

Research on BIM Course System and Ideological and Political Essentials of Cost Engineering Major

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Abstract: The era of information technology has dawned on the construction industry, and Building Information Modeling (BIM) is one of the necessary engineering skills for those engaged in civil engineering professions at present and those who will engage in these professions in the future. Therefore, top universities have begun exploring ways to increase BIM-related teaching content in the curriculum system. In this paper, we discuss the integration of BIM in an in-depth manner with regard to the four course modules offered by cost engineering majors (professional foundation course, professional core course, industry-oriented course, and professional practical course) and analyze the construction of BIM curriculum ideology and politics system, the setting of teaching objectives, and the key points of curriculum ideology and politics.

Keywords: Cost engineering; BIM technology; Curriculum ideology and politics system; Key points of curriculum ideology and politics

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1. Introduction

Building Information Modeling (BIM) is a data-based tool applied to engineering design, construction, and management. Through the integration of data-based and information-based models of buildings, they are shared and delivered throughout the whole life cycle, which embodies project planning, operation, and maintenance, thus enabling engineers and technicians to understand and provide efficient responses to various building information and forming design teams and construction entities, such as construction and operation units, to provide a basis for collaborative work and play important roles in improving productivity, saving costs, and shortening schedules ^[1]. In April 2021, the Ministry of Housing and Construction released the “Report on the Development of China’s Construction Industry Informatization (2021),” proposing the vigorous development of digital design, smart production, smart construction, and smart operation and maintenance, as well as the acceleration of the development and application of BIM (as an important part of the informatization of the construction industry, the value of BIM is highly regarded by the government and generally recognized by the construction industry) ^[2].

2. Integrating BIM into the curriculum of cost engineering majors

The cost engineering majors offered by applied undergraduate universities should follow the development trend of the industry, update their personnel training programs in a timely manner, include BIM-related courses, and integrate BIM into the existing curriculum system. According to research on the teaching reform of many local and foreign universities, there are two specific optimized settings for BIM courses and relevant professional courses: (1) adopt independent BIM courses and (2) add BIM contents that match

relevant professional knowledge to existing courses (*i.e.*, “implantation”) [3,4]. For example, in Chongqing Engineering College, the independent BIM courses “BIM Application,” “BIM Application and Project Management (A),” and “BIM Application and Project Management Course Design” have been added to the professional foundation course, the professional core course, and the professional practical course, respectively. Through “implantation,” “Introduction to Civil Engineering (A)” and “Civil Engineering Drafting (A)” have been included in the professional foundation course, “Construction Technology of Building Engineering” and “Application of Engineering Costing Software” have been included in the professional core course, and “Measurement and Pricing of Construction Works” and “Measurement and Pricing of Installation Works” have been included in the industry-oriented course. The optimization of the curriculum system is shown in **Table 1**.

Table 1. Optimization scheme for the integration of BIM into the curriculum of cost engineering majors

Course module	Course name	Optimization measures	BIM content	BIM software
BIM-based professional foundation course	Introduction to Civil Engineering (A)	Implantation	The application of BIM presents several classic cases in the field of civil engineering through a three-dimensional (3D) information model, allowing students to visualize the scope of research and development (R&D) in the field of civil engineering, consider the main issues involved in engineering construction, and gain a preliminary understanding of the concept, use, and importance of BIM.	Autodesk Revit
	Building Architecture (B)	Implantation	Using 3D models of buildings, students will be able to grasp the basic theory of civil building construction, familiarize with typical construction practices, and read common construction details.	Autodesk Revit
	BIM Modelling Application	New	Modelling of small building structures using Revit, a modeling software.	Autodesk Revit
BIM-based professional core course	Application of Engineering Costing Software	Implantation	Students will be familiar with the principles and methods of bill of quantities measurement and pricing and will be able to apply BIM civil measurement software to calculate quantities quickly and accurately.	Quanta BIM Civil Metrology Platform, Cloud Pricing Platform GCCP
	BIM Application and Project Management (A)	New	Students will be able to use BIM5D collaborative management for technology, production, quality, safety, and operations module applications.	Quanta BIM5D Platform
BIM-based industry-oriented course	Measurement and Pricing of Construction Works	Implantation	Students will be able to grasp the basic principles and methods of BIM construction calculations.	Quanta BIM Civil Metrology Platform GTJ
	Measurement and Pricing of Installation Works	Implantation	Students will be able to grasp the basic principles and methods of BIM installation calculations.	Quanta BIM Installation Metrology GQI

