Teaching Method Reform for Architectural Design Courses Using the Building Information System (BIM) Technology—Case Study of the Teaching of Building Information Engineering Management Technology Course

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Abstract. This paper describes how to introduce advanced information technology, such as building information model (BIM) to improve teaching quality in architectural design courses. This paper systematically expounds the problems faced by architectural design series courses, the key ideas of introducing new technologies, and the assistant role BIM plays in the teaching of current architectural design series courses. Combining with the course of building information engineering management technology taught by the author himself, this paper puts forward how to use BIM method to supplement the course content and realize the reform of teaching methods and the improvement of teaching quality. It is hoped that this paper can be used for reference to improve the teaching level of architectural design and construction information management in China.

Introduction

With the advent of the information age, various industries pay more and more attention to information. Many fields are exploring how to use these massive data to improve the service quality of the industry. Construction industry is not only one of the industries that produce the largest amount of data, but also one of the industries with low-value usage of data. How to realize the value of these big data and make good use of them to reform teaching methods has become a difficult problem in the teaching of architecture specialty.

One the other hand, in the information age, the introduction of various ideas and technologies, such as big data and building information model (BIM), has brought about corresponding changes in teaching methods, teaching time and teaching contents. Definitely, how to adapt to these changes and improve the teaching level of basic courses of architectural design has become an important teaching reform topic.

The Architectural Design Course Series (including the Application for Architectural Engineering Information Management course) is the core course of five-year undergraduate architecture teaching. According to the needs of large-scale undergraduate education and diversified personnel training, as well as the characteristics of students ‘employment mainly facing local enterprises and the relative lack of high-quality resources suitable for architectural design students’ learning, it should actively deal with the cultivation of talents in Colleges and Universities under the background of information technology. The improvement and
innovation are required in-depth to explore the case-based and open architectural design teaching information platform, which could combines web-based teaching, collaborative learning with the traditional teaching modes, efficiently promote the quality of teaching of architectural design courses.

Starting from the reform of the teaching mode of architectural design basic course in the information age, this paper analyses the current situation and problems faced by the curriculum setting of architectural design basic course, puts forward the reform direction of the curriculum setting such as informatization assistance and big data analysis method in the basic course of architectural design, and provides a new way of thinking for the reform of the teaching system of architectural design basic course.

**Current Problems of Architectural Design Series Courses**

Architectural design course is the core of architectural education all over the world. In many architectural schools, architectural design courses require a large number of teaching hours, huge workload, and the most intensive time investment. Architectural design courses integrate all other architectural specialty courses with one point [1, 2]. At present, all architectural design courses in universities in the world still have a sustained and powerful influence on the creation of teaching environment in the field of art and design. In the traditional architectural design course, students learn knowledge by directly participating in design projects, and increase social experience by communicating with other students and tutors. The teaching mode of combining on-site teaching with practical design has been proved to be the most effective way to train students. However, this mode has existed for hundreds of years, has been proved that there are many defects, such as lacking of the capture of sensitivity of design elements which are easily ignored by competition, the insufficient integration of modern advanced technology, and the insufficient absorption of elements in current information technology [3, 4].

In addition, after the introduction of information technology into the architectural design curriculum, it will inevitably bring a great impact on the traditional architectural design technology. Before starting a project, teachers are not clear about the purpose of the project, how to formulate new design concepts relying on information technology, big data analysis methods, building information and how to use these new technologies to consummate design concepts in the architectural education. Moreover, students are often not given enough opportunities to use these new information technologies to develop their own new design concepts and methods; at the same time, they are not able to accurately measure whether students have the ability to obtain useful design concept information from large data and complex information; how to apply these information to the whole design process is also lack of adequate explanation.

