Reconstruction of the Practical Teaching System for Water Conservancy Engineering Cost Major from the Perspective of Industry-Education Integration

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Abstract: The practical teaching system of the water conservancy engineering cost major specialty faces several challenges, including outdated teaching content, weak practical skills among teachers, insufficient enterprise involvement, inadequate cultivation of students' practical capabilities, and a simplistic evaluation system. In response to the digital and intelligent transformation trends in the water conservancy industry, and to cultivate interdisciplinary talents in engineering cost management, this paper proposes optimizing pathways for practical teaching. These include restructuring a modular curriculum system, strengthening the practical engineering capabilities of faculty, building an interdisciplinary practical teaching framework, refining the course evaluation system, and improving the supporting mechanisms for practical teaching. By deepening school-enterprise cooperation and incorporating project case studies and new technology applications, a four-stage practical curriculum system is established, comprising "foundation-expansion-practice-demand". This aims to shift the practical teaching of water conservancy engineering cost from a theory-driven approach to a competency-based model, contributing to the cultivation of high-quality engineering cost professionals in the field.

Keywords: Water Conservancy Engineering; Engineering Cost; Industry-Education Integration; Practical Teaching; System Reconstruction

1. Introduction

Nowadays, the application of information technology in the water conservancy industry is becoming increasingly widespread. How to cultivate innovative and interdisciplinary technical talents who can adapt to the future development of the water conservancy industry and support industrial transformation, and upgrading has become a new challenge that the engineering cost specialty must address[1]. The water conservancy engineering cost specialty undertakes core functions in multiple aspects such as project budget preparation, cost control, and contract management, requiring students to possess solid foundational knowledge and strong practical abilities[2]. Currently, the curriculum for engineering cost major in higher education institutions continues to emphasize traditional skills such as cost estimation and project valuation. However, there is a significant deficiency in the integration of new-generation information technologies, for instance building information modeling (BIM), big data, and cloud computing, into the teaching content. Emerging tools and methods related to digital cost control and intelligent project management are rarely taught in a systematic manner. As a result, there exists a gap between the knowledge structure of graduates and the demands of industry digital transformation, making it challenging for them to fully meet the developmental needs of enterprises[3]. The traditional teaching system for engineering cost major is no longer sufficient to meet the evolving demands of the industry. It is imperative to optimize and reform the curriculum framework, which includes updating textbook content, redesigning practical modules, and enhancing deep collaboration between education and industry. These measures are necessary to ensure that the educational content is compatible with engineering practices and aligns with the future development direction of the water conservancy industry.

In recent years, China has been actively advancing the integrated development of industry and education. Under the integration of industry and education, the industrial system and the educational system should leverage their respective resource advantages and rely on mechanisms such as school-enterprise cooperation. With mutual benefit and win-win scenarios as the fundamental goal, there should be a continuous effort to promote the optimization, integration, and deep fusion of both systems[4]. It is crucial to continuously promote the optimization, integration, and deep fusion of both systems. Deepening this integration helps achieve effective connections between the education chain, talent chain, and the industry chain and innovation chain, serving as a key measure for promoting structural reforms on the supply side of human resources[5]. This process has significant practical implications for comprehensively enhancing the quality of education and teaching, broadening employment and entrepreneurship channels, facilitating the transformation and upgrading of the economic structure, and nurturing new drivers for economic development[6]. Currently, many universities are attempting to advance the integration of industry and education; however, from a practical effective standpoint, issues such as "insufficient depth" and "incompatibility" persist, resulting in a disconnect between talent cultivation and industry needs[7]. As a relatively traditional engineering discipline, the water conservancy engineering cost major requires strong practical capabilities from students. Practical teaching, as an essential approach to cultivating students' practical abilities, is crucial to the development of these skills. In the context of industry-education integration, it is urgent to reconstruct the practical teaching system in engineering cost to enhance students' professional technical knowledge and strengthen their practical abilities. Based on the perspective of industry-education integration, this paper aims to improve the quality of talent cultivation for the water conservancy engineering cost major through the reconstruction of the practical teaching system.

