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INTEGRATION OF BIM5D TECHNOLOGY INTO THE TEACHING REFORM AND INNOVATION OF "CONSTRUCTION ORGANIZATION AND MANAGEMENT" COURSE

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Abstract: Against the backdrop of intelligent construction technology, this paper analyzes the changing demands for professional talent cultivation due to industrial upgrading. It also summarizes the current state of the core course "Construction Organization and Management" in vocational colleges of architecture, including issues such as lack of supporting resources for the course, low integration of BIM technology, and shallow integration of industry and education. Therefore, it proposes major reforms and exploration paths for integrating BIM5D technology into the curriculum. These include using BIM innovation design competition projects to promote learning through competition, leading professional main courses with BIM5D practical training, and forming BIM student interest groups to carry out project-based practical services, aiming to enhance the effectiveness of course teaching and improve the quality of student practical training.
Keywords: Intelligent construction; BIM5D technology; Construction engineering; Construction organization management; Teaching reform

1 INTRODUCTION

With the development of computers and the internet, society has now entered an era of interconnected information. Consequently, new disciplines have emerged in the field of architecture and civil engineering. Modern intelligent construction technologies, based on intelligent development, are increasingly receiving close attention from scholars both domestically and internationally. The national housing and urban-rural development departments have also pointed out the need to vigorously promote intelligent buildings and popularize intelligent applications. The upgrading of industries will further increase the requirements for the cultivation of talents in architectural engineering specialties at vocational colleges. However, there is a widespread shortage of qualified teachers and a lack of practical teaching equipment and venues at most institutions, as well as a deficiency in research on practical teaching methods. Therefore, although BIM course teaching is gradually getting on track, it has not yet been integrated with courses like "Construction Organization Management" in actual teaching processes, which still poses certain developmental obstacles. It is necessary to initiate some curriculum teaching reforms and research, starting from actual engineering cases, to better integrate BIM5D technology into core professional courses, with the aim of enhancing teaching effectiveness and improving the quality of student practical training.

2 THE IMPORTANCE OF BIM5D TECHNOLOGY

Currently, China's construction industry is at a critical period of reform, transformation, and development, with digital technology driving the industry's transformation and upgrading. As early as 2017, the Ministry of Housing and Urban-Rural Development has called for accelerating the adoption of Building Information Modeling (BIM) technology, promoting intelligent and prefabricated construction, and increasing policy support. In September 2020, the Ministry also proposed advancing intelligent construction technologies and accelerating the deep integration of new industrialized construction with high-end manufacturing. In January 2022, the Ministry of Housing and Urban-Rural Development pointed out the need to accelerate the coordinated development of intelligent construction and new industrialized construction, promote the application of BIM technology throughout the entire process in general contracting projects, and emphasize the delivery and application of digital results throughout the entire construction process[1]. Therefore, the upgrade of the construction industry will further raise the requirements for the training of talents in architectural engineering majors at vocational colleges.

Intelligent construction fully utilizes intelligent technology and related technologies to establish and apply an intelligent system for the construction process, enhancing the level of intelligence in the construction process[2]. Compared to traditional extensive construction methods, intelligent construction has advantages such as higher product quality, higher construction efficiency, and less resource consumption. The application of information technologies such as BIM, big data, cloud computing, and the Internet of Things, along with new processes, materials, technologies, and methods, have accelerated the renewal and learning improvement of practitioners. This has also raised higher demands

for the quality of professional talent training in the construction field, necessitating the cultivation of more laborers who possess a spirit of model workers and craftsmen, and who are knowledgeable, skilled, and innovative—qualities that are increasingly needed in the civil construction field in the new era. BIM5D technology centers around the integrated platform of BIM models, integrating multiple specialties such as civil engineering, installation, and mechanical and electrical through a three-dimensional model data interface[3]. It integrates information on safety, quality, progress, processes, costs, materials, and equipment during the construction process onto a unified platform, providing real-time interactive information on schedule progress, resource consumption, quality, and safety management for project construction processes. It also allows for timely adjustments and corrections, achieving refined and real-time project management, and effectively advancing project progress.

In order for students in vocational colleges to truly and quickly take up practical positions after graduation, it is essential that professional skills training be a part of their on-campus practical teaching. However, currently in the field of education, various construction and civil engineering professionals lack background and experience in intelligent construction. Many institutions are facing a shortage of qualified teachers and a lack of practical teaching facilities and equipment. Due to limitations in training spaces and teaching resources, our school's "Construction Management" course has found that the effectiveness of practical training sessions is average at best, with students not showing significant improvement and often completing tasks in a perfunctory manner. It is necessary to integrate BIM5D technology into this course, based on actual engineering projects, to achieve educational reform and enhance the quality and effectiveness of teaching. Therefore, under the backdrop of intelligent construction, it is very important to integrate BIM5D technology into the curriculum reform and exploration of various professional courses in the field of building engineering.