According to a survey of 40 universities in China, data enhancement design methods were few introduced into architectural design courses [5]. We found that only two universities explicitly used big data analysis in architectural design courses, 25 universities did not support the introduction of new information technology teaching methods, while several other universities maintained a wait-and-see attitude [5]. This shows that the traditional architectural design curriculum still holds a negative attitude towards the introduction of information analysis methods, and the problem is serious. In addition, hand-drawing and computer drawing are still considered the best way of architectural design drawing. It is undeniable that in the
basic stage of teaching, hand-drawing and computer CAD are the focus of students 'architectural design learning. As basic technical methods, they play an extremely important role in providing students with solutions to the preliminary architectural design methods. However, to the advanced teaching courses, the existing universities still have no other better way to enhance the inspiration of students ‘design and efficient way to construct design concepts, making students become artists.

Because data information can provide the most authentic first-hand data and important resources for building site and design. Architects who can make rational use of data information can rapidly improve their work efficiency and competitiveness. Data information provides a good opportunity for the development of architectural design courses. To this end, the course of architectural design needs to establish effective information aids, and then through data analysis and data enhancement design technology, to improve the availability and information of design concepts, enhance design inspiration, and realize network design teaching, enrich the means of design.

BIM for Teaching Method Reform of Architecture Design Courses

The training of architectural engineers is an arduous system engineering. In order to meet the requirements of the rapid development of various kinds of engineering construction, it needs to build large-scale, large-span, high-rise, light, large-scale, precision equipment modern buildings. In addition, it requires not only high quality and rapid construction technologies, but also the high economic efficiency in design. For this sake, the student must have strong practical ability and innovative ability. At the same time, students rely heavily on experimental teaching in the process of training. That is, the teaching of architecture course with the advanced information technology plays an important role in students ‘engineering technology ability and practical application ability [4, 6].

Building BIM-assisted course system of architectural design is mainly for architecture and planning specialties. Based on BIM technology, a highly simulated virtual simulation experiment system is constructed to provide students with experimental environment of theoretical cognition and practical practice, so as to improve students ‘practical ability and innovative spirit, and further adapt to the development trend of China's architectural industrialization industry and the characteristics of our school's construction. The bright development trend of comprehensive universities which lay equal stress on research and practice. The architecture of BIM-assisted architecture course system is shown in Figure 1.
In the course system construction of building design assisted by BIM, the three-dimensional graphics data of BIM can be seamlessly and rapidly transformed into VR software system, and then displayed on various VR hardware devices by VR software. Combining with relevant hardware platforms such as virtual reality system, BIM information can be seamlessly transferred to VR software information mainly including: model information (structure, MEP, etc.), material information, component attributes, which will be conducive to data analysis, interaction and display in virtual simulation system.

In addition, according to the training requirements of students ‘knowledge, ability and quality, BIM-assisted architecture curriculum system can construct multi-level virtual simulation module of professional knowledge training, engineering ability training and innovation quality training; develop the application of virtual reality technology based on three-dimensional visualization of BIM technology and GIS technology, and construct a virtual simulation platform based on BIM, so as to complete engineering construction. The process is the main axis to build a multi-disciplinary and interdisciplinary virtual simulation experiment platform. At the same time, such a curriculum system design framework also achieves the combination of virtual and real, complementary to each other, meets the needs of professional experimental teaching, and forms design curriculum teaching resources that closely integrate engineering practice, scientific research projects and teaching needs.

Finally, in the course system of architectural design assisted by BIM, students can vividly and effectively grasp the differences of the requirements of these roles by playing various roles through simulation experiments of various subjects in civil architecture \[7\]. For example, owners, contractors, project managers. At the same time, BIM combines traditional design and advanced information technology to enrich the practical understanding of the whole design, construction and operation stages. BIM technology provides a better technical tool for architectural design teaching. From graphic visualization to life-cycle information of civil construction industry, the former planning and construction, architectural design and construction management models of sub-specialties can be integrated in one model, and the experimental teaching of various professional links can be completed by stages, sub-specialties and sub-subjects. Therefore, the experimental teaching of Architecture Specialty Based on BIM...
technology is an upgrade of virtual simulation teaching technology and mode in the stage of
graphics visualization. More importantly, it is a teaching reform and innovation that conforms
to the development of civil construction industry.

