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Reform Practice of Curriculum Integration of Industry and Education Based on OBE Concept: Taking Quantity Surveying and Pricing of Construction Engineering as an Example

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Abstract: Quantity surveying and pricing of construction engineering is a core course for civil engineering majors such as construction cost and construction engineering technology. It combines strong practicality, policy orientation, and industry specificity, serving as a crucial link between professional theoretical knowledge and on-the-job operational skills. Currently, traditional teaching methods commonly suffer from issues such as unclear goal orientation, disconnection between theory and industry practice, rigid teaching models, and single evaluation methods, making it difficult to meet the demand for high-quality technical and skilled personnel in the construction industry in the new era. Based on the outcome-based education (OBE) concept, this paper closely aligns with the core requirements of industry-education integration in application-oriented undergraduate institutions. Using the course of quantity surveying and pricing of construction engineering as a vehicle for reform, it conducts systematic curriculum reform practices through pathways such as reverse designing course objectives, reconstructing job-aligned teaching content, and innovating school-enterprise collaborative teaching models. The aim is to provide a replicable and scalable reference model for OBE-based industry-education integration reforms in similar engineering practical courses, facilitate precise alignment between talent cultivation in civil engineering majors and industry job requirements, and enhance the quality and social adaptability of talent cultivation in higher education.

Keywords: OBE concept; Industry-education integration; Curriculum reform; Quantity surveying and pricing of construction engineering

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1. Introduction

China's construction industry is accelerating its transformation towards green, industrialized, and digital directions, leading to continuously increasing demands for technical and skilled personnel in the field of construction costs. These demands not only require solid professional theories but also emphasize comprehensive practical abilities such as standard compilation, precise quantity calculation, independent pricing, and cost control [1]. As the primary frontline for cultivating industry-oriented talent, universities must closely follow industrial development trends and promote in-depth reforms in teaching models and content systems [2]. The course of quantity surveying and pricing of construction engineering directly aligns with core positions in cost consulting, construction, and engineering management units, and its teaching quality directly impacts students' job adaptability and career development potential. For a long time, this course has faced numerous pain points under traditional teaching models, such as low alignment between course objectives and job competencies, unsynchronized updates between teaching content and industry standards, weak practical teaching links, insufficient student autonomy in learning, and evaluation systems that struggle to comprehensively reflect learning outcomes. Outcome-based education (OBE) emphasizes starting from final learning outcomes, reverse planning the entire teaching process, highlighting competency-based education and continuous improvement; industry-education integration emphasizes school-enterprise collaboration and job-course alignment, serving as a core pathway for high-quality talent cultivation in higher education. Deeply integrating the OBE concept with industry-education integration mechanisms and applying it to the reform of the quantity surveying and pricing of construction engineering course can effectively address traditional teaching challenges, promote a shift from knowledge transmission to competency cultivation, and achieve seamless alignment between talent cultivation and industry demands.

2. Analysis of current teaching situation and issues in quantity surveying and pricing of construction engineering course

2.1. Core issues in current course teaching

In the teaching practices of civil engineering majors in universities, the course of quantity surveying and pricing of construction engineering commonly adheres to traditional teaching organizational methods, resulting in a significant gap from the actual demands of industry positions. The main issues are concentrated in the following aspects [3].

Course objectives are not clearly defined and lack sufficient alignment with graduation requirements and job competencies. Traditional course objectives often focus on knowledge acquisition, with vague descriptions of students' practical operational abilities, problem-solving abilities, and awareness of professional norms, lacking specific, measurable, achievable, and evaluable indicators. This makes it difficult to support professional graduation requirements and precisely align with the core competency requirements of positions such as cost estimators and budgeters. Teaching content is disconnected from industry practice, lacking front-line relevance and practicality.

Course content is often organized based on textbook chapters, emphasizing theoretical explanations while lacking real engineering projects as carriers, resulting in inconsistency with actual work processes such as enterprise budget compilation, bill preparation, and quantity verification and pricing. Meanwhile, the integration of industry front-line content such as the latest pricing standards, digital costing technologies, and BIM applications is insufficient, and cross-course knowledge integration is weak, making it difficult for students to form systematic job-related work thinking.