3 ANALYSIS OF THE CURRENT STATE

The "Construction Organization and Management" course is a core subject offered by Zhejiang College of Security Technology for the major in Engineering Safety Assessment and Supervision. It serves as a follow-up to courses such as Building Construction and Drawing, Introduction to Engineering Supervision, and Laws and Regulations of Construction Projects. The course requires students to possess basic capabilities in construction organization and management. Its purpose is to align with the professional talent training objectives, targeting positions such as engineering supervisors, quality control managers, and construction organization technicians. It aims to cultivate students' abilities in construction enterprise management, engaging in the organization of construction projects, and other related practical engineering skills.

Additionally, the course establishes a knowledge, technical, and methodological framework necessary for managing the organization of construction projects, fostering students' fundamental abilities to identify, analyze, and solve practical issues in project organization management. However, in the actual teaching process, the content on standard engineering quality, progress, and safety is too theoretical and does not integrate with the current professional trends in intelligent construction and industrialization of building. Although BIM5D technology could be incorporated into the curriculum, it is currently not well integrated into the classroom [4]. Upon analysis, it is common for most institutions to face issues such as insufficient course resources, low integration of BIM5D technology, and a shallow level of industry-education collaboration.

3.1 Insufficient Supporting Resources for the Course

The main content of this course involves the research objects of construction organization, tasks, and project construction procedures, objectives of construction management, preparation for construction work, investigation and collection of original data, site preparation for construction, project structure, and basic knowledge of controlling construction objectives. Teaching can be carried out based on diversified teaching organization forms and principles of information technology. However, this course lacks practical engineering training sites, and real experience cannot be guaranteed. Based on the current major trend of intelligent construction, students will mainly use information management tools to engage in construction project management, project bidding and tendering management, project data management, and business management after employment. They also need to combine BIM5D technology for project cost consulting, project management consulting, target control, full-process project management, and maintenance. The practical training resources provided by the course cannot meet the actual job requirements of the industry in the future.

3.2 Low-Level Integrated BIM5D Technology

Currently, the traditional "Construction Organization and Management" course uses textbooks and teaching cases that have not effectively integrated BIM5D technology, and the degree of integration in some textbooks is also not high. In chapters such as progress management, quality management, and safety management, if a dynamic management model established using BIM5D technology is adopted, the theoretical explanations and practical training sessions of the course will be more efficient in ensuring that students can smoothly understand and master the material. Students can clearly understand that refined and comprehensive management methods can improve the efficiency and quality of project management. In response to the industry's requirements for practitioners to be proficient in "understanding drawings, knowing technology, and being skilled in management," schools should consider focusing on cultivating

students' BIM5D collaborative project management capabilities during the learning phase [5]. This also lays a solid foundation for students to obtain the "1+X" Building Information Modeling (BIM) vocational skill level certificate and prepares them for future work related to BIM positions.

At present, the "Construction Organization and Management" course covers content such as progress management, three-dimensional site layout modules, collision detection modules, contract information management, and construction organization design, with an emphasis on the explanation of theoretical knowledge. The results presented are also traditional paper-based textual materials, but these contents are basically covered in the BIM platform. However, during the "BIM 3D Modeling" teaching process, BIM5D technology does not import information according to different teaching needs, and more often only involves simple functional demonstrations. This results in the "Construction Organization and Management" and "BIM 3D Modeling" courses having intersections but remaining independent of each other. Therefore, the practical training segment of the "Construction Organization and Management" course has not established an intrinsic connection with BIM5D technology, resulting in a low degree of integration and generally average practical training effects. Reforms and improvements need to be carried out.

3.3 Low Integration Level of Production and Teaching

Vocational colleges have high requirements for training labs. If the focus is primarily on theoretical teaching, it does not truly harness the students' abilities to think and act practically. Due to limitations in school facilities during the practical training phase, adopting actual construction engineering projects as the task axis to carry out project-based case training throughout the classroom is a pedagogical design concept that encompasses the entire lifecycle of a project. However, this approach is nearly impossible for most institutions to implement. On one hand, student training lacks case reliance; on the other hand, there is a shortage of professionals who can proficiently master BIM5D technology. Additionally, many collaborations between colleges and enterprises are superficial, preventing students from effectively participating in the actual ongoing engineering projects of partner companies. Furthermore, improper curriculum design in professional talent training programs, irrational course sequencing, and a lack of specialized BIM faculty in higher education institutions are also significant factors affecting the effective integration of BIM5D technology into the industry-education collaboration [6]. Therefore, the current "Construction Management" course falls short in terms of the depth of its industry-education integration.

