Reform and Practice of Civil Engineering Drawing Course Integrating Building Information Modeling Technology

Yuan Liu [1,*] Qingjun Guo[2] Jingxiao Zhang[3] Jie Lai[1]

[1] *Xi'an Institute of high technology, Xi'an, Shaanxi 710025*
[2] *School of architectural engineering, Xi'an University of technology, Xi'an, Shaanxi 710000*
[3] *School of economics and management, Chang'an University, Xi'an, Shaanxi 710000*
[*]*Corresponding author. Email: liuyuanbixue@163.com*

ABSTRACT

With the transformation and development of the civil engineering industry, the demand for building information modelling (BIM) technical talents is increasing. As a talent training base for civil engineering construction, introducing BIM technology into civil engineering teaching is urgent for universities. Combined with thinking on the study and application of BIM technology in the process of teaching implementation in recent years, this paper summarizes the path of the integration of civil engineering drawing teaching and BIM technology, realizes the reform of civil engineering drawing course, conforms to the development trend of the civil construction industry, and meets the personalized demand for practical talents in the field of civil engineering.

Keywords: civil engineering drawing; BIM; fusion.

1. INTRODUCTION

In the field of civil engineering construction, using BIM technology for relevant design, construction, and management has become the trend of the industry, and the technical revolution it brings to the civil engineering industry has been formed[1-4]. In 2017, the opinions on promoting the sustainable and healthy development of the construction industry issued by the general office of the State Council pointed out to accelerate the integrated application of building information modeling (BIM) in the process of planning, survey, design, construction, operation, and maintenance. In 2020, the Ministry of Housing and Urban–Rural Development and other units clearly stated in the guidance on promoting "the coordinated development of intelligent construction and building industrialization" (Jianshi [2020] No. 60) that the coordinated development of new-generation information technology and building industrialization technology should be accelerated, and the integration and innovative application of new technologies (e.g., BIM, Internet of things, and big data) in the construction process should be increased. With the strong promotion of the state, BIM technology will be continuously widely used in the field of civil engineering in China.

Civil engineering drawing is a subject based on projection theory and drawing and reading engineering drawings in combination with national standards and graphic expression methods. It is a concentrated reflection of design and construction knowledge and lays a solid foundation for the follow-up study of reinforced concrete structure principles, construction engineering budget, construction technology, and other courses. However, the course is highly theoretical and abstract. Some students with weak logical thinking ability and spatial imagination can only float on the surface in the process of learning and cannot understand the connotation of drawings and the functions of various components. Given the difficulties in the existing civil engineering drawing teaching, BIM technology is applied to the course; the teaching mode is innovated; the BIM teaching resource database is established, and the traditional elevation, section, and other two-dimensional drawings are transformed into three-dimensional engineering entities to stimulate students' interest, facilitate students' imagination and understanding, and enable students to quickly and deeply understand the connotation of drawings and the functions of various components to significantly improve teaching efficiency, effectively enhance students' spatial imagination and

innovation ability, and lay a foundation for their future study and work.

2. CONNOTATION OF BIM TECHNOLOGY

BIM technology is a new generation of information technology in the field of civil engineering construction. It is the digital bearing and visual expression of the physical and functional characteristics of engineering project facilities. The core idea is to use three-dimensional digital technology to realize data management and information sharing in the whole life cycle of the project, improve design quality, improve production efficiency, improve the management level, and promote conservation and environmental protection[5-7].

BIM technology presents the work results through intuitive and accurate three-dimensional models and gives clear results through scientific and accurate data calculation, which provides the most direct judgment basis for engineering scientific decision-making. The process, elements, and life cycle of engineering construction management can be expressed by a three-dimensional digital model, which is used for the decision-making, analysis and management of survey and design, engineering construction and use, and maintenance. In addition, BIM technology can be used horizontally for collaborative design of various disciplines (e.g., architecture, structure, water supply and drainage, ventilation and air conditioning, and vertically for collaborative management) and used by all participants in the project. Thus, it is convenient to be widely used by all disciplines and participants.

BIM technology is increasingly widely and deeply used in the field of civil engineering construction because of its advantages for scientific decision-making, achievement visualization, process digitization, information integration, and business collaboration[8,9].