2. The Current Situation and Issues of Practical Teaching in the Field of Water Conservancy Engineering Cost Major

Currently, the curriculum system for water conservancy engineering cost major in higher education institutions mostly adopts a structure of "basic theory - specialized knowledge - practical training", forming a teaching logic where theory precedes and is complemented by practice[8]. Under the traditional teaching model, there is greater emphasis on the explanation of theoretical knowledge, lacking systematic application and practical use of knowledge. At present, the water conservancy industry is undergoing digital and intelligent transformation, with the application of new generation information technologies, such as BIM, big data, and artificial intelligence (AI), becoming increasingly widespread. However, under the traditional teaching system, there is little coverage of new technology-related content. In the context of the new era, cultivating a new type of engineering cost talent faces significant challenges, and it is urgent to construct a new practical teaching system to comprehensively enhance the quality of student training. Currently, the practical teaching system for water conservancy engineering cost major mainly faces several issues:

(1) The curriculum content is outdated and disconnected from industry demands.

Currently, most higher education institutions offering water conservancy engineering cost major primarily focus on traditional topics such as bill preparation, quantity calculation, and project budgeting. There is a lack of coverage, or only superficial treatment, of cutting-edge technologies like BIM-based cost analysis and AI cost prediction. Although some universities have introduced courses related to modern information technologies such as BIM, the depth of learning in these courses is generally insufficient. Most of them emphasize theoretical knowledge with limited opportunities for practical application in real-world engineering scenarios. With the ongoing development and adoption of digital and intelligent technologies in the water conservancy industry, these courses can no longer meet the needs of enterprises and industry advancement. In actual engineering projects, BIM and AI have gradually become essential tools for cost estimation and management. However, the existing curriculum framework has failed to adequately integrate relevant practical content. With the development and application of digital and intelligent technologies in the water conservancy industry, the current curriculum for engineering cost major in water conservancy is no longer able to meet the needs of enterprises[9].

(2) The practical capabilities of the teaching faculty are weak.

At present, most teachers in the engineering cost major enter teaching positions directly after completing their higher education, and their career development paths often lack practical experience in engineering projects. This situation leads to teachers relying primarily on textbooks and simplified case studies during instruction. When there is a gap between the course content and actual engineering practices, students' learning outcomes are inevitably affected, making it difficult for them to truly understand and address complex engineering cost issues. Especially in recent years, with the rapid development of new technologies such as big data and AI, some teachers have failed to update their teaching content in a timely manner and have not integrated these cutting-edge technologies into the classroom, resulting in a disconnect between the knowledge students acquire and the actual needs of enterprise development. Consequently, after graduation, students may face issues such as insufficient technical application skills and a lack of problem-solving capabilities in real-world scenarios, thereby affecting students' competitiveness in the job market. It is crucial to enhance teachers' engineering practical abilities and update teaching content to improve students' overall competence and adaptability.

(3) Low levels of enterprise engagement have hindered the full integration of industry and education.

Although some institutions have signed cooperation agreements with enterprises, these collaborations mainly remain at the level of establishing internship bases or organizing on-site visits for learning[10]. In terms of practical teaching, the integration of industry and education is not deep enough. The proportion of enterprise engineers participating in university course design is relatively low, and the new methods and production tools used in enterprise project practices have not been fully integrated into the educational system. For instance, the integration of BIM-based cost management into the curriculum is rarely implemented, and the mechanism for enterprises to provide feedback on course content is not well established. This has resulted in a disconnect between teaching and professional practice. Additionally, there is a lack of systematic mechanisms for enterprises to provide feedback on curriculum content, resulting in teaching materials that often lag into actual industry developments. Furthermore, when students intern at companies, they mostly engage in basic tasks such as observation or data organization, with very few opportunities to involve themselves in the core business of engineering cost management. This limits their exposure to critical processes such as project budgeting, cost control, and tender preparation. As a result, students gain inadequate practical experience, which hinders their ability to apply theoretical knowledge to real-world scenarios and affects their professional readiness after graduation. To address these issues, it is essential to establish a more profound collaborative relationship between educational institutions and enterprises, facilitating deeper cooperation in areas such as curriculum development, practical teaching, and student guidance.

(4) Insufficient cultivation of students' engineering practical abilities.