4 BIM5D TECHNOLOGY INTEGRATION AND IMPLEMENTATION STRATEGIES

4.1 Promote Learning through Competition

Our school has previously organized key teachers to lead teams in participating in the BIM Innovation Design Competition within this field, and has completed many case models, such as the F track of the Ninth National University BIM Graduate Design Innovation Competition: the BIM design of Building 7 of a certain shared property rights project in Beijing (as shown in the figure 1). This project integrates Guangsha building structure CAD software, REVIT, BIM-FILM, Glodon BIM construction site layout software, and conventional office software to complete the virtual practical operation of a certain prefabricated concrete building and steel structure building component factory production, procedural construction; individual structure design of Residential Building 7; assembly node and component split design for floors 3 to 14 (standard layers); detailed design of precast components; construction organization and simulation of the case project.

Based on this engineering case, students can have hands-on contact with the project, achieving the goal of promoting learning and teaching through competition. The abilities of students in basic knowledge mastery, BIM software operation, and teamwork are all improved through the assessment of the competition. Later on, our school used the competition topics as practical training teaching cases, closely integrating the teaching content of progress plan formulation, construction site layout, and construction scheme formulation from the "Construction Organization Management" practical training segment with it, achieving the migration of case application in the teaching process, truly reaching the goal of promoting learning through competition, and providing rich teaching resources for the practical training segment of the course.

4.2 Articulated Core Courses

Currently, teachers of various courses generally design teaching cases based on their own teaching experience. The teaching cases for each course are essentially independent, lacking a process of mutual integration and joint lesson preparation. However, the professional courses involved in "BIM 3D Modeling" are numerous, ranging from design, construction, target control, to project management. These professional knowledge areas are interconnected and progressively spiral. By selecting different cases, the BIM knowledge students acquire becomes fragmented and unsystematic [7]. Such a teaching method may be successful for a particular course, but it is not successful for the overall process of talent cultivation, nor does it reflect the progressiveness and coherence of BIM5D case teaching.

The core course "Construction Organization and Management," which incorporates BIM5D technology, actively promotes teaching reform. In the process of building the curriculum system for talent training programs, it can accumulate important data information for the practical training segment. Based on the above case background, in the courses of "Cost Software Application" and "Construction Engineering Quantity and Pricing," the BIM modeling, rebar

quantity calculation, and pricing of the project can be completed; in the teaching of construction technology courses, using the same residential building engineering case as an example, the division of flow sections and step distances can be completed, software can be used to compile the engineering progress plan, and double-coded time-scale network diagrams can be drawn; BIM construction site layout software can be used to establish three-dimensional models of the construction site layout at various stages of the project; in the "Engineering Economics" course, based on the division of construction sections and flow sections of the teaching building, material requirements are extracted according to different classification methods, combined with the schedule, to estimate the funding needs at each stage. That is to say, with BIM5D technology at the core, a series of core courses are connected, centered around a specific engineering case, to promote teaching reform in a series of professional core courses. This not only improves teaching effectiveness but also accumulates teaching materials for subsequent practical training courses in "Construction Organization and Management," realizing the integration of a series of core courses based on BIM5D practical training. Thus, a variety of blended teaching methods are realized, effectively enhancing the overall teaching effect and quality.

Figure 1 Schematic diagram of BIM design and BIM5D model for prefabricated buildings

4.3 Establishing Student Interest Groups

Organize the establishment of a BIM (Building Information Modeling) student interest group, integrating resources from off-campus partner enterprises to create a dual-teacher teaching team composed of full-time faculty from the school's engineering field and industry mentors from the intelligent construction sector[8]. Based on the BIM modeling needs of architectural engineering projects involved by enterprises, the enterprises "pose problems," and the interest group "solves them." With a foundation of certain basic knowledge and practical skills, the BIM student interest group can carry out project services under the guidance of instructors, with the results of these services being utilized for enterprise requirements. By conducting actual engineering project services through the established BIM student interest group, not only are the work needs of enterprises met, understanding the application value of BIM technology at various stages of project construction organization in current industry enterprises, but also important bases are provided for the teaching reform and research of related courses, the inspection of talent training links, and the optimization and enhancement of training programs.

5 CONCLUSIONS

At present, BIM technology has matured and is widely applied to the full lifecycle management of intelligent construction. By integrating BIM5D technology with the teaching content of the "Construction Organization and Management" course, we carry out curriculum teaching reforms and innovative explorations. This approach significantly enhances student participation in practical training classes to a certain extent, aiding students in better mastering the transfer and application of theoretical and practical knowledge, thus improving the effectiveness of course teaching and the quality of student practical training. The proposed solutions such as BIM design competitions, BIM practical training serial courses, and BIM student interest groups can further optimize the current teaching status of management courses, enhancing students' abilities to manage the full lifecycle informatization of project construction when they move towards their future work positions. Consequently, this significantly improves the effectiveness of practical training teaching and enhances the quality of talent cultivation.

COMPETING INTERESTS

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