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Research on the Talent Cultivation Model of Engineering Cost Major in Vocational Undergraduate Colleges Based on the Integration of Industry and Education

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Abstract: This study focuses on the innovative paths of the talent cultivation model for the engineering cost major in vocational undergraduate colleges under the background of the integration of industry and education. Aiming at the prominent problems existing in the current talent cultivation, such as the imbalance of the faculty structure, the lag of curriculum content, and the weakness of practical teaching, a talent cultivation system with "school-enterprise cooperation, competence-based" as the core is constructed. By reconstructing the curriculum system led by BIM technology and whole-process cost management, establishing a "three-level and four-stage" practical teaching mechanism, building a two-way flowing "dual-teacher" teaching team, and forming a multi-participatory quality evaluation system, the supply-side reform of talent cultivation is systematically promoted. The research aims to promote the organic connection of the education chain, talent chain, and industrial chain, and provide a theoretical basis and practical solutions for cultivating high-level technical and skilled personnel who adapt to the digital transformation of the construction industry.

1. Introduction

As a combination of higher education and vocational education, vocational bachelor's education is tasked with cultivating high-level technical and skilled personnel who can adapt to the high-end development needs of industry. However, the traditional talent training model for engineering cost has exposed structural contradictions between the supply side and the industrial demand side[1]. Therefore, in the context of industry-education integration, systematically exploring a new talent training model for the engineering cost major in vocational bachelor's colleges is not only an inevitable requirement for responding to the national vocational education development strategy but also a fundamental path to solving the dilemma of talent training being detached from real-world needs and enhancing the ability of education to serve industrial development, which has important practical significance for ensuring the high-quality development of the construction industry[2].

Scholars at home and abroad have conducted a series of studies on industry-education integration and engineering cost talent training. Existing research generally recognizes that industry-education integration is key to improving the quality of talent training and focuses on aspects such as school-enterprise cooperation mechanisms and the construction of practical teaching systems[3]. However, most studies focus on the higher vocational college level, with insufficient attention paid to the particularities of vocational bachelor's education, an emerging type of education, and a lack of top-level design for a systematic talent training model that matches it. Specifically, engineering cost majors in vocational bachelor's colleges currently face several deep-seated problems at the practical level. In terms of faculty, there is a substantial shortage of "dual-qualified" teachers, and there is a gap between teachers' engineering practice ability and the forefront of industry technology. In terms of the curriculum system, content updates are lagging, and it is out of sync with the industry's digital process represented by BIM, failing to effectively integrate new industry standards and technologies. In terms of practical teaching, school-enterprise cooperation often remains at the agreement level, lacking a sustainable mechanism for deep integration, resulting in insufficient authenticity and comprehensiveness of the engineering practice projects in which students participate[4]. The existence of these problems seriously restricts the realization of vocational bachelor's talent training goals. Therefore, this study aims to construct a systematic and operable industry-education integration talent training model that addresses the dual attributes of higher education and vocational nature of vocational bachelor's education to make up for the shortcomings of existing research.

The core content of this study is to construct an industry-education integration-based engineering cost talent training model suitable for vocational bachelor's colleges. The study will deeply analyze the internal logic of industry-education integration and professional development, systematically diagnose the key shortcomings of the current training model, and focus on the theoretical construction and practical path design of the model from five dimensions: training system, curriculum structure, practical teaching, faculty, and evaluation mechanism.

2. Intrinsic Logic

2.1 Theoretical Foundation and Policy Evolution of Industry-Education Integration

As a core characteristic of the modern vocational education system, industry-education integration's theoretical foundation stems from the deep intersection of educational ecology and human capital theory. This concept breaks through the superficial interaction model of traditional school-enterprise cooperation, emphasizing the formation of an organic whole where industrial and educational systems are mutually embedded, co-exist, and co-grow through factor exchange, structural reorganization, and value co-creation. Observing from the perspective of policy evolution, industry-education integration in China has experienced a deepening process from the initial exploration of "school-enterprise cooperation" to the institutional establishment of "industry-education integration." The promulgation of the "National Vocational Education Reform Implementation Plan" marks the rise of industry-education integration from local practice to a national strategy, with its policy orientation shifting from simply promoting employment to serving industrial transformation and upgrading, as well as innovation-driven development. This policy shift places higher demands on vocational undergraduate education, requiring the urgent establishment of a collaborative mechanism that resonates with industrial development[5]. As an application-oriented major closely related to the development of the construction industry, the quality of talent cultivation in the construction engineering cost major directly depends on the depth and breadth of industry-education integration, necessitating the construction of an ecosystem that organically connects the education chain, talent chain, industrial chain, and innovation chain.

