

Curriculum Reform and Practice Based on Online and Offline Blended Teaching— Take the Course "3D Modeling of Building Electromechanical Systems" as an Example

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Abstract: The proposal of the construction of "new engineering" is a new reform carried out in the field of engineering education in china's education community in response to the new demand for engineering talents proposed by the state to implement the innovation-driven development strategy. In the process of new engineering transformation based on "traditional industries", the article explores the BIM series of course research of "Building Environment and Energy Application Major", which provides a reference for the cultivation of new talents in the construction environment under the new engineering transformation.

Keywords: New Engineering; BIM; Curriculum Reform

1. Introduction

Wu Yan, the director of the Higher Education Ministry Department, said that it is necessary to fully implement the "new infrastructure" of higher education and teaching. Starting from the aspects of majors, courses, teaching materials, learning technology methods, teachers, etc., the high quality of higher education will be supported by this "five implementations". Among them, learning technology is a new educational productivity, a new ability of teachers, teachers' "teaching" should use new technologies, and students' "learning" should be learned through new technologies. The new integration of technology and teaching education will trigger a new learning revolution. Teaching in the blended way should become the new normal of higher education and teaching in the future. Especially after the outbreak of the new crown epidemic, major universities have carried out the adjustment of the "suspension of classes and non-stop learning" online teaching model, and with the promotion of various online teaching platforms, this hybrid teaching model has been unprecedentedly applied and explored.

As students in science and engineering colleges pay more attention to the progress of engineering applications, industrial needs, technological innovation, and cutting-edge technology, although in the context of Internet + education, public basic courses already have rich teaching content, materials, etc. on the Internet, but compared with the more subdivided engineering majors, online learning resources are limited. The content of the curriculum and teaching materials is relatively lagging behind, and the evaluation system is relatively rigid and one-sided. So, it is difficult to effectively stimulate students' learning enthusiasm and improve the learning effect during the course. As a teacher of professional courses in colleges and universities, how to use the network platform and combine it with the characteristics of professional courses in each school, organically integrate the concept of "new technology, new format, new model, new industry" and school education, extend and evolve the traditional classroom teaching to the virtual network space, provide students with a multi-dimensional learning environment, broaden the depth and breadth of professional courses, and let students' personalized learning be realized, which is what we need to explore and practice in our work, and the following course "Three-dimensional Modeling of Building Mechanical and Electrical Systems" is an example. The key links in the implementation of online and offline hybrid teaching are introduced to provide reference for the teaching of similar courses.

2. Introduction to the 3D Modeling Course of Building Electromechanical System

The three-dimensional modeling of building electromechanical system is a compulsory course for the major disciplines of construction and environmental protection, and it is also a required course for practice. In order to build a first-class undergraduate course for construction and environmental protection that meets the requirements of Industry 4.0, under the background of new engineering transformation, based on employers and construction market demand, a new course was created. This course provides interface introduction and skill application of Revit MEP software. Through learning, students will learn to build BIM electromechanical models (plumbing, electrical, fire protection, etc.) in Revit MEP, and can combine professional models in various construction fields for collision check to establish collaborative working methods and optimize programs. At the same time of modeling, this course needs to rely on the ability of building environmental protection major to read drawings, combined with the knowledge points of professional courses such as heating, air conditioning, water supply and drainage, etc., to build and optimize building mechanical and electrical engineering models. As can be seen from the above figure, although at the surface is a tool course based on learning BIM software, the underlying design of the course relies on the core professional competence of the construction and environmental protection major, which can be said to be the manifestation of the core courses of the construction and environmental protection major. These three-dimensional information models are built on the core of main curriculum on the contrary. As a professional course content, it was offered in the 5th semester. The earliest teaching plan of the class hour in 2017 were 60 hours. In 2019, the teaching plan was adjusted and the class hours were 32 hours. The content of BIM courses has been continuously updated with the times. According to the previous teaching methods, The density of teaching content and the intensity of students' acceptance is quite high, so it is difficult to complete the teaching task with quality and quantity.

In recent years, the author's team has been devoted to the research of BIM series courses based on the new engineering transformation of "traditional majors" for the major of building environment and energy application (hereinafter referred to as the major of building environment), and initially has a certain foundation. Through years of research and analysis on the continuous course training of undergraduates, the author combines the advantages of professional field with the background of science and engineering colleges together to adapt the requirements of construction industry 4.0, cultivates applied professionals with digital literacy and innovative entrepreneurship capabilities, and establishes a curriculum system for new engineering majors that integrates BIM technology throughout the process under the background of "Internet +". The curriculum system structure of three-level progression and integration of production and education as shown in Figure 1 below is formed. The course "3D Modeling of Building Electromechanical System" plays a linking role in this system. It is a professional extension of the traditional basic drawing courses, and it is also the main professional skill support and application for subsequent course design, graduation design and employment.

