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Student-Centered Teaching Reform and Practice Research in the "Building Information Modeling Application" Course

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Abstract: Driven by both the digital transformation of China's construction industry and the high-quality development of vocational education, the teaching reform of the "Building Information Modeling Applications" course has become a critical component in enhancing the quality of technical and skilled talent cultivation. However, the traditional teaching model has several drawbacks, such as the lack of ideological and political guidance, insufficient teaching adaptability, and a single evaluation mechanism. Therefore, grounded in a student-centered educational philosophy and integrating the "Practicing Before Learning" approach that emphasizes the fusion of theory and practice, this study constructs a systematic reform model characterized by "one core guiding principle, dual-track driving mechanisms, and three-dimensional support." Through teaching practice, this model significantly enhances students' professional skills, vocational competence, and innovative capabilities. It provides valuable support for digital curriculum reform in higher vocational education and offers important reference experience for advancing the quality of technical and skilled talent cultivation in vocational education.

1. Introduction

Building Information Modeling (BIM) technology, serving as the core support throughout the entire project lifecycle, has become an essential skill for professionals in the construction field. As a core course bridging professional education and industry demands, the teaching quality of BIM Application directly determines whether students can meet the requirements of emerging roles such as digital construction and intelligent collaborative management. However, traditional teaching models are significantly out of step with the reform direction of vocational education in the new era, which emphasizes a student-centered approach and competency-based learning.

Since the 1980s, U.S. higher education has actively promoted student-centered undergraduate teaching reforms to address the practical challenges of declining teaching quality, achieving remarkable results (Zou Qin, 2014)[1]. Chinese scholars have also conducted extensive research under the student-centered philosophy. They proposed the "new three centers" perspective: "student development, student learning, and learning outcomes" (Zhao Juming, 2016) [2]. Concurrently, further explorations have been conducted in ideological and political education courses at universities, introducing a comprehensive implementation pathway encompassing “concepts-content-methods-evaluation-practice” (Wang Lujuan, 2026) [3].

Guided by the student-centered philosophy, this study explores a novel reform model. By precisely aligning with student needs, innovating teaching platforms, and refining educational mechanisms, it addresses the challenges of traditional BIM instruction. This approach provides a replicable and scalable theoretical framework and practical solution for digital curriculum reform in higher vocational education.

2. Core Challenges in Course Instruction and Student Learning Profile Analysis

Based on my years of teaching experience in this course, I have identified three primary pain points in the curriculum reform. These issues not only hinder improvements in teaching quality but also run counter to the student-centered philosophy that guides educational direction. They severely constrain efforts to optimize the learning experience and enhance learning outcomes(Han Lifu, 2006) [4].

2.1. The absence of ideological and political guidance, lack of endogenous motivation to stimulate

Instruction has long focused on imparting BIM software operation techniques, failing to establish a systematic ideological education framework. Elements such as cultural confidence, craftsmanship spirit, and patriotic sentiment are often superficially embedded as labels, lacking precise alignment with students' diverse cognitive characteristics and career aspirations（Long Yan,2022) [5]. This disconnect between “curriculum” and “ideological education” has resulted in two separate entities. It fails to guide students ideologically toward embracing the professional conviction that “skills lead to success and serve the nation,” and it struggles to address issues such as unclear learning objectives, pronounced reluctance to tackle challenges, and a lack of intrinsic motivation among students（Yuan Suyu,2021) [6].

2.2. Insufficient Integration of Theory and Practice, Lack of Differentiated Instruction

Course content is confined to generic BIM operation tutorials, failing to deeply integrate with the specialized characteristics of each discipline within the overall model. It lacks modular content design tailored to core professional needs, resulting in a disconnect from real-world job tasks and skill standards. This leads to weak knowledge transfer abilities among students, hindering the development of collaborative “BIM + discipline” thinking. Simultaneously, teaching methods remain rigidly standardized as “instructor demonstration + student imitation,” ignoring significant variations in students' software proficiency and career aspirations. This approach fails to provide a “safety pad” for students with weaker foundations or an “incubator” for those with high potential.