3. TEACHING DIFFICULTIES IN CIVIL ENGINEERING DRAWING COURSE

The core goal of civil engineering drawing course is to cultivate students' spatial imagination ability, configuration ability, and reading and drawing civil engineering drawings on the basis of implementing national standards. Prominent problems exist in the traditional teaching of civil engineering drawing, which restrict the improvement of teaching effect.

(1) It is difficult for concepts and actual forms to correspond to each other. For some difficult concepts in the course of civil engineering drawing, it was found out through communication with the students that the examination can only be coped with by rote, but it is difficult to achieve the real purpose of teaching without

really understanding the meaning of the concept. In the traditional teaching process of the drawing course, the vast majority of teachers explain the relevant contents through drawings and photos, and few relevant models exist to assist the classroom explanation contents. The method of explaining three-dimensional concepts with these two-dimensional graphics itself has certain limitations. Thus, students cannot grasp the relevant concepts of civil engineering drawing.

(2) It is difficult to transform 2D drawings and 3D engineering forms. Professional drawings mainly teach building and structural construction drawings. Students are unfamiliar with professional drawings, lack understanding of the internal and external modeling of buildings, and lack a clear understanding of structural layout, structural practices, and node details. Traditional teaching only shows two-dimensional plane graphics and rarely involves the display of three-dimensional space. Therefore, the learning of civil engineering drawing course is more difficult for students who lack spatial imagination.

(3) (1) It is difficult to match the class hours with the content. At present, undergraduate students majoring in civil engineering have 48 class hours or even less. Teaching the course content within a limited class hour will lead to some students' difficulty in learning and it is difficult to keep up with the teaching schedule. However, each student's spatial imagination is different, resulting in different students' mastery and absorption of knowledge. Therefore, it is difficult to effectively complete the teaching objectives and achieve the teaching effect.

4. WAYS TO INTEGRATE BIM TECHNOLOGY INTO THE TEACHING OF CIVIL ENGINEERING DRAWING SPECIALTY

4.1. Innovation of teaching concept

Teachers of drawing courses should follow the development trend of the industry, change the traditional teaching methods, add a new way of classroom interaction, and introduce BIM technology into the teaching course of civil engineering drawing. Using BIM technology, the traditional teaching concept of two-dimensional plane drawing and drawing reading is changed, the teaching of theoretical knowledge with architectural engineering structure is integrated, a three-dimensional model is built, and the teaching concept of three-dimensional expression and two-dimensional drawing correspond to each other is transformed based on shape and product. For example, in the building section drawing, Revit is used to establish the three-dimensional model of the drawing in the teaching material. During the teaching process, the teacher selects the typical location of the building, cuts the model, and

explains it in comparison with the two-dimensional drawing, so that the students have a more comprehensive understanding of the generation process and principle of the section drawing, which is helpful for the students to understand and master the relevant concepts and realize the consistency between what they think and what they build and what they see; reduces the loss of information during the transformation from two-dimensional drawing to three-dimensional entity; guides students to actively train spatial thinking; and improves the learning efficiency of drawing and map recognition.

4.2. Reconstruction of teaching system

The traditional teaching system of civil engineering drawing courses is based on "drawing theory teaching, supplemented by instrument drawing and computer drawing." Take BIM technology as the mainline to conduct the teaching of civil engineering drawing course; integrate the relevant knowledge of BIM into the engineering drawing course; simplify the teaching content of descriptive geometry; weaken the knowledge explanation of points, lines, and surfaces; highlight the position of the body; rely on a complete set of engineering drawings; divide knowledge modules according to professional drawings (e.g., architecture, structure, and electromechanism); and integrate theoretical teaching with the teaching of CAD, Revit, and other computer drawing software. The students are allowed to visit the physical buildings around them to stimulate students' interest in learning, form a complete integrated teaching system of theory and practice, and lay the foundation for the follow-up study of relevant professional courses.

4.3. Optimization of teaching content

In the traditional teaching of civil engineering drawing, the two-dimensional professional drawing is not closely combined with the three-dimensional engineering entity, which makes it difficult for students to understand. Providing the learning situation of the three-dimensional model from the 3D perspective and increasing the links of three-dimensional model design, production, and explanation corresponding to architectural and structural construction drawings is very convenient when using BIM technology so that students can more deeply understand and use two-dimensional drawings and lay a good foundation for subsequent professional courses. Simultaneously, relying on network resources, creating a new form of teaching materials integrating three-dimensional models, animation demonstration, and microvideo explanation improve students' learning effect.