Students in school typically follow a process of "course study-final exams-graduation projects", which lacks systematic training in engineering practical abilities. Although some institutions offer practical courses, they are mostly limited to basic calculation exercises or observational learning, lacking deep engagement with real-world projects. Throughout their learning journey, students rarely have the opportunity to experience the complete workflow of engineering cost management, including core aspects such as project bidding, cost control, and budget adjustments. This teaching model results in insufficient student capability to address actual engineering problems and hampers the translation of theoretical knowledge into practical skills. At the same time, the integration of practical teaching with modern intelligent technologies remains inadequate, with teaching methods being relatively traditional. Widely adopted digital tools and intelligent platforms in the industry are not sufficiently incorporated into the teaching system, creating a gap between the skills students acquire and the evolving demands of the profession. After graduation, students often require a considerable amount of time to adapt to job requirements, which affects the starting point and pace of their career development. To address this situation, a comprehensive reform of the practical teaching system should be promoted. By introducing real engineering cases, implementing project-based teaching, and enhancing virtual simulation training, a more industry-aligned teaching environment can be established. Concurrently, integrating intelligent technology platforms into the teaching process will help students master cutting-edge industry tools.

(5) The evaluation system is singular and fails to meet the comprehensive development needs of

students.

At present, the evaluation of learning outcomes in engineering cost major primarily relies on the traditional model of "continuous assessment + final examination". This assessment approach can only reflect the extent of students' knowledge acquisition and fails to systematically represent their capabilities in areas such as project practice and technical application. The evaluation of practical skills mainly occurs during the practice process; however, most courses fail to implement process-oriented assessments. For instance, when evaluating learning outcomes in courses related to information technologies like BIM, the existing evaluation criteria still emphasize the normative aspects of modeling and the completeness of content, lacking effective evaluation of the students' completion processes[11]. This singular evaluation system fails to fully capture students' comprehensive abilities in analyzing problems and addressing the complexities of real-world engineering cost management. It also does not effectively encourage the development of students' potential in areas such as teamwork, innovative application, and technological integration. The singularity of evaluation criteria can easily lead students to focus on examination-oriented knowledge and static achievements, thereby neglecting the cultivation of core professional competencies, such as flexibly applying tools in dynamic project environments, coordinating multi-stakeholder needs, and responding to unexpected changes. To cultivate interdisciplinary talents that meet the needs of industry development, it is essential to establish a more diversified and process-oriented evaluation system. This could involve introducing various assessment methods, such as project outcome presentations, simulated decision-making evaluations, and phased practical reports, while also inviting industry experts to participate in competency assessments. By incorporating multi-dimensional indicators, such as process performance, technical application capabilities, and effectiveness in solving real-world problems, the evaluation system can more scientifically and comprehensively reflect students' overall competencies.

3. Reconstruction of the Practical Teaching System from the Perspective of Industry-education Integration.

3.1 Reconstruct the Modular Curriculum System by Establishing Tiered Practical Teaching Content

The design of the curriculum system should be oriented towards employment directions, integrating the genuine needs of enterprises into the curriculum, and reinforcing the cultivation of students' engineering practical abilities. A modular curriculum system, guided by the training of application-oriented talents, can be constructed into a four-stage practical curriculum system comprising "foundation-expansion-practice-demand". The basic professional module contains courses related to engineering cost, where students are required to master fundamental professional knowledge to lay a solid foundation for subsequent practical courses. The professional expansion module involves the enhancement of course content based on enterprise needs, primarily including applications of BIM, big data, and AI within the engineering cost industry. These expansion components are essential parts of practical teaching. The professional practice module can be divided into two parts: on-campus training and off-campus internships. On-campus training primarily allows students to complete engineering cost related tasks using real project examples, honing their project practice skills. Off-campus internships require students to engage in specific projects within enterprises, facilitating a more comprehensive learning experience that integrates theory with reality. The graduation thesis/design module should reinforce students' capabilities to apply new technologies in completing engineering cost assessments. The curriculum system design is illustrated in Table 1.

Table 1. Modular Curriculum Design

Types of modules	Explanation
Fundamental module	Focus on the foundational courses in engineering cost major to strengthen students' professional fundamentals.
Specialized expansion module	Combine real enterprise needs to expand students' learning of new technologies.
Professional practice	Conduct practical training on real projects within the campus and engage in

module	specific project internships at enterprises outside the campus.
Graduation thesis/design module	Topics should be more closely aligned with the real needs of enterprises, and the process should incorporate new technologies.