2.3. Evaluation Mechanisms Remain Single-Dimensional, with an Incomplete Educational Feedback Loop

Assessment methods primarily rely on summative evaluations where “one exam determines everything,” lacking formative assessments that cover the entire learning journey. This approach fails to objectively track students' skill development trajectories, interdisciplinary collaboration performance, and ideological cultivation, while also struggling to align with differentiated objectives for tiered education. Furthermore, evaluations rely heavily on subjective human judgment, lacking objective and systematic quantitative assessment tools（Li Nan, Duan Rongxia, Ma Nan, 2025) [7].

This results in biases in assessing core competencies such as BIM model standardization and parameter completeness. The absence of an evaluation feedback optimization mechanism prevents the adjustment of teaching content and practical training programs based on assessment outcomes.

3. Implementation Pathways for Student-Centered Teaching Reform

In the pursuit of high-quality development in higher vocational education, the student-centered teaching philosophy serves as a cornerstone for reform and advancement. To effectively translate this philosophy into teaching practice, reform implementation measures can be developed across three dimensions, empowering students to grow into high-caliber technical and skilled professionals who meet contemporary demands.

3.1. Focus on One Core: Precisely Identify Student Needs, Tailor Personalized Teaching Plans, and Foster Internal Motivation through Ideological and Political Guidance

Student-centered teaching reform begins with accurately identifying and addressing students' diverse developmental needs. The key lies in organically integrating ideological and political education throughout the entire cultivation process, achieving synchronized resonance between value guidance and competency development(Gu Tongda,2012) [8]. Addressing the diversity among vocational students, a tiered and categorized cultivation approach should be adopted to build a systematic curriculum-based ideological and political education framework. Aligned with the characteristics of students at the foundational, advanced, and extension levels, elements such as cultural confidence and the spirit of craftsmanship should be integrated appropriately, avoiding a one-size-fits-all approach and superficial implementation.

During the initial enrollment period, multi-channel surveys are conducted to assess students' awareness and attitudes toward ideological and political education elements. Big data technology is employed to create “Learning-Ideological Education Profiles,” providing personalized teaching guidance at both knowledge/skill and ideological/value levels.

Based on these profiles and career planning, personalized pathways are designed for different students, clarifying learning and ideological goals for each stage. For instance, students with entrepreneurial aspirations follow a “course-incubation” path, participating in team-based initiatives like the China International College Students Innovation Competition. This integrates social responsibility education, exposure to corporate craftsmanship, and innovation practices aligned with societal needs. A comprehensive evaluation system incorporating ideological performance is established to cultivate high-caliber talents equipped with both skills and character.

3.2. Leveraging Two Major Platforms: Creating Diverse Learning and Practice Spaces to Promote Students' Holistic Development

Aligning with the core concept of “learning through practice” proposed by Mr. Mao Yisheng, we focus on building two major educational platforms. On one hand, we utilize online and offline resources to foster a lifelong learning environment accessible anywhere. On the other hand, we fully integrate theory with practice, systematically establishing a virtuous cycle mechanism of “learning by doing, doing while learning, and integrating learning with application.” This creates a truly student-centered, diversified learning and practice space. The organic integration of these two platforms not only significantly expands the boundaries of teaching resources and scenarios but also effectively strengthens the cultivation of students' comprehensive abilities in authentic professional contexts. This provides a robust foundation for promoting the holistic development of students' knowledge, skills, and competencies(Feng Xiaoying, Wang Ruixue,2019) [9].

3.2.1. Blended Learning Platform

We make full use of the resources within the open education system to develop online materials such as video courses and virtual simulation experiments, inviting industry experts to participate to ensure that the content remains cutting-edge and practical. We have established an online learning community to facilitate student interaction and collaborative learning. In-person teaching adopts project-based and case-based teaching methods, which are seamlessly integrated with online resources to form an integrated teaching model of ‘preparation, discussion and consolidation’.

