

# An Innovative Classroom of "Building Architecture" Based on BIM Technology and Model Making

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**Abstract.** Taking the "Building Architecture" course of engineering cost major as an example, this article introduces BIM technology, model making, model use and achievement sharing into the regular teaching process. It creates a dual teaching situation with teachers as the leading and students as the main body, forming an innovative classroom. The purpose is to highlight the dominant position of students, cultivate students' innovative ability, enhance the communication and interaction between teachers and students, and realize the organic combination of theory and practice.

**Keywords:** Building architecture; BIM technology; Architectural model; Innovation ability.

## 1. Introduction

"Building Architecture" is a professional basic course for construction majors such as engineering management, engineering cost, and civil engineering. It includes two parts: architectural design and architectural construction. It embodies the whole process of building from general to detail, from plane to space. According to the post ability requirements, the goal of the course is to let students initially master the procedures, principles and methods of architectural design, master the basic theory of building construction, cultivate students' ability to draw and read construction drawings, and deepen their understanding of commonly used typical construction methods and standard atlases. It also lays a solid foundation for students to learn subsequent professional courses.

As a basic professional course, the students often only learn professional courses such as "Building Materials" and "Construction Engineering Drawing" before learning this course. Their professional knowledge reserves are small, the sense of architectural space is not strong, and they lack an overall understanding of architecture [1]. On the other hand, students lack practical experience due to constraints such as training plans, internship funds or internship safety. Teachers mostly use traditional teaching methods to teach, which makes most of the more abstract theoretical knowledge points more boring to explain.

The traditional teaching mode is a teaching mode centered on teachers, teaching materials and classrooms. With the development of media diversity, teaching materials have gradually expanded to multimedia courseware, videos and other resource forms. However, in the whole teaching process, students are still in the position of passively accepting knowledge, their enthusiasm for classroom participation is not high, and the classroom teaching effect is not good. Among the teaching resources, the plane teaching resources focus on the analysis and interpretation of knowledge principles, the three-dimensional animation focuses on reflecting the changing laws of things, and the solid model can make knowledge specific and visualized. Benjamin Franklin said, "Tell me and I forget, teach me and I may remember, involve me and I learn [2]. In order to better develop students' subjective initiative, it is necessary to create innovative classroom based on traditional teaching mode and constructivism environment.

## 2. Teaching Design Based on Traditional Teaching Mode and Constructivism Environment

### 2.1 Teaching Situation Based on BIM Technology

#### 2.1.1 Advantages of BIM technology

This situation is dominated by teacher lectures. The content of this course is theoretical and practical. Some of the components in the building structure are hidden works. Students are unable to observe and analyze the completed buildings in their daily life. As a result, when the teacher teaches the structural principle of this part of the component, it is difficult for the students to learn and the teacher to teach. The results of the questionnaire found that 56.41%, 68.75%, and 67.16% of students in the majors of building environment and energy application, civil engineering, and construction management hope to intuitively experience the three-dimensional space of the building through the BIM model and make up for the three-dimensional space. Inadequate sense of space [3].

BIM technology builds a three-dimensional solid physical graphics, showing the interaction and feedback between different components. Teachers can use its visibility to combine two-dimensional and spatial three-dimensional teaching. Use roaming animation to simulate the detailed construction principle and construction process of each component node. Students can feel and recognize the various components of the building in a "real" environment, understand their functions, stimulate students' interest in learning, and enhance the sense of achievement and gain for both teachers and students.

#### 2.1.2 Design ideas

The design of this teaching situation can be realized with the help of Revit, Glodon BIM GTJ, BIMMAKE and other BIM technology series software. The curriculum resources of the engineering cost professional teaching system adopt integrated case projects, which are a two-story frame structure project and a four-story frame shear wall project. Using BIM technology series software, the two-dimensional drawings of the case project are transformed into three-dimensional models. In the teaching session, the teacher's presentation is the main focus, showing the plane and spatial composition of the model file of the case project, and observing the case project from multiple dimensions, analyzing the design points of the case project, and enhancing the students' sense of space. The teaching situation based on BIM technology can visually display the basic styles, reinforcement measures of walls, construction points of hidden works such as infill wall tie bars, etc., to deepen students' cognitive experience and facilitate understanding and memory. The teaching situation design ideas are shown in Figure 1.