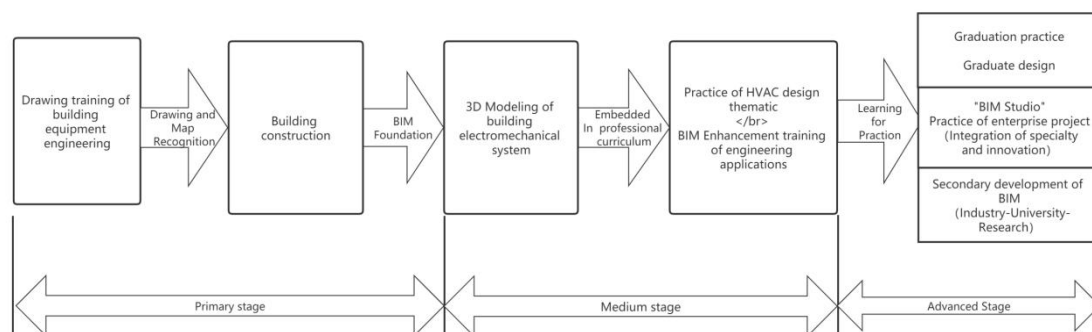


Figure 1 Curriculum structure of three-level progressive integration of production and education

3. Construction and application of online and offline blended teaching

The course is reconstructed from five aspects: teaching objectives (six dimensions), the course content which deepen by OBE concept (reverse design of teaching projects based on occupational job requirements), integration of online and offline resources (multimedia teaching resources), diversified teaching organization (echelon-style tutoring + school-enterprise collaborative education model), and learning accuracy evaluation (learning process evaluation and analysis and personalized teaching). The following will describe in detail about the specific content and some application examples of the teaching system of the "3D Modeling of Building Electromechanical Systems".

3.1 Reconstruction of teaching objectives based on the concept of six dimensions

The new teaching objectives of the 3D modeling of building mechanical and electrical systems are restructured from the six dimensions of knowledge, application, integration, emotion, value, and learning. The learning objective of emphasizing knowledge and skills increases the sense of innovation, the spirit of cooperation, and establishes a sense of innovation. It aims to stimulate students' active learning interest and motivation, as shown in picture 2.

3.2 Reshaping course content

The main effort is deepen the OBE teaching concept, and design teaching projects reversely according to the requirements of BIM electromechanical modeling positions. The project cases are come from the real cases of the front-line enterprises, which are refined, and driven by typical work tasks. The curriculum teaching project is set up as shown in Figure 2.

The nature and objectives of the course should be determined based on the actual ability requirements of BIM electromechanical modeling positions in the enterprise. In the setting of ability training goals and the design of learning situations, the principle of "staged and progressive" is adopted based on the job position, and the teaching projects are determined according to the BIM modeling process, so that students can complete the actual engineering tasks in a relatively real occupational situation and acquire the necessary comprehensive vocational competencies and skills in the learning process.

Guided by the innovation and entrepreneurship activities of college students such as "Internet +", the "BIM Modeling Studio" project is added to the course, so that students can combine it with the theoretical knowledge learned in the innovation and entrepreneurship course, and simulate the establishment of a BIM studio. Start from separate investigate to the formation of a short version of the business plan for public defense, students' market awareness and risk awareness are cultivated in the training. The ideological and political elements will be explored among them, which will infiltrates students' national feelings, global vision, legal awareness and ecological awareness, the habit of lifelong independent learning, communication and negotiation skills, and engineering leadership.