Teaching models are relatively traditional, failing to fully reflect students' subjectivity. Classroom instruction is primarily teacher-led, with shallow integration of online and offline teaching. Information platforms are mostly used as resource storage tools, failing to form a complete closed loop of pre-class autonomous preview, in-class learning and practice integration, and post-class consolidation and expansion. Students mainly passively receive information, with limited opportunities for autonomous exploration, team collaboration, and practical exercises, making it difficult to effectively exercise their autonomous learning and innovative application abilities.

Practical teaching links are weak, with industry-education integration remaining superficial. On-campus practical training mainly consists of simulated exercises, lacking support from real projects, real scenarios, and real standards; off-campus practical training bases have low utilization rates, with limited depth of enterprise mentors' participation in teaching and guiding practical training. Practical teaching is disconnected from job work processes, making it difficult for students to cultivate rigorous, standardized, and striving for excellence professional qualities in real environments.

Evaluation methods are single, lacking process-based and comprehensive evaluations. Course evaluations still primarily rely on final written exams, focusing on theoretical memorization while paying insufficient attention to practical outcomes, process performance, team collaboration, and professional qualities. The evaluation subjects are mainly teachers, lacking student self-evaluations, peer evaluations, and enterprise evaluations, making it impossible to comprehensively reflect learning outcomes and support teaching effectiveness diagnosis and continuous improvement. The integration of course ideology and politics is not deep enough, failing to fully exert its value-leading role. Ideological and political elements are often simply implanted as add-ons, failing to deeply integrate with the normative awareness, responsibility consciousness, integrity qualities, and craftsmanship spirit in quantity surveying and pricing work, resulting in a lack of organic unity between knowledge transmission, ability cultivation, and value leading.

2.2. Analysis of issue causes

The issues in course teaching result from the combined effects of multiple factors such as educational philosophies, talent cultivation mechanisms, teaching implementation, and support conditions [4]. At their roots, firstly, teaching philosophies are relatively outdated, with most teaching still centered on knowledge-based education, failing to truly implement the core requirements of outcome orientation, student-centeredness, and continuous improvement in the OBE concept, and failing to form closed-loop designs for objectives, content, implementation, and evaluation. Secondly, the industry-education integration mechanism is not robust enough, with insufficient collaboration between schools and enterprises in course development, teaching implementation, and evaluation and assessment, resulting in limited enthusiasm and effectiveness of enterprise participation in talent cultivation and difficulty in achieving deep alignment between courses and positions and between teaching and production. Thirdly, teaching organizational methods are inconsistent with job work logic, with teaching progressing according to knowledge systems rather than being reconstructed according to job work processes, leading to a disconnection between student learning and practical application. Fourthly, the evaluation system does not match course objectives, with evaluation content and methods unable to effectively test ability attainment levels and lacking data support and feedback improvement mechanisms. Fifthly, the structure and abilities of the teaching staff need optimization, with some teachers lacking front-line enterprise practical experience and having difficulty meeting reform requirements in terms of project-based teaching, information-based teaching, and course ideology and politics design abilities.

3. Overall design of curriculum reform based on OBE integration of industry and education

3.1. Core reform concepts

This curriculum reform adopts OBE as its core philosophy, with the integration of industry and education and school-enterprise collaboration as the implementation path. It adheres to the overall approach of "reverse design, forward implementation, alignment of job requirements with courses, diversified evaluation, and continuous improvement." Starting from the job requirements in the construction industry and the graduation requirements of the program, the curriculum objectives and learning outcomes are determined in reverse [5]. Using real engineering projects as the medium and job workflows as the logic, schools and enterprises jointly reconstruct the teaching content. A student-centered teaching model that combines online and offline learning and school-enterprise collaboration is established. A comprehensive, multi-subject, and diversified assessment and evaluation system is constructed based on the achievement of outcomes. A teaching diagnosis and improvement mechanism is established based on evaluation data to continuously optimize the curriculum implementation effects. Ultimately, this aims to achieve alignment between curriculum content and occupational standards, teaching processes and production processes, and skill development with job requirements, thereby cultivating high-quality technical and skilled talents who meet the needs of the frontline of the industry.