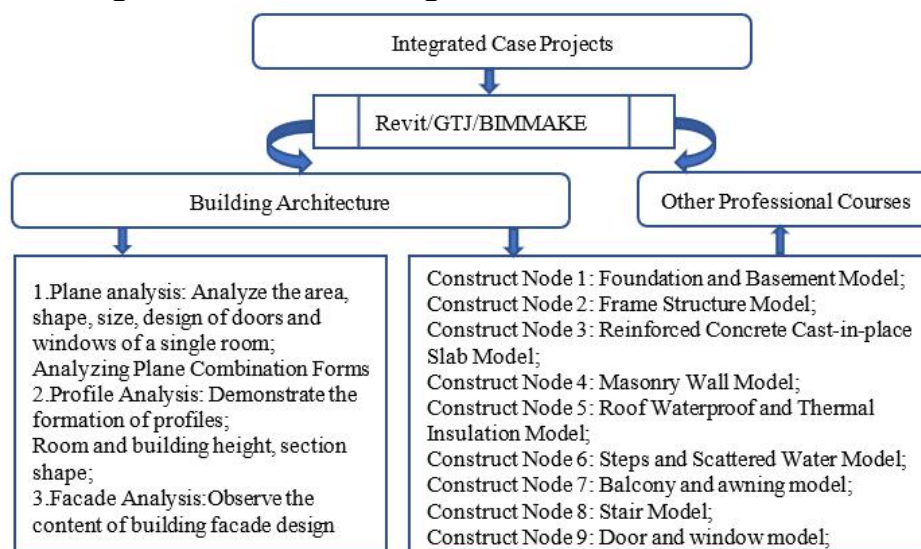


Fig. 1 Teaching situation design ideas based on BIM technology

## 2.2 Operation Practice Situation Based on Architectural Model Making

In this situation, students' practical operation is the main body. David Kolb believes that effective learning should start from experience and end from experience, which is a process of "practice-theory-practice" cycle [4]. Referring to professional design courses such as environmental art design and architecture, architectural model making is introduced into the regular teaching process as a process practice. Create an operation activity situation based on the production of architectural models, let students make physical teaching aids by themselves, add fun to the classroom, stimulate students' interest in learning, improve learning subjective initiative, and cultivate students' hands-on ability and creativity.

### 2.2.1 Assigning model tasks

Architectural model making is a part of classroom theory teaching. For non-architecture students, building model making is a challenge because there are no other related model courses to pave the way. The model tasks assigned by the teacher should not only meet the teaching needs, but also meet the business ability of the students of this major. Taking into account the information integration teaching, and the multi-purpose model, the teacher should carefully conceive the model task. Design some simple and representative model tasks that are close to life and assign them to students. Prepare a list of knowledge points and model tasks before class.

### 2.2.2 Model analysis

Based on CAD drawings and 3D models, students analyze the spatial form and combination of building construction node models from various angles with the help of Revit or GTJ. Because the architectural model has the most intuitive display, the selected materials and scales should be closely combined with the knowledge points of the course, so as to achieve a clear structure, appropriate proportions, accurate dimensions and clear colors. For example, in order to deepen students' understanding of the foundation, the teacher assigns practical tasks to make independent foundation models. Students first analyze the plan, cross-section, and 3D model of the freestanding foundation (Figure 2), and determine a 1:3 scale. In order to better reflect the configuration and position of the internal reinforcement of the foundation, the material of the external outline of the model is selected as transparent plexiglass material.