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Course module	Course name	Optimization measures	BIM content	BIM software
BIM-based industry-oriented course	Municipal Engineering Measurement and Pricing	Implantation	Students will be able to understand the basic principles and methods of BIM municipal calculations.	BIM Municipal Metrology GMA
BIM-based professional practical course	BIM Application and Project Management Course Design	New	Students will be able to apply BIM to actual projects and produce complete BIM engineering project management consultancy documents.	Quanta BIM5D Platform
	Building Construction Measurement and Pricing Course Design	Implantation	Students will be able to perform BIM building calculation model construction to complete the construction project budget documentation for any given project.	Quanta BIM Civil Metrology Platform GTJ
	Measurement and Pricing of Installation Works Course Design	Implantation	Students will be able to perform BIM installation calculation model construction to complete the installation project budget documentation for any given project.	Quanta BIM Installation Metrology GQI

3. Building an ideological and political system for BIM-based courses

In order to ensure that higher education courses can achieve better development and ideological and political courses can be more effective, it is necessary to strengthen the ideological and political construction in professional cost engineering BIM-based courses and the establishment of the ideological and political system and operating mechanism; in addition, it is important to ensure that professional courses and ideological and political education are progressing in the same direction^[5]. The BIM course system for cost engineering majors is also composed of four modules: professional foundation course, professional core course, industry-oriented course, and professional practical course. According to the different types of modules and teaching content, the ideological and political element integration path is explored to construct four progressive modules of curriculum ideology and politics.

3.1. Ideological and political elements embedded in BIM-based professional foundation courses

The professional foundation courses of academic disciplines refer to professional groups of the same professional class, reflecting the commonality of the professional class and the core compulsory foundation courses. The BIM-based professional foundation courses for cost engineering majors include “Introduction to Civil Engineering,” “Civil Engineering Drawing,” “Housing Architecture,” and “BIM Modelling Application.” These courses are usually offered in the second semester of freshman and sophomore years. The path of integrating curriculum ideology and politics relies on exploring the ideological and political elements in the foundation courses according to the characteristics and teaching contents, summarizing and refining them, as well as cultivating socialist values among students. Through this, students will be able to develop core socialist values, love for the country, understanding of traditional Chinese culture and national policies, engineering thinking, craftsmanship, humanism and national pride, as well as the spirit of self-improvement to pursue their dreams^[6].

Using “Introduction to Civil Engineering (A)” as an example, we present the course orientation and teaching objectives as well as the key points of curriculum ideology and politics.

3.1.1. Course orientation and teaching objectives

“Introduction to Civil Engineering (A)” is a basic course for engineering and construction majors. This course takes the common types of civil engineering as the teaching subject and presents the whole picture of civil engineering to students in a general way, mainly elaborating the nature and characteristics of civil engineering, the history of development of civil engineering, the materials used in civil engineering, types of civil engineering, and its future development direction. Students must be familiar with the general contents of civil engineering as a discipline and the importance of civil engineering, so that they can fully understand the broad field of civil engineering, establish a professional mindset, gain a strong desire for knowledge and to pursue a career in civil engineering, as well as lay the foundation for subsequent professional courses.

3.1.2. Key points of curriculum ideology and politics

- (i) Teaching the introductory course, along with the introduction to the major and the mega projects in the construction industry in recent years, students are guided to establish ambitious ideals and patriotism, correct world views, outlook on life, and values; bravely shoulder the glorious mission put forward by the times; and improve their ideological and political quality.
- (ii) Using actual accidents as examples and speaking about various standard codes, teachers teach students to be compliant to the law and to develop good habits, professional ethical qualities, and a sense of safety and responsibility. In that way, students would develop a strong sense of responsibility and mission.
- (iii) Through the study and understanding of civil engineering, students will be able to develop the “craftsmanship” spirit, including dedication, commitment, concentration, and innovation; a conscientious, responsible, practical, and dedicated work attitude; as well as a rigorous and meticulous work style. Moreover, they will learn to view and deal with problems with the idea of materialistic dialectics, practice correct thinking methods, develop scientific thinking habits, and think logically and dialectically.