2.2 Talent Demand Trends

The construction industry is undergoing a profound transformation characterized by "digitalization, intelligence, and green development." This transformation is driving the construction engineering cost major to shift from traditional measurement and pricing to whole-process cost control and digital decision support. This transformation trend places new demands on the ability structure of vocational undergraduate-level construction engineering cost talent. The market urgently needs professionals with a composite ability of "technology + management + innovation," whose core ability dimensions include: BIM-based whole-process cost control capabilities, the ability to use big data tools for cost analysis and prediction, cross-professional collaboration and project communication skills, and cost optimization and innovation capabilities based on value engineering. Vocational undergraduate education must accurately grasp this change in ability structure, and through deepening industry-education integration, transform new industry technologies, standards, and specifications into teaching content in a timely manner, cultivating high-level technical and skilled personnel who can competently handle complex project cost management tasks in a digital environment[6].

2.3 Mechanisms and Pathways

Industry-education integration drives the development of the construction cost engineering major through three interconnected mechanisms. At the strategic level, it promotes a shift in professional positioning from "supply-oriented" to "demand-oriented," requiring professional development to proactively align with the digital upgrade of the construction industry and regional economic development strategies. This shift necessitates that vocational undergraduate institutions establish strategic partnerships with leading industry enterprises to jointly formulate talent development plans, ensuring that the direction of professional development remains consistent with industry evolution trends.

At the resource integration level, industry-education integration provides indispensable practical resources and technical support for the construction cost engineering major. By jointly building industry-education colleges, collaborative innovation centers, and other tangible platforms, schools can promptly acquire cutting-edge industry technology tools and real-world project cases, resolving the structural contradiction of teaching content lagging behind technological development. In-depth corporate participation in curriculum development, practical training base construction, and teaching resource updates integrates the latest industry BIM applications, cost databases, intelligent quantity surveying, and other practical content into the entire teaching process, effectively bridging the gap between theory and practice[7].

At the process collaboration level, industry-education integration constructs a new governance structure of "multi-agent collaborative education." This structure requires the establishment of a teaching guidance committee with the joint participation of schools and enterprises, implementing a "dual leader" system to jointly oversee professional planning, curriculum design, textbook development, and quality evaluation. Through the introduction of enterprise mentors to participate in practical teaching, organizing student participation in real project cost management, and conducting graduation designs based on actual problems, an integrated "teaching-practice-innovation" training process is formed. This deep collaboration not only enhances students' engineering practice ability and professional skills but also promotes the improvement of teachers' engineering capabilities and enterprises' technological innovation, creating a virtuous cycle of talent development and industrial advancement.

3. Current Situation and Problems

3.1 Imbalanced Faculty Structure

The construction cost engineering program in vocational undergraduate institutions faces structural contradictions in faculty development, mainly manifested as a dual dilemma of insufficient quantity and substandard quality of "dual-qualified" teachers. Analyzing the sources of faculty, professional teachers are mainly composed of two categories: one category consists of doctors and masters who graduated from higher education institutions, who have systematic theoretical knowledge but generally lack practical engineering experience; the other category consists of part-time teachers from industry enterprises, who have first-line operational skills but often lack systematic teaching theory and methods. This binary opposition in the faculty structure leads to a clear capability gap in the teaching process.

The core problem with the current teaching staff is the disconnection between professional practical abilities and industry development. As the construction industry accelerates its digital transformation, emerging fields such as BIM technology, big data analysis, and smart cost management place new demands on teachers' professional skills. However, most in-service teachers still remain in the traditional teaching scope of quantity surveying and valuation, and their cognitive depth and practical ability in digital cost management are significantly insufficient. Although some institutions organize teachers to learn new technologies through short-term training and other methods, this fragmented knowledge update cannot support systematic teaching reform. More noteworthy is that the existing teacher evaluation system still places more emphasis on scientific research papers and vertical projects, and the assessment weight of practical engineering ability and teaching innovation achievements is significantly insufficient. This institutional orientation further weakens teachers' initiative to improve their practical abilities.

