, effectively boosting students' autonomous learning capabilities and engineering practice skills.

4.2 Student-Centered and Time-Relevant Competition to Stimulate Innovative Potential

Traditional teaching methods mostly involve teachers "instilling" theoretical knowledge into students or simply letting students understand process flows through related videos, placing students in a state of "being taught." However, now, through virtual simulation technology, students can increase their practical abilities while being taught, integrating traditional theoretical knowledge into virtual operations.

This allows students to truly simulate real-world operations in virtual simulations, enhancing their learning enjoyment and enabling them to better grasp theoretical knowledge. Training plans are revised based on student characteristics and social demands, with active applications for graduate teaching research projects and the implementation of teaching reform and innovation practices. Students are encouraged to expand their interests through auditing and self-study, and research is conducted on credit certification methods for such learning. The educational and teaching mode of "replacing classes and learning with competitions" is explored to stimulate students' learning potential and enhance their professional practice literacy.

4.3 A Teaching Mode for Innovative Talent Cultivation through University-Enterprise Collaboration

Characterized by the application and innovation of cutting-edge technologies, a "university-enterprise jointly established postgraduate training base for civil engineering" has been set up to facilitate student internships and practical training, as well as to collaboratively supervise graduation theses with partner organizations, ultimately enhancing students' social practice experience and employment prospects. In the prefabricated building components production course, students are guided by the prefabricated component production process as the main thread. They leverage virtual simulation and human-computer interaction technology to virtually replicate the entire prefabricated component production workflow.

This approach not only emphasizes honing students' practical operational skills but also enables them to engage in prefabricated component production tasks within the school setting[5]. It addresses the challenge of insufficient conditions for conducting real experimental projects by conducting large-scale, comprehensive training in civil engineering through virtual experimentation. This method not only sharpens students' hands-on abilities but also bridges the gap left by the lack of real experimental conditions, providing them with extensive and integrated training experiences in civil engineering through immersive virtual experiments.

5 Significance of the Construction of Intelligent Online Virtual Interactive Teaching

5.1 Constructing a New Talent Cultivation System for Civil Engineering Majors Combining Virtual and Real Elements

Combining virtual simulation teaching with real teaching helps improve the effectiveness of practical teaching. It enables students to overcome the limitations of venues and equipment and acquire more practical skills, playing a crucial role in enhancing the practical abilities of civil engineering students. By introducing multimedia simulation technology into various aspects of practical teaching in civil engineering, a multi-level practical teaching system combining virtual and real elements is constructed, improving and refining practical teaching[6].

5.2 Expanding Teaching Resource Content Innovation and Strengthening Process Management Method Innovation

Great attention is given to students' process management, where teaching activities are primarily a collaborative process between teachers and students, highlighting the student's central role while teachers act as "guides." By integrating industry's latest technologies into existing courses, internship practices are conducted, and graduation theses for both undergraduates and graduates are jointly supervised, thereby enhancing students' social practice experience and employment prospects[7]. Practical innovation forms the core cultivation chain for deepening theoretical knowledge, enhancing practical abilities, sparking learning interest, and fostering innovative thinking. This chain encompasses teaching experiments, internship practices, course designs, graduation projects, and innovative initiatives. With a student-centric approach and guided by the cultivation of engineering abilities and innovative consciousness, the practical teaching system for civil engineering majors has been comprehensively redesigned and implemented.

6 Conclusion

Following the educational laws of civil engineering's strong practicality, the contribution of practical teaching in the integrated construction of industry-academia-research-application is enhanced. A multi-dimensional practical education system is formed, consisting of basic course cognitive internships, professional course internships, comprehensive professional internships, industry technical services, and university student innovation projects, increasing the proportion of practical teaching credits in total credits. The project is applicable and has guiding significance for the construction of talent cultivation modes, teaching staff, and curriculum systems in civil engineering majors, and can be extended and promoted for application in the professional construction of civil engineering colleges nationwide.

Funding

This work was supported by University of Shanghai for Science and Technology Undergraduate Curriculum Ideological and Political Demonstration Course Construction Project (KCSZ202407)

References

[1] Zhang Xiaojie, Wang Xi. Research and Practice on the Teaching of Introduction to Civil Engineering for Building Electricity and Intelligence Major [J]. Journal of Jilin Jianzhu University, 2015, 32(4): 95-110.

[2] Tang Zhanzhan, Li Xiayuan, Ma Yao. Application of Blended Teaching Mode in Civil Engineering Education [J]. Modern Vocational Education, 2022(22): 49-51.

[3] Zhang Chao, Chen Qiunan, He Jianqing, Yang Qijun, An Yonglin. Exploration of Practical Teaching Reform in Civil Engineering under the Background of First-class Undergraduate Construction [J]. Anhui Architecture, 2022, 29(2): 129-130.

[4] Qi Dongchun, Lei Jinsheng, Chen Xinghua. Reform of Civil Engineering Curriculum System and Teaching Methods Based on BIM [J]. Information Technology in Civil Engineering and Architecture, 2021, 13(5): 115-118.

[5] Zhan Meng, Wang Sheliang. Application of Virtual Simulation Experiment Platform in Civil Engineering Practical Teaching [J]. Contemporary Educational Practice and Teaching Research, 2020(6): 204-205.

[6] Jiang Jianqing, Cao Guohui, Chen Donghai, He Ran, He Min. Exploration on the Construction of Virtual Simulation Experimental Teaching Center for Civil Engineering in Application-Oriented Local Universities [J]. Research and Exploration in Laboratory, 2018, 37(2): 144-149.

[7] He Yanqing. Research on the Reform of Practical Teaching in Civil Engineering Major [J]. Jiamusi Vocational Institute Journal, 2017(12): 494.