3.2. Reverse design of curriculum objectives

Based on the OBE concept, following the reverse design chain of "graduation requirements—curriculum objectives—teaching content—evaluation methods," and in conjunction with the occupational standards for cost estimation positions and the professional talent cultivation plan, the curriculum objective system is clarified. Curriculum objectives are formulated around the knowledge, abilities, and qualities that students should ultimately achieve, corresponding to graduation requirement indicators such as engineering knowledge, problem analysis, and professional ethics, ensuring that the objectives are implementable, measurable, and evaluable.

Through course learning, students should understand the basic principles of construction project measurement and pricing, master the normative requirements for bill of quantities pricing, and possess a theoretical foundation related to construction cost estimation. They should be able to apply quota knowledge and engineering measurement rules to accurately calculate quantities and complete the preparation of tender bill of quantities. They should be able to reasonably determine comprehensive unit prices and construction costs in accordance with national standards and norms, independently completing the preparation of project budget documents. They should be able to abide by industry laws, regulations, and professional ethics, forming a rigorous and standardized work ethic, a spirit of craftsmanship that strives for excellence, and a highly responsible professional attitude. The curriculum objectives cover both core professional competencies and professional quality requirements, providing clear directions for the reconstruction of teaching content and the construction of an evaluation system.

3.3. Basic principles of reform

The curriculum reform consistently adheres to the principle of outcome orientation, with all teaching activities centered around learning outcomes and using the abilities and qualities ultimately achieved by students as the core basis for teaching organization and evaluation. It upholds the principle of student-centeredness, highlighting the dominant role of students in learning and constructing a teaching approach that combines autonomous learning, collaborative learning, and practical training. It adheres to the principle of alignment between job requirements and courses, promoting consistency between teaching content, workflows, technical standards, and actual enterprise job requirements, achieving integration of learning and application. It follows the principle of industry-education collaboration, encouraging deep enterprise participation in the entire process of curriculum objective setting, content development, teaching implementation, and assessment evaluation, forming a collaborative educational model between schools and enterprises. It adheres to the principle of continuous improvement, establishing a closed loop of evaluation, feedback, and improvement, continuously optimizing the curriculum system based on student learning data, enterprise feedback, and teaching effectiveness. It follows the principle of integrating ideological and political education, naturally integrating professional ethics, a sense of responsibility, a spirit of craftsmanship, and a concept of the rule of law into the entire teaching process, achieving a holistic approach to cultivating knowledge, abilities, and values.

4. Specific practical pathways for curriculum reform

4.1. Reconstructing teaching content through school-enterprise collaboration

The reconstruction of teaching content is a core aspect of curriculum reform. Following the IFMOS instructional design approach, both schools and enterprises participate jointly, using real engineering projects as the medium to break away from the traditional chapter-based logic of textbooks and reorganize teaching content according to job workflows [6]. Real construction projects, such as senior apartment complexes, are selected as comprehensive cases that run throughout the entire course. The core task of the course is positioned as the preparation of project budget documents, which is broken down into three progressive task modules: preparation of pricing principles, preparation of tender bill of quantities, and preparation of project budget documents. Centered around these core tasks and sub-modules, content such as bill of quantities pricing norms, quantity calculations, bill preparation, determination of comprehensive unit prices, and budget document preparation is integrated. Theoretical knowledge, practical skills, industry norms, and professional qualities are incorporated into the entire project implementation process. At the same time, the latest national standards and industry policies are promptly integrated, and new technologies such as BIM modeling and digital quantity calculation are supplemented. Strengthening connections with courses such as Civil Engineering Drawing, Construction Technology, and Construction Cost Estimation Software Application, cross-course resource associations are achieved through knowledge graphs, enhancing the systematicity, cutting-edge nature, and practicality of teaching content. This enables students to master core skills required for their positions while completing real projects.