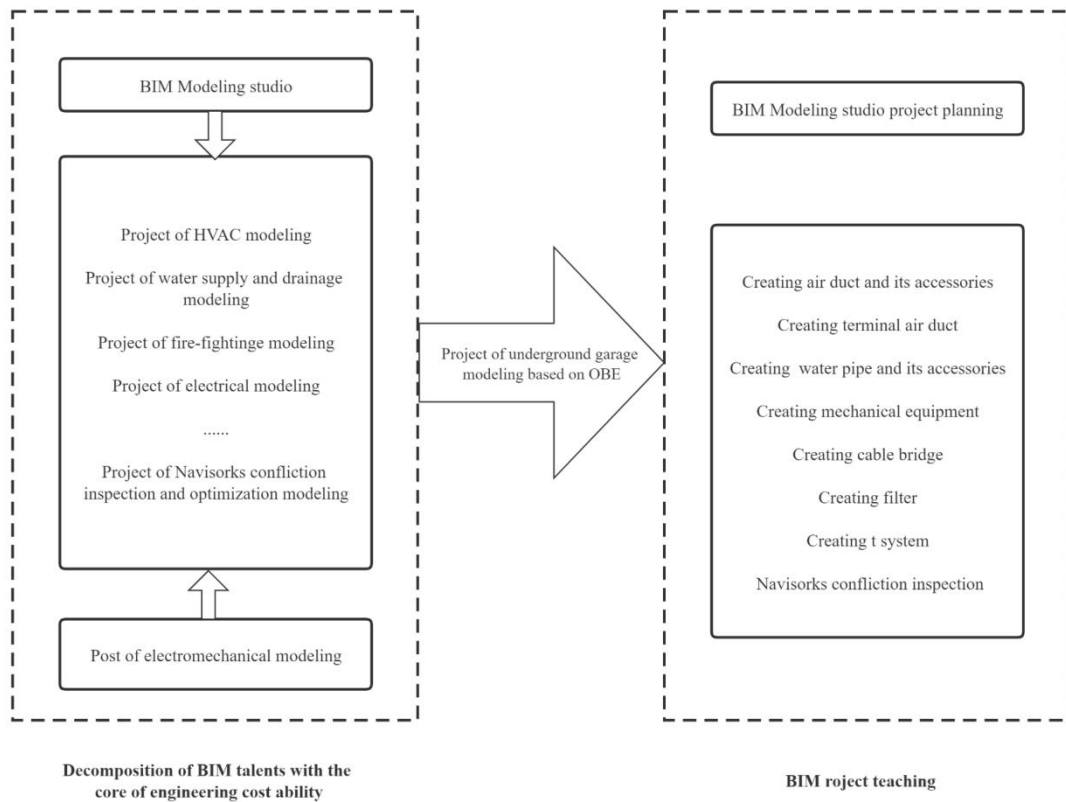


Figure 2 OBE teaching concept design

3.3 Online and offline resource integration

Online teaching resources mainly use "cloud class" as a platform to optimize and reorganize teaching resources, which integrate online teaching resources, and link the teaching resources of Chinese MOOC, Wisdom Tree, bilibili website, Zhulong.com and other platforms to build BIM relevant theoretical test question bank. And then upload the course introduction, syllabus, teaching calendar, assessment method, teaching plan, main teaching materials and teaching reference books, electronic lecture notes or electronic teaching plans, homework, typical engineering cases, homework (product) display, Upload of exam syllabus and study guides, FAQs, etc.

The offline teaching resources are based on the characteristics of the course, and the corresponding school-based teaching materials are developed and compiled on the basis of the reorganization of teaching content based on the OBE concept (the next step is to prepare multimedia teaching materials). On the basis of introducing software skills, the textbook integrates a large number of relevant professional course knowledge points, which is different from the general software manuals on the market. Based on the BIM@Smart Building Laboratory, a book corner is set up in the laboratory, and various BIM-related teaching aids are open to students. The second classroom is regularly used, and enterprise experts are hired to give training and lectures, so as to broaden the students' professional scope and keep abreast of the market frontier knowledge. Curriculum resources are integrated, categorized and graded to meet students with different abilities and needs. By ensure that students flexibly carry out hierarchical, diversified and personalized learning, the learning effect is guaranteed.

3.4 Diversified Teaching Organization

By utilizing the second classroom space and time of "BIM Studio", hiring senior classmates as class assistants and relevant technical experts from enterprises as off-campus instructors, using the "Enterprise WeChat" live class function and

meeting function to conduct video teaching and discussion counseling online, opening the BIM smart laboratory offline, regularly hiring off-campus experts to give lectures, training, and discussions, the experience of the enterprise and the cutting-edge information of the industry will be passed to the students as soon as possible to create a "echelon-style + combination of production and education" online and offline teaching, forming a self-learning interactive mode and a long-term mechanism.

3.5 Learning Accuracy Assessment

According to the new teaching objectives and models, scientific evaluation standards are formulated, oriented to detect the achievement of course learning objectives, and to stimulate students' learning motivation and professional interests.