4.4. improvement of assessment methods

Reform the traditional examination mode, pay more attention to the process assessment, and highlight the students' ability of practical application. The assessment mode of "formative assessment + final examination" is adopted, focusing on modular teaching and modular test. Corresponding computer operation homework is arranged in each teaching unit to cultivate students' ability to use their knowledge to transform two-dimensional drawings into three-dimensional models. Assess the learning and practice contents of students in different stages, change one assessment to multiple assessments, and change the end assessment to process assessment. Pay attention to the monitoring of students' learning process, refine the score weight of stage assessment, and highlight the importance of three-dimensional software modeling practice skills. At the same time, we can also participate in various drawing competitions to test students' knowledge application ability, so as to achieve the purpose of promoting teaching and learning through competition.

4.5. Analysis of reform effect

By introducing BIM Technology into the teaching of civil engineering drawing, students can deepen their understanding of two-dimensional drawing in three-dimensional learning situation, so as to effectively solve the difficult problems in traditional teaching. By comparing and analyzing the effect of teaching reform on students at the same level.

The author randomly selected 20 students from 64 undergraduates majoring in civil engineering in 2019 to establish a QQ group. In his spare time, the author encouraged students to learn the theory of BIM 3D drawing and the practical training of Revit 3D drawing software, cultivated the ability of active learning and enhanced the ability of self-study.

From the comparative analysis of students' usual classroom performance, usual homework and final examination results, the students trained after the reform of civil engineering drawing are better than the traditional teaching in classroom self-participation, knowledge acceptance, comprehensive application and learning efficiency. Among them, according to the statistics of 8 times of homework completion, among the 20 students who accepted the subject, 80% of the students' homework was evaluated as excellent and 20% of the students' homework was evaluated as good. Among the six assignments of students who did not accept the subject, 50% of the students' homework was evaluated as excellent, 20% of the students' homework was evaluated as good, 20% of the students' homework was evaluated as medium, and 10% of the students' homework was evaluated as qualified, as shown in Figure 1. According to the analysis of the final examination results of these 20

students, students with more than 70 points account for 98% of the total number, and students with more than 80 points account for 30%, which is better than the traditional teaching effect.

In the "National College Students' advanced cartographic technology and skills competition", the 13th National College Students bim-cim competition and the 8th National College BIM graduation design competition, the passing rate and enthusiasm of students who have received BIM Technology training are significantly higher than those who have not accepted the competition, and have achieved excellent results in relevant competitions.
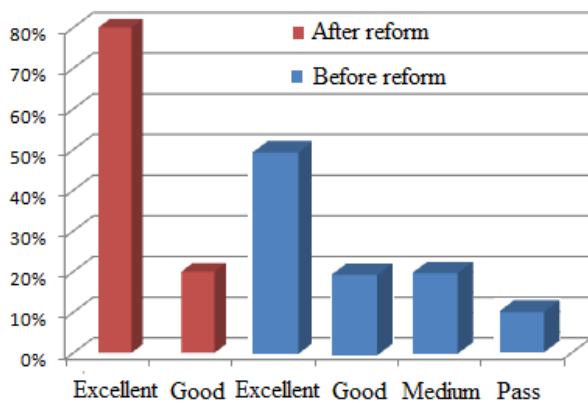

Figure 1 Comparative analysis of teaching effect before and after reform.

5. CONCLUSION

The application of BIM technology in the civil engineering industry is continuously becoming extensive and in-depth. As the training base of civil engineering professionals, universities should respond to the new requirements of China's civil engineering industry, actively explore the methods and paths of integrating BIM technology into the teaching of civil engineering, and form a BIM teaching reform plan for the training of civil engineering professionals. As a professional basic course, the teaching method reform of civil engineering drawing should also keep up with the trend of the times. Integrating BIM technology into civil engineering drawing teaching can better mobilize students' enthusiasm, improve knowledge application and practical ability, and improve learning efficiency. Consequently, the reform and practice of civil engineering drawing course can be realized, the development trend of civil construction industry can be complied, and the personalized needs of practical talents in the field of civil engineering can be met.

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