4.2. Innovating the teaching model for industry-education integration

Leveraging an information-based teaching platform, a student-centered, school-enterprise collaborative blended teaching model combining online and offline learning is constructed, forming an integrated learning loop that spans pre-class, in-class, and post-class phases [7]. Before class, resources such as micro-videos, courseware, and normative documents are pushed through platforms like Chaoxing Xuexi Tong, allowing students to independently complete knowledge previews and organize mind maps. Teachers use preview data to understand student learning conditions and achieve precise teaching. During class, relying on intelligent teaching platforms, case libraries, and project libraries, teaching is conducted using methods such as case-based instruction, task-driven learning, team collaboration, and industry quantity comparison simulations. Students are organized into groups for practical operations, self-assessments, peer assessments, and discussions, achieving learning while practicing and inspecting while practicing, thereby enhancing knowledge application and collaboration abilities. After class, extended tasks are pushed through online platforms, team-based mutual quantity comparisons and Q&A guidance are conducted, and learning process data is systematically collected to provide a basis for personalized guidance and teaching improvements. Additionally, enterprise instructors are introduced to participate in classroom teaching, case analysis, and practical guidance, bringing enterprise workflows, industry standards, and practical experience into the classroom, enhancing the authenticity and relevance of teaching. Through blended teaching and school-enterprise collaboration, the contradiction between abundant teaching content and limited class hours is effectively alleviated, and students' autonomous learning and practical application abilities are improved.

4.3. Constructing an OBE-based diversified outcome evaluation system

Centered around course objectives and learning outcomes, a comprehensive, multi-dimensional, and multi-subject evaluation system is constructed to achieve deep integration between evaluation and outcomes, evaluation and teaching, and evaluation and improvement. Evaluation content covers dimensions such as knowledge understanding, skill operation, process performance, team collaboration, and professional qualities. Daily performance, after-class assignments, experimental project outcomes, and final exams are incorporated into the total score in a reasonable proportion, emphasizing process-based evaluation and practical outcome evaluation. The evaluation subjects consist of teachers, students, and enterprise instructors, implementing a combined approach of teacher evaluation, student self-assessment, peer assessment, and enterprise evaluation. Through information-based platforms, automatic recording of process data and automatic calculation of grades are achieved, ensuring objective and fair evaluation. Based on evaluation data, the achievement degree of course objectives is analyzed, weak teaching areas are diagnosed, and a closed-loop mechanism of evaluation, analysis, feedback, and improvement is formed to support continuous teaching optimization.

4.4. Building a dual-qualified teaching staff

A structured teaching team combining "in-house full-time teachers + enterprise part-time instructors" is established to provide stable faculty support for curriculum reform. On one hand, in-house teachers are supported to engage in on-the-job training in enterprises, participating in frontline work such as construction cost consultation, project budget preparation, and quantity comparison and price verification to enhance their practical operation and project-based teaching abilities. Regular training on teaching abilities such as OBE instructional design, blended teaching, information tool application, and curriculum ideological and political development is organized to improve the implementation level of curriculum reform. On the other hand, technical experts and industry professionals from cost consultation companies and construction enterprises are hired as part-time teachers to undertake tasks such as case-based teaching, practical training guidance, and evaluation, introducing new industry technologies, methods, and norms into the classroom. A regular teaching and research mechanism is established to conduct collective lesson preparation, case discussions, teaching reflections, and experience exchanges regularly, promoting continuous improvement in the overall capabilities of the teaching staff.

5. Conclusion

Combining the OBE outcome-oriented concept with the industry-education integration talent cultivation mechanism is an effective pathway for curriculum reform in measurement and pricing of construction engineering at universities. In the future, as the digital and intelligent transformation of the construction industry continues to deepen, the course will continue to integrate new technologies, norms, and models, continuously optimizing teaching content and implementation pathways to enhance talent cultivation quality. The ideas, methods, and implementation pathways formed through this reform can provide a replicable and promotable paradigm for similar curriculum reforms in civil engineering majors at universities, helping university education better serve the high-quality development of the regional construction industry.

Disclosure statement

The authors declare no conflict of interest.

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