3.2. Ideological and political elements embedded in BIM-based professional core courses

Professional core courses are courses that reflect the core knowledge, ability, and quality requirements of the profession. The cost engineering BIM-based professional core courses are mainly courses on construction technology, engineering costing software application, and BIM application and project management, which are usually offered in the first semester of sophomore and junior years. The path of integrating curriculum ideology and politics relies on the knowledge points and professional characteristics of the professional courses, the discovery of ideological and political elements in the professional courses, their summary and refinement, as well as the construction of the leading ideology of the course teaching. On the basis of Module 1, students will further develop awareness of engineering ethics and the rule of law, bottom-line thinking, dialectical thinking, double-creative thinking, integrated thinking, rigorous and meticulous thinking, as well as a sense of responsibility and contractual spirit.

Using “BIM Applications and Project Management (A)” as an example, we present the course orientation and teaching objectives as well as the key points of curriculum ideology and politics.

3.2.1. Course orientation and teaching objectives

“BIM Application and Project Management (A)” is a professional core course for cost engineering majors. Based on the whole process of engineering projects, this course provides a comprehensive and systematic study of the key aspects of engineering projects, including cost, schedule, quality, organization, and contract management, and applies BIM tools to the whole process of engineering project management. Through this

course, students will master the basic theoretical knowledge of engineering project management, establish a framework of professional knowledge and global awareness of project management, be able to apply advanced management methods and BIM to solve practical engineering problems, broaden their professional knowledge, improve their multidisciplinary literacy, establish a sense of teamwork, enhance their independent learning ability and communication and coordination skills, as well as lay the foundation for engagement in engineering project management and other related work upon graduation ^[7].

3.2.2. Key points of curriculum ideology and politics

- (i) In terms of engineering project management practice, the idea is to enable students to understand the standards and specifications related to engineering project management, as well as to cultivate good professional ethics and a scientific and rigorous working attitude related to engineering project management among students.
- (ii) The course content integrates multidisciplinary knowledge of management, economics, psychology, history, environmental art, *etc.*, broadens students' subject knowledge and learning horizons, and develops students' literacy in aesthetics, history, literature, economics, and psychology with regard to project management.
- (iii) Using social engineering cases for teaching, updating professional knowledge, and focusing on cultivating students' overall understanding and ability to analyze and deal with specific problems in engineering projects, knowledge from various disciplines and fields as well as new technical methods and means are applied.

3.3. Ideological and political elements embedded in BIM-based industry-oriented courses

Industry-oriented (professional direction) courses are restricted courses for majors and are centered on the concepts of individual student development and teaching according to students' ability. In each major, industry-oriented courses are set up according to the professional orientation and objectives of the major, as well as the needs of local economic and social development, so as to fully reflect the connotation of the major and the needs of the industry. BIM-based industry-oriented courses for cost engineering majors are courses on measurement and pricing of construction works, measurement and pricing of installation works, and measurement and pricing of municipal works. These courses are mainly offered in the first semester of junior and senior years. The path of integrating curriculum ideology and politics relies on on-campus practical training bases, teaching facilities, and comprehensive practical training courses. Through professional practical training, skills and discipline competitions, and the presentation of professional learning outcomes, ideological and political elements are integrated into industry-oriented courses and quality development activities. This enhances students' awareness of cost and social responsibility as well as promotes students' sustainable development, systemic thinking, and adherence to professional ethics ^[8].

Using "Measurement and Pricing of Construction Works" as an example, we present the course orientation and teaching objectives as well as the key points of curriculum ideology and politics.