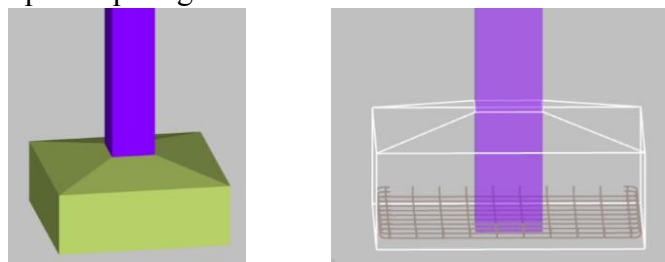


Fig. 2 3D model diagram of the independent foundation

### 2.2.3 Choosing material

There are many structural nodes in civil buildings, and the types of materials required to make models are also different. Mainly include cardboard, corrugated paper, plexiglass, paint, glue, synthetic plastic plate, foam board, sponge, multi-layer board, high density board, bamboo strip, galvanized iron wire, cement, fine sand, clay model brick, etc. For non-architecture students, the tools used in model making mainly include small tools such as scissors, paper cutters, hand tools, hacksaws, pencils, rulers, compasses, and protractors. Use tools to measure, draw, cut, paste, assemble, and decorate.

### 2.2.4 Blanking and making models

When making a model, different components should be distinguished by material type or coloring. For example, the frame structure model can intuitively reflect the relationship between the columns, beams, slabs and foundations of the structure, thereby deepening students' understanding

of the structural system. By analyzing the task of the model, the students decomposed the various components of the building, printed out the map using a 1:20 scale, and pasted it on the Chevron board for cutting and gluing (Figure 3 shows the stage results completed by the students). With the deepening of the course, in the later stage, infill wall masonry will be done in local positions on the frame structure system. Finally, color the foundation, foundation beams, columns, beams, slabs, walls and other components [5]. The 3D model of the frame system of a two-story frame building and the students' first-floor practical results

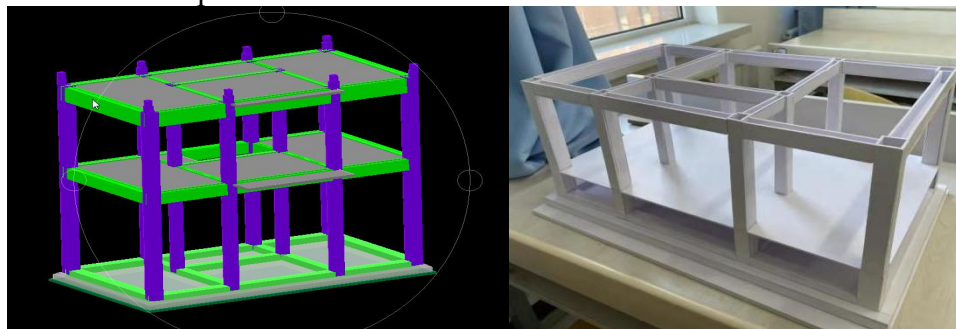


Fig. 3 3D model of the frame system and the students' first-floor practical results

### 2.2.5 Achievement sharing

After the model is completed, each group organizes and summarizes the process of making the building model, the problems encountered, the solutions and the principles of building construction used. The results are shared by drawing lots or taking turns, teachers ask questions, and teachers and students discuss together. The teacher takes the model making process as a process practice assessment into the usual grades, and selects excellent works as professional teaching aids for teachers and students to use in different professional courses.

## 3. Summary

The article creates a teaching and practical situation that is conducive to teachers' teaching and students' learning, and creates a dual-subject efficient classroom. First, enrich teachers' teaching content and methods on the basis of information-based teaching resources, and solve the problem of students' lack of practical cognition. Secondly, the model making, use and results sharing are introduced into the regular teaching process, so that students can actively discover, think, explore and solve problems through practical operation. Let students really learn and use, and realize the organic combination of theory and practice in the whole process. In order to strengthen the teaching effect, improve the teaching quality, and achieve the goal of cultivating innovative talents.

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