Case Study: Teaching method Reform of Building Information Engineering Management
Technology Course Assisted by BIM

Information management technology of construction engineering is a core undergraduate
course in the College of Architecture and Civil Engineering of Xiamen University. The goal of
this course is to familiarize undergraduates with the basic theoretical knowledge of building
engineering informatization, to grasp the sources, generation and processing methods of
building engineering information, and to use advanced information technology to improve
students’ cognitive ability of building engineering itself, and to improve the ability of building
design. In order to enable students to grasp the analytical means of architectural information in
the process of design, the auxiliary curriculum construction system of BIM is introduced. By
familiarizing with the basic theory of BIM technology, students can master the commonly used
application technology of BIM software and the related application technology of management
software. They can use BIM technology software to model, apply BIM design and Construction
Comprehensive skills, carry out project management and BIM application case analysis and
comprehensive application ability. In the course construction, according to the principle of
"consolidating basic training, emphasizing ability training, combining theory and practice,
supporting discipline competition, relying on scientific research and innovation”, curriculum
resources are systematically constructed, which is mainly divided into six teaching modules:

1) BIM Project Management Part.
2) BIM Building Environment Analysis Part.
3) BIM Mechanics Computing Part.
4) BIM Spatial Analysis Part.
5) BIM Design Expression Part.
6) BIM Digital Expression Part.

In the process of software selection, "Swell BIM - three-dimensional computation: “For
Revit” is introduced. This software is the first BIM calculation software running on Revit
platform and compatible with Revit platform in China. Based on the Revit development, it
directly uses the Revit design model, according to the Chinese standard list specification and
the national quota engineering quantity calculation rules, completes the engineering quantity
calculation and Analysis on the Revit platform, quickly outputs the calculation results, and the
calculation results can be used directly by the pricing software. "Swell TH-3DA2014" is the
first civil engineering calculation software developed on AutoCAD platform in China. It is
mainly used in engineering bidding, construction and completion stage. In the same software,
Swell realized the functions of basic earthwork calculation, structure calculation, building
calculation, decoration calculation, reinforcement calculation, checking and checking, progress
management and the original CAD platform, avoiding duplication of drawings, redefining
components, and omitting modification in design changes, so as to achieve multi-calculation of
one drawing, multi-use of one drawing and multi-pair of drawings, and improve the calculation
efficiency in an all-round way. On the other hand, this course relies on the teaching of "VILL
BIM-Three-dimensional Computation for Revit" and "SWELL TH-3DA2014" software, and
uses the way of three-dimensional modeling to realize the visualization of the whole calculation
process. The project can be displayed in three-dimensional and simulate the reality most truly. Furthermore, students are guided to use "VILLBIM - Three-dimensional Computation for Revit" to output lists, quotas and physical quantities, and to learn the function of counting quantities according to time schedule.

For example, in the course design, we let the students build the building model of Beijing South Railway Station through Revit (Figure 2). From every detail, we know the difference between the style of traffic architecture design and other types of buildings. In addition, the analysis of building function is added - through the realization of human flow simulation inside the building (Figure 3), which enhances the students ‘intuitive and quantitative evaluation of the design works, and enhances the evaluation ability of the design objects.

In summary, through the reform of innovative teaching methods, students ‘interest in scientific research and scientific thinking are guided. Through the BIM-assisted course design and related software learning and data statistical analysis, the understanding of professional courses has been deepened, professional skills have been improved, and solutions for developing data enhancement design have been recognized.

![Figure 2. The BIM for Beijing South Railway Station.](image-url)
Conclusions

This paper discusses the BIM-assisted construction of architectural design curriculum system ideas and teaching methods of reform. Based on the current advanced information technology and big data background, this paper illustrates how BIM realizes the role of information integration in the teaching of building design model and model evaluation. Taking the course of building information engineering management technology of Xiamen University as an example, this paper illustrates the ideas and methods of building design curriculum reform assisted by BIM, and puts forward the methods of how to train students of compound architecture under the new situation. Of course, there are many shortcomings in this paper, such as how to integrate BIM into all architectural courses and as a compulsory method, which will be discussed in the follow-up study.

References