3.2 Disconnection between Curriculum System and Industry Practice

The curriculum setting of construction cost engineering programs in vocational undergraduate institutions presents obvious lag, making it difficult to adapt to the needs of the digital transformation and upgrading of the construction industry. Analyzing the curriculum content, most institutions still focus on traditional knowledge modules such as quota-based pricing and manual quantity calculation, with limited coverage of teaching content in emerging fields such as BIM cost management, big data analysis, and whole-process engineering consulting. This lag in curriculum content directly leads to a mismatch between the knowledge and skills acquired by students and the actual needs of the industry.

In terms of curriculum structure, the problem of imbalance in the proportion of theoretical courses and practical courses is still prominent. Although universities have generally increased the number of practical teaching hours, the practical content is mostly verification and decentralized skills training, lacking comprehensive and innovative project practice. The logical connection between courses is weak, failing to form a knowledge system based on the whole process of engineering projects. Especially in the integration of information technology and professional courses, most institutions only offer new technologies such as BIM as independent courses, failing to integrate them into all teaching links of the entire cost management process. This "labeling" curriculum reform makes it difficult to achieve deep integration of information technology and professional education.

3.3 Insufficient Support for Practical Teaching System

The practical teaching component is a weak link in the cultivation of talent in the vocational undergraduate engineering cost program. The problems are mainly reflected in three aspects: practical conditions, practical content, and practical management. Regarding practical conditions, although all colleges and universities have built cost training rooms, the equipment configuration and software update speed are obviously lagging behind the development of the industry. The training equipment in some colleges and universities is still dominated by traditional quantity surveying software, and there is insufficient investment in emerging technology platforms such as BIM collaborative platforms, cloud computing, and big data analysis. This lag in hardware conditions seriously restricts the cultivation of students' modern engineering capabilities.

In terms of practical content design, the existing training projects are mostly simplified simulation cases, which have a large gap from the complexity and uncertainty of real engineering projects. The cost cases that students come into contact with are often limited to a single stage such as construction drawing budgets, and lack comprehensive practice covering the entire process of investment decision-making, design, construction, and operation and maintenance. This fragmented practical training makes it difficult to cultivate students' systematic engineering thinking and whole-process cost control capabilities. At the same time, training projects emphasize standardized operating procedures, and insufficient attention is paid to the cultivation of students' innovative thinking and problem-solving abilities, which is in sharp contrast to the industry's demand for compound talents.

There are also problems with the management mechanism of practical teaching. Cooperation between schools and enterprises mostly remains at the agreement level, and the phenomenon of "enthusiastic schools and indifferent enterprises" is still common. Companies are often unwilling to accept students for in-depth internships due to factors such as production efficiency, safety guarantees, and trade secrets. Even if students enter enterprises for internships, they are mostly observational or auxiliary work, making it difficult to access core business links. The collaborative guidance mechanism between on-campus and off-campus teachers is not yet sound. On-campus teachers focus on theoretical guidance, and corporate mentors lack teaching experience. This lack of cooperation between the two types of mentors greatly reduces the effectiveness of practical teaching.

3.4 Singular Talent Development Evaluation Mechanism

The talent development evaluation system for vocational undergraduate construction cost engineering programs exhibits a clear tendency towards singularity, making it difficult to comprehensively reflect students' overall capabilities and professional qualities. The current evaluation methods are still mainly based on summative written examinations, focusing on students' mastery of theoretical knowledge and standardized processes, while the assessment of practical abilities, innovative thinking, and soft skills such as professional qualities is clearly insufficient. This evaluation orientation, which emphasizes results over process and knowledge over abilities, directly affects students' learning behavior and teachers' teaching focus.

The singularization of evaluation subjects is another prominent problem. The evaluation power of talent development quality is mainly in the hands of on-campus teachers, and stakeholders such as industry enterprises and employers have low participation. Although some colleges and universities have introduced corporate evaluation links, they are mostly limited to a few links such as graduation internships, and have not formed a diversified evaluation mechanism that runs through the entire process of talent development. This closed evaluation system makes it difficult to accurately reflect the matching degree between talent development quality and industry needs, and cannot provide effective feedback information for professional construction and teaching reform.