3.3.1. Course orientation and teaching objectives

"Measurement and Pricing of Construction Works" is an industry-oriented (professional direction) course for cost engineering students. The course mainly focuses on engineering projects, drawing literacy, and the correct application of current national codes and current quotas for engineering project measurement and pricing activities. With the knowledge of civil engineering drawing, housing architecture, construction technology, and the principles of construction quotas, students will be able to understand the basic principles of construction work measurement and pricing, gain familiarity with the composition of bill of quantities and the rules for calculating the quantity of works, master the use of national specifications and

quotas for construction works, develop skills in preparing bill of quantities and engineering budgets, and gradually achieve professional growth in terms of rigorous specification, objectivity and impartiality, as well as the mindset to strive for excellence.

3.3.2. Key points of curriculum ideology and politics

- (i) Through theoretical learning and skills practice in measurement and pricing, students will be equipped with scientific and rigorous thinking when calculating construction quantities, strictly implement national norms, without falsification of pricing, develop excellent professionalism, adhere to professional ethics, and gain awareness of job responsibilities ^[9].
- (ii) In terms of subject expertise and professional practical skills, the professional knowledge points and contents of engineering project costing are constantly updated to meet the needs of industrial digitalization, industrialization, and intelligence. Through practical cases, students will analyze the impact of cost control and cost management on the parties involved in engineering projects and develop a sense of professional identity and social responsibility.
- (iii) Students are encouraged to ask questions or inquire in the learning process, using inspirational, case-based, and question-based approaches. Through all these, students' learning initiative and self-learning ability will improve, and they will grow into well-rounded talents in their field of study.

3.4. Ideological and political elements embedded in BIM-based professional practical courses

The goal of professional practical courses is to cultivate students' scientific literacy and academic standards, knowledge application and hands-on skills, design ability, investigation and analytical skills, decision-making and consultation skills, creativity, as well as organization and management skills. The BIM-based professional practical courses for cost engineering majors include "BIM Application and Project Management Course Design," "Construction Engineering Measurement and Pricing Course Design," and "Installation Engineering Measurement and Pricing Course Design." These courses are offered in sophomore, junior, and senior years, across 17–18 weeks. Students are required to simulate actual work scenarios on the basis of learning the theoretical aspect. The path of integrating curriculum ideology and politics is through the completion of specific work tasks, hands-on practice and training, gaining real-life practical experience, appreciating the great changes in the economy and society brought by the reform and opening up, the cultivation of professionalism, professional ethics, honesty, and trustworthiness, along with internet thinking, cross-border integration, and collaborative thinking, as well as the development of lifelong learning habits, social responsibility, and commitment ^[10].

Using "BIM Applications and Project Management" as an example, we present the course orientation and teaching objectives as well as the key points of curriculum ideology and politics.

3.4.1. Course orientation and teaching objectives

"BIM Applications and Project Management" is a course that embodies comprehensive training based on students' theoretical knowledge of project management. Based on the application of BIM in all stages of project management, including BIM model establishment, design plan optimization, construction management organization structure optimization, project scheduling, cost analysis, construction quality monitoring, and construction plan simulation display, the course takes housing architecture drawing and engineering information as the basis to apply BIM to actual engineering project management. In that way, students will be able to prepare complete BIM-based engineering project management consultancy documents.

3.4.2. Key points of curriculum ideology and politics

In this course, students will be able to deepen their theoretical understanding of previous professional courses by completing various BIM-based engineering project management consultancy documents, which would also help students gain global awareness of project management and establish professional knowledge framework, equip them with skills to solve practical engineering project management problems by using BIM, create better teamwork spirit among students, and enhance their communication and coordination skills.

4. Conclusion

The vigorous promotion of BIM has brought about challenges and opportunities to cost engineering majors. In order to cultivate “BIM + cost engineering” composite talents, various teaching reforms are still being explored. In this paper, we study the reform of the BIM curriculum system, analyze the key points of curriculum ideology and politics in cost engineering majors, and discuss the optimization of the four modules (professional foundation course, professional core course, industry-oriented course, and professional practical course), so as to build a suitable BIM curriculum system embedded with ideological and political elements for applied undergraduates.

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