3.2 Strengthen the Construction of Engineering Practical Abilities within the Faculty Team

Teachers are the executors of the reform in the practical teaching system, and enhancing the practical abilities of the faculty team is a crucial component of the entire practical teaching framework. This necessitates not only the enhancement of individual teaching skills among educators but also a structured approach to strengthen the capacity of the faculty to participate in and impart authentic engineering practice experiences. To improve teachers' engineering practical skills, a dual-track strategy of "going out and bringing in" can be implemented. The "going out" approach encourages young teachers to take positions in enterprises and participate in specific engineering projects. By engaging directly with real-world applications, teachers can gain firsthand experience and understanding of the latest technologies in engineering cost, such as the use of BIM and intelligent estimation systems in actual projects. This experience can then be transformed into practical teaching case studies, making classroom instruction more relevant and up to date. The "bringing in" aspect involves inviting frontline engineers from external enterprises to act as guiding instructors at the school. These industry professionals can take charge of practical course design, teach practical courses, and mentor practical projects. For example, corporate engineers can introduce industry-standard workflows and emerging tools currently in use within the field. Such collaboration can significantly enhance students' professional practice capabilities, bridging the gap between theoretical knowledge and practical engineering applications. On the other hand, it also fosters communication between educators and industry practitioners, contributing to the continuous improvement of the teaching team's practical skills and adaptability.

By adopting this two-way approach, the faculty team can be better equipped to deliver a more practical and industry-aligned education. This not only enhances teachers' professional development but also ensures that students are prepared with the skills needed to succeed in their future careers.

3.3 Construct an Interdisciplinary Practical Teaching System to Deepen School-Enterprise Collaboration

The interdisciplinary practice teaching system is constructed around the main line of "professional foundational knowledge-core professional skills-integrated on-campus training-off-campus project practice" (Figure 1). The "professional foundational knowledge" segment emphasizes the imparting and accumulation of students' professional knowledge. Regarding the establishment of foundational professional courses, schools can deeply integrate with enterprises, selecting professional courses based on the demands of the industry and the school's teaching conditions, thereby ensuring that the knowledge acquired by students can serve engineering practice. The "core professional skills" focus on imparting the essential skills required for engineering practice. Through learning and training in these core skills, students are equipped to master the latest core technologies in their field. "Integrated on-campus training" not only requires students to grasp foundational knowledge but also demands that they possess the ability to solve practical problems. This training can involve significant participation from enterprises, collaboratively creating training scenarios that are closely aligned with real engineering practices, effectively enhancing students' practical abilities. "Off-campus project practice" necessitates in-depth collaboration between schools and enterprises, enabling students to further improve their capacity to address actual engineering cost issues through project internships. Simultaneously, the partnership between enterprises and schools can yield a win-win situation, as enterprises can cultivate engineering cost professionals who better meet their specific requirements through intensive collaboration and hands-on project practice.

3.4 Optimize the Curriculum Evaluation System to Emphasize Practical Abilities.

The traditional evaluation system for engineering cost major often fails to comprehensively assess students' practical competencies. Therefore, it is necessary to optimize the course evaluation system by focusing on practical ability assessment. Specific evaluation criteria should be established for the practical process and outcomes, such as students' proficiency in industry-specific software, their performance in problem-solving within simulated project scenarios, and their ability to apply theoretical knowledge to real-world tasks. Furthermore, assessment methods should be diversified to better showcase students' comprehensive skills. This could include project portfolios, group presentations, and practical project reports. The evaluation process could involve collaboration between faculty members and industry mentors, encompassing both the completion of practical courses and the final outcomes. Such a collaborative approach ensures that the assessment criteria align closely with actual industry standards and requirements. Corporate mentors can provide valuable insights based on engineering practice, while on-campus educators can assess the integration of theory and learning progress. Regular communication between the two parties facilitates the further refinement of evaluation standards, aligning them with advancements in technologies and methodologies within the industry. By optimizing the assessment framework in this manner, the cultivation of students' practical capabilities can be strengthened, better meeting the demands of their post-graduation career development. Such an evaluation system also encourages students to actively engage in experiential learning, fostering a mindset oriented toward practical application and honing their abilities to solve real-world engineering problems.