The connection between evaluation standards and professional qualification certification is not close enough. The professional qualification standards in the field of construction cost engineering have gradually shifted to digitalization and whole-process management, but the evaluation standards of colleges and universities have not kept up with this change in a timely manner. There is a gap between the skill evaluation obtained by students during their studies and the professional abilities required by the industry, which greatly reduces the effectiveness of the "dual certificate" system. Establishing a diversified evaluation system that is synchronized with industry development and aligned with professional standards has become a key link in improving the quality of talent development.

4. Talent Development Model Construction

4.1 Building a "School-Enterprise Collaboration, Competency-Based" Talent Development System

Based on the concept of outcome-oriented education, the training system for engineering cost major is restructured. Using industry needs as the logical starting point, schools and enterprises jointly determine the core competency indicators that graduates should possess, including BIM technology application ability, whole-process cost control ability, data analysis ability, and project management ability. By establishing a professional construction committee jointly led by schools and enterprises, teaching standards that are aligned with occupational standards are developed, forming a closed-loop system of "industry needs - competency goals - curriculum system - teaching implementation - evaluation feedback." The school can implement a dual-mentorship system of "school teachers + enterprise mentors," integrate real enterprise projects into the graduation design process, and ensure that talent development is precisely aligned with job requirements.

4.2 Deepening the Reform of Practical Teaching

A "three-level and four-stage" practical teaching system should be established, which includes: basic skills level, professional integration level, and innovative practice level, as well as cognitive practice, specialized training, comprehensive training, and on-the-job internship. Schools and enterprises jointly build a construction engineering cost studio with the functions of teaching, training, and technical services, and introduce real enterprise project resources. Under the guidance of teachers, students participate in actual engineering cost consultation, cost control and value analysis, etc., in real working scenarios, thereby enhancing their professional abilities. Thus, an elastic practical teaching management system is established to adapt to the characteristics of enterprise project cycles and ensure the effectiveness of practical teaching.

4.3 Building a "Dual-Teacher" Teaching Team

A faculty development mechanism that combines "introduction and cultivation, and two-way flow" should be implemented. Schools should establish teacher enterprise workstations, arranging professional teachers to regularly go to cooperative enterprises to provide technical services and practical training, participate in actual engineering projects, and accumulate engineering experience. At the same time, they should improve the teacher assessment and evaluation system, incorporating engineering practice ability and technical service level into the evaluation system for professional title assessment and performance evaluation. Through joint efforts between schools and enterprises in conducting technological research, standard formulation, etc., they can enhance teachers' engineering practice ability and industry influence, and form a teacher development path that emphasizes both teaching and engineering capabilities.

4.4 Establishing a Diversified Talent Training Evaluation Mechanism

A quality evaluation system involving multiple parties such as schools, enterprises, and industries should be constructed. The school can adopt a combined approach of process-based evaluation and summative evaluation to focus on assessing students' comprehensive performance in real working scenarios. At the same time, a tracking mechanism for graduates' career development should be established, with employment quality, career development ability and enterprise satisfaction serving as the core evaluation indicators. An evaluation model combining "course assessment with professional qualification certification" should also be implemented, integrating the requirements for the professional capabilities of cost engineers into the course assessment standards. Finally, through regular conducting of graduate capability diagnosis and professional evaluations, a continuous improvement quality assurance mechanism can be formed to ensure that the quality of talent cultivation keeps pace with the development of the industry.

5. Conclusion

This study systematically constructs a talent development model for the vocational undergraduate program in construction engineering cost in the context of the integration of industry and education. The research indicates that by constructing a "school-enterprise collaboration, competency-based" training system, restructuring the curriculum content with BIM technology and whole-process management as the core, deepening the "three-level, four-stage" practical teaching reform, building a "dual-teacher" teaching team, and establishing a diversified evaluation mechanism, the structural contradictions between talent development and industry needs can be effectively resolved, and students' professional competence and innovative development capabilities can be improved. It is recommended that vocational undergraduate colleges and leading enterprises in the industry establish strategic cooperative relationships to jointly formulate talent development plans. Educational authorities should improve the institutional guarantees for the integration of industry and education and establish a mechanism for the co-construction and sharing of school-enterprise resources. Industry associations need to actively participate in the formulation of professional standards and the evaluation of talent quality to form a joint educational force.

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