3.2.2. On-Campus and Off-Campus Collaborative Practice Platform

We are upgrading our on-campus training facilities, with a focus on using virtual simulation technology to replicate real-world industrial production environments, whilst introducing state-of-the-art equipment and management processes. We are expanding our off-campus internship bases, collaborating with companies to organise work-based placements and jointly developing internship plans and assessment criteria. We are promoting industry-academia-research collaboration projects, encouraging students to participate in practical research and development, and fostering their innovative capabilities and engineering practice skills.

3.3. Establishing a Three-Dimensional Driving System

We will establish a three-dimensional education mechanism featuring tiered instruction, empowerment by category, and evaluation feedback loop to promote the coordinated enhancement of students' abilities and competencies.

3.3.1. Implement tiered instruction to accommodate differentiated development needs

Based on students' varying academic backgrounds and career goals, establish a three-tier progressive teaching pathway: Foundation Level – Advanced Level – Extension Level.

For students with weak foundational skills, unclear career direction, or insufficient hands-on abilities, create a Foundation Proficiency Group focused on achieving the skill objectives of “understanding theory, mastering operations, and meeting standards.” Through modular task decomposition, hands-on guidance, and career orientation, students master core competencies and develop professional identity. Techniques like “step-by-step video breakdowns” and “modular task decomposition” (e.g., independently completing columns, beams, slabs) ensure foundational proficiency and deliver standard-compliant basic models.

For students who have mastered foundational skills, possess clear objectives, and aspire to enhance their job competitiveness, a skill enhancement group will be formed. This group will focus on achieving the skill objectives of “mastering skills, applying knowledge effectively, and fostering collaboration.” Leveraging real-world projects and an integrated teaching approach that combines coursework, competitions, and certification, the program cultivates students' comprehensive application and collaborative innovation capabilities. Employing a “project-driven” model, students independently complete a small-scale integrated project (e.g., a minor public building) encompassing architecture and structural design. Through the practical tasks of “drawing generation” and “quantity takeoff,” they deliver a comprehensive deliverable demonstrating solid technical application.

For students with strong technical foundations, active minds, and a drive for technological breakthroughs and entrepreneurial exploration, an Innovation Excellence Group is established. This group is guided by the skill objectives of “daring to innovate, tackling challenges, and understanding entrepreneurship.” The “Advisor-Project” system drives cutting-edge technology integration and research practice, guiding students to explore innovations aligned with national strategic needs. This cultivates a sense of technical mission and innovative leadership among elite talents. By connecting students with advanced topics in research, competitions, or real-world engineering projects, this system promotes deep integration between BIM technology and frontier technologies, yielding innovative research reports with significant exploratory value.

3.3.2. Strengthen Categorized Empowerment to Build a Deeply Integrated System of Ideological and Political Education with Technology

We integrate ideological and political elements tailored to students' cognitive stages at all teaching levels, forming a dual-empowerment model of "skills cultivation and character development".

At the foundational level, we set ideological and political objectives of "cultivating dedication, boosting confidence, and upholding standards." Modular skill training is combined with case studies of excellent craftsmen as role models to guide students in mastering basic skills and forging professional identity, so as to achieve the goal of "skilled expertise plus firm ideals and convictions".

The Advanced Track centers on cultivating craftsmanship, strengthening collaboration, and upholding integrity. It integrates teaching through job-course-competition-certification pathways with real-world engineering case studies and ideological education. Through project collaboration and skill competitions, it hones comprehensive abilities and professional ethics, achieving both skill refinement and character development.

The Expansion Tier centers on "Forging Character, Embracing Breakthroughs, and Embracing Responsibility." It supports research, innovation, and entrepreneurship through mentorship programs, integrating traditional cultural wisdom with national strategic needs. This cultivates students' awareness of technological inheritance and innovation responsibility, empowering them to grow into top-tier talent.