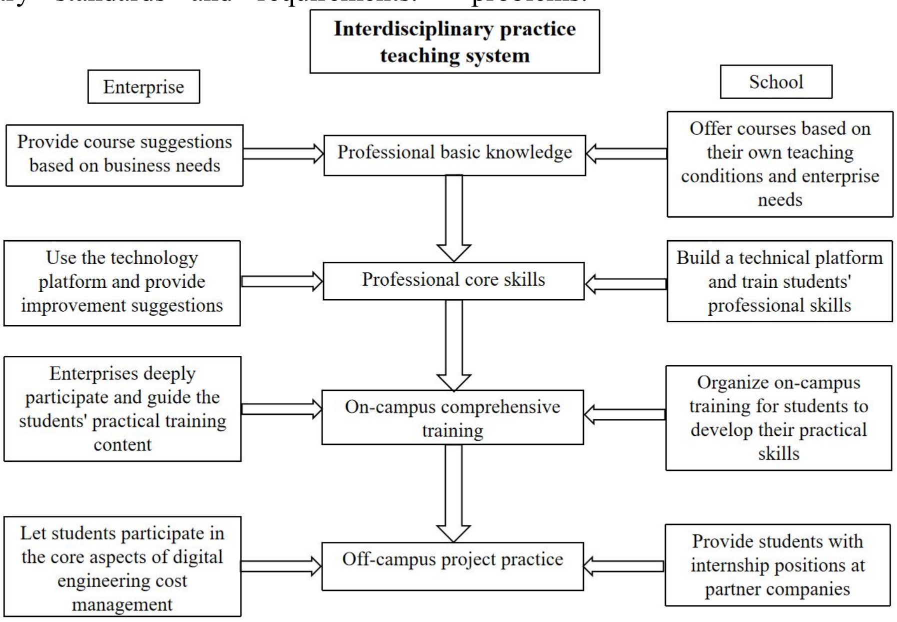

Figure 1. Interdisciplinary Practice Teaching System

3.5 Improving the Supporting Mechanisms for the Practical Teaching System

The practical teaching system must not remain merely theoretical; it is essential to establish comprehensive regulations and guidelines to ensure the effective implementation of the practical teaching framework. Detailed specifications should be developed concerning various aspects such as course design, implementation processes, resource allocation, and quality monitoring. Furthermore, it is crucial to clearly delineate the roles and responsibilities of faculty members and industry partners to ensure smooth collaboration and effective execution. As a vital component of the integration between education and industry, the long-term effectiveness of school-enterprise cooperation also requires institutional safeguards. A well-structured and effective system can facilitate the transition from superficial collaboration to substantial engagement, ultimately achieving a synergistic relationship where talent development and mutual benefits are realized through deep integration. To this end, measures such as establishing regular communication mechanisms, collaboratively developing educational resources, and creating incentive structures to encourage ongoing participation from both parties should be implemented. By executing these initiatives, the practical teaching framework can operate in a more standardized, stable, and sustainable manner, providing stronger support for students' professional development. Moreover, a monitoring and feedback mechanism should be established to continuously assess the effectiveness of these regulations. Periodic reviews and adjustments based on feedback from stakeholders, including students, faculty, and industry partners, will help ensure that the practical teaching system remains dynamic and adaptable, aligning with the evolving educational and industry demands.

4. Conclusion

In the context of digital transformation and intelligent upgrading in the water conservancy industry, the reconstruction of the practical teaching system for the engineering cost major is a pivotal measure to align talent cultivation with industry demands. This paper, based on the perspective of industry-education integration, analyzes the existing issues in the practical teaching of water conservancy-related engineering cost major and proposes a systematic reconstruction pathway encompassing curriculum structure, faculty development, school-enterprise collaboration, evaluation mechanisms, and institutional safeguards. Through modular course design, a tiered arrangement of practical content, in-depth collaboration between schools and enterprises, and the optimization of process-oriented evaluations, the initiative aim is to enhance students' engineering practical abilities and thereby support the cultivation of talent in water conservancy engineering cost major.

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