The assessment process is guided by the ability to solve practical engineering problems, and the grading standard attaches great importance to the cultivation of students' engineering application ability. Emphasis is placed on both ability and attitude, the learning process and learning outcomes, and the combination of online and offline assessments. The online part uses the Mosoteach platform to build the corresponding question bank, and the theoretical questions are scored by online answering. The modeling project part adopts the project evaluation method: submit the corresponding BIM model + screen recording operation. Each student selects a knowledge point through the Internet, performs software operation and explains the operation process, records the screen and submits it, and repeatedly strengthens key knowledge points and skills through assessment, so that students can master modeling skills. On the basis of the five modeling training projects, an assessment of "BIM studio planning" was added to highlight the evaluation of innovation and entrepreneurship capabilities. Each team should submit a "BIM Studio" business plan + PPT, and representatives of each team will be responsible in front of invited corporate instructors and teachers from the innovation and entrepreneurship department.

4. Construction effectiveness

4.1 The improvement of students' learning enthusiasm and the analysis of the academic achievement degree

A new assessment mode was adopted for students in grades 18 and 19, and the achievement degree analysis was carried out. It can be seen from the data of course achievement degree that each graduation requirement index point of course support is higher than 0.7, the course goal has been achieved, and the overall teaching effect is good.

The data of the achievement degree evaluation value of each index point are relatively close, indicating that all aspects are relatively balanced, and there is no situation where the requirements of a certain index point are obviously insufficient.

4.2 Integration of production and education, introducing project resources and expert resources of enterprises, and participating in teaching with real cases and standards

By introducing BIM-related companies to settle in, build laboratories together, and build a BIM comprehensive training platform, we will create an actual working environment that adapts to and surpasses the level of today's construction industry, and shorten the time for students to adapt to the requirements of the company's jobs. The project cases come from the real projects of the front-line enterprises, which are refined to set up curriculum teaching projects. In the teaching process of each

project, each teaching link is designed according to the actual enterprise project workflow, so that students can experience the real modeling work flow in the learning process to achieve a comprehensive improvement of professional ability, knowledge and skills, professional quality, teamwork, communication, planning and decision-making.

4.3 Adopt online and offline blended teaching to form a long-term mechanism

Utilize the Mosoclass platform to integrate and construct online teaching resources, use the hybrid teaching mode of online (enterprise WeChat) and offline (BIM & Smart Lab), hire senior class assistants and corporate professionals as off-campus tutor Teachers, in order to form a long-term teaching guidance mechanism of "echelon type + combination of production and education" to ensure the effective completion of courses.

4.4 Integrating science and education to find new ways to cultivate talents

The "BIM Studio" innovation and entrepreneurship module is embedded in the course to cultivate students' market awareness and risk awareness. It is our duty to assist the student community to create a "BIM studio" and participate in the "Internet +" and other innovation and entrepreneurship competitions for college students across the country. By training and hone students individually, their interest and motivation in learning will be increased. After truly achieve the seamless link of innovation and entrepreneurship links, the ideological and political education is will moist the students silently. The innovative team based on BIM technology formed by students won the first and third prizes at the municipal level in the 2019 and 2020 Beijing University College Students Outstanding Entrepreneurship Team Competition; the students participated in the fifth and sixth China International "Internet + "College Student Innovation and Entrepreneurship Competition (Beijing Division Rematch) won the second and third prizes respectively.

5. Conclusion

In the course reform and practice based on online and offline blended teaching, we have explored a new teaching model for the course "3D Modeling of Building Mechanical and Electrical Systems". Incorporating six-dimensional teaching objectives, guided by industrial needs, introducing project resources and expert resources of enterprises, using real cases and standards to participate in teaching, using Mosoteach + Enterprise WeChat as an online education exchange platform, and using the second classroom time with BIM studio as the carrier, it integrates innovative consciousness, innovative thinking and innovative ability, explores ideological and political elements, and jointly cultivates students through school-enterprise cooperation. Creating ability-based courses based on real projects will highlighting the characteristics of regional special courses serving the positioning of Beijing's "Four Centers".

Fund Projects: Beijing Union University Teaching Innovation Course Construction Project - 3D Modeling of Building Mechanical and Electrical Systems

References

- [1] Zhao, PL., Innovation and Reform of Talent Training Mode of Higher Vocational Architectural Engineering Technology Specialty Based on BIM Technology [J]. Education and Teaching Research, 2020(3).
- [2] Ferrandiz, J., Evaluating the benefits of introducing "BIM" based on Revit in construction courses, without changing the course schedule. [J]. Architectural Research and Development, Conference Series,10.1007/s10209-017-0558-4.

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