3.3.3. Refine the evaluation feedback loop to integrate formative and summative assessments

We establish an "AI-empowered + multi-dimensional feedback loop" evaluation system to break away from the traditional "one examination decides everything" model. We objectively quantify skill proficiency and ideological-political awareness to form a virtuous cycle of "training-evaluation-feedback-optimization."

Design differentiated evaluation metrics for three tiers: foundational, advanced, and advanced. The foundational tier emphasizes operational standards and "adherence to norms" in ideological and political performance, with completion of designated models as the final assessment. The advanced tier focuses on project collaboration and "cultivating craftsmanship" competencies, with attainment of BIM technology certification as the final assessment. The elite tier highlights innovative contributions and the "courage to take responsibility" spirit, with competition achievements and research outcomes transformation serving as the final assessment.

The introduction of an "AI+BIM automated grading system" enables objective quantitative assessment of skills such as model standardization and parameter completeness. It simultaneously records learning process data, providing a basis for formative evaluation and instructional optimization.

We implement a blended evaluation model of "Formative (60%) + Summative (40%)".Formative assessment integrates classroom performance, collaborative skills, and ideological literacy, while summative assessment incorporates AI scoring. We have established a standardized feedback mechanism to continuously optimize teaching, thereby building a closed loop of "evaluation - diagnosis - improvement" and promoting student-centered teaching reform.

4. Conclusion and Outlook

This study addressed three core challenges in traditional teaching of the Building Information Modeling Applications course. Guided by the SC concept, it developed and implemented a student-centered teaching reform system characterized by “one core guiding principle, dual-track driving mechanisms, and three-dimensional support.”

The reform centers on “tiered ideological and political education + personalized development,” precisely stimulating students' intrinsic motivation by mapping “learning-ideological profiles” and formulating differentiated development plans. It employs a dual-track approach of “blended online-offline learning platforms + collaborative on-campus/off-campus practice platforms” to transcend temporal and spatial constraints in teaching. Driven by a three-dimensional framework of “tiered instruction, categorized empowerment, and closed-loop evaluation,” it establishes a virtuous cycle of “cultivation-evaluation-feedback-optimization” through an AI-enabled multi-dimensional assessment system. Practice demonstrates that this reform system effectively resolves challenges inherent in traditional teaching. It progressively achieves the organic integration of value shaping, knowledge transmission, competency development, and innovation stimulation. This approach significantly enhances students' professional skills, career competencies, and innovative capabilities, providing robust theoretical foundations and practical models for digital curriculum reform across multidisciplinary contexts.

Looking ahead, the curriculum team will continue to deepen research in the following areas.

First, we deepen the development of a personalized education system. Leveraging big data and artificial intelligence technologies, we will establish a real-time tracking platform for students' ideological dynamics and learning progress, enabling the dynamic alignment of ideological and political education elements with tiered cultivation strategies. This will create a precision education model tailored to individual students. Second, we strengthen the integration of dual-track platforms by advancing the modular and scenario-based restructuring of online resources. We deepen the university-enterprise collaborative education mechanism and develop and refine “virtual teaching and research rooms” to alleviate spatial and temporal constraints. Furthermore, we facilitate cross-university, cross-regional, and cross-disciplinary collaborative teaching, research, and project-based learning to achieve seamless integration of learning and practice. Third, we establish a dynamic content update mechanism for courses. We continuously align with new industry standards, technologies, and processes to develop modular and loose-leaf teaching resources. Fourth, we optimize AI-empowered evaluation systems by expanding AI assessment applications. We develop quantitative evaluation algorithms for qualitative indicators such as ideological literacy and innovative thinking, constructing a tripartite intelligent evaluation model integrating “skills + literacy + innovation” to enhance the comprehensiveness and precision of assessments（Dai Yonghui, Xu Bo, Chen Haijian,2018) [10].

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