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Application of Virtual Reality in Building Construction Courses

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Abstract: At present, the theoretical teaching of "Building Construction" course relies too much on courseware and teaching materials. Practical training lacks effectiveness. Bringing virtual reality into the classroom. D-Sketch technology is theoretically and software-feasible in the course process. By using the characteristics of three-dimensional visualization of the model, D-Sketch technology is integrated into the teaching and implementation of "Building Construction" before, during and after class, so as to improve students' ability to read construction drawings.

Keywords: Virtual Reality; D-Sketch; Building Construction.

1. Introduction

Building construction is the study of the structural composition of buildings and the combination principles and construction methods of each component. Its main task is to provide a reasonable structural scheme according to the use function, technical economy, and artistic modeling requirements of the building, so as to serve as the technical basis and guarantee of architectural design [1]. However, students reported that "building construction is not easy to learn", teachers felt that "building construction is too difficult to teach", and some even thought that "building construction is useless" [2]. Judging from the results of the graduation design and the feedback of the intern employers of the design institute, a considerable number of students have insufficient structural design ability, even if they have good architectural design intentions, they cannot fully and accurately express and implement them, making it difficult for good plans to build truly excellent architectural works [3]. Virtual simulation technology has been applied to all aspects of the construction industry due to its intuitive, interactive and experiential advantages. In 2017, the Ministry of Education officially put forward the concept of actively cultivating "new engineering" in engineering education, which emphasized the use of virtual reality and simulation technology to reform and innovate the current engineering practice teaching methods, which provided a good opportunity for vigorously promoting the reform and innovation of engineering education and the cultivation of engineering application talents [4].

Based on the above situation, some scholars have discussed the application of virtual simulation technology in building structure teaching. Combining the characteristics of architectural design teaching, Ge Bixiao analyzed the application of virtual simulation experimental teaching platform in the field of architectural teaching, including course teaching and experimental training teaching [5]. Xu Hui et al. deeply applied virtual simulation practice teaching to the training of engineering management professionals, and specifically built an engineering management professional teaching information platform, which is jointly built by information resources and hardware resources, and is jointly used for student learning, teacher teaching, and school-enterprise cooperation [6]. Based on the actual reform experience, Dong Teng proposed a teaching system of house architecture teaching, after-school tutoring, curriculum design and understanding practice based on the simulation experimental platform [7]. These studies provide a preliminary exploration of the application of virtual simulation in the construction industry.

At present, many civil engineering majors in vocational colleges and universities regard building construction as a compulsory course, but there are still problems such as disconnection between structure and map recognition, disconnection between theory and practice, and disconnection between content and practice, and students are relatively passive in mastering structural knowledge. Therefore, it is of great significance to build a teaching platform for building construction based on virtual simulation.

2. The Overall Concept of Virtual Simulation Technology in the Teaching of Building Construction Experiments

(1) Course Teaching Objectives

Enable students to establish the concept of spatial thinking through the study of this course. In addition, students can establish a relatively complete concept of house construction, and initially grasp the basic principles and applications of building construction. In addition, students have the basic ability to proficiently read construction drawings and construction drawings, and cultivate students' ability to comprehensively use the structural theory knowledge they have learned to analyze and solve engineering problems. So as to achieve the training goal of high-quality technical and skilled talents who "understand design, can construct, can manage, and be good at innovation".

(2) Course Instructional Design

For some students, going to school is a helpless choice, and the sense of loss caused by the gap between reality and ideals coupled with their educational methods that are not adapted to exam-oriented education has become a relatively common phenomenon. Higher vocational education, which follows the old model of student training and education, is increasingly powerless in the face of students who lack motivation to learn [8]. In general, learning motivation is divided into internal motivation and external motivation. Internal motivation stems from the learner's sense of pleasure and satisfaction with the

activity itself [9]. With the help of the D-Sketch platform, the architectural design major applies experiential teaching to design courses, promoting learners' learning motivation by presenting personalized features, colorful media forms and stimulating dialogues. A large number of cases have proved that experiential teaching can bring students positive emotions such as relaxation, pleasure, interest, and stimulate internal motivation for learning [10].

Learning motivation is not only affected by internal factors of individual learners, but also by external factors such as learning environment. With the D-Sketch platform, realistic scenes can be created, providing dynamic, highly interactive settings in which learners show high learning motivation and engagement. Whether it's virtual simulation of architecture, simulation of interior spaces, or digital planning and design, the platform allows students to learn through immersive experiences. Learners, especially young learners, are accustomed to self-representation and express their thoughts and feelings through roles. More importantly, this experiential learning stimulates learners' creativity and imagination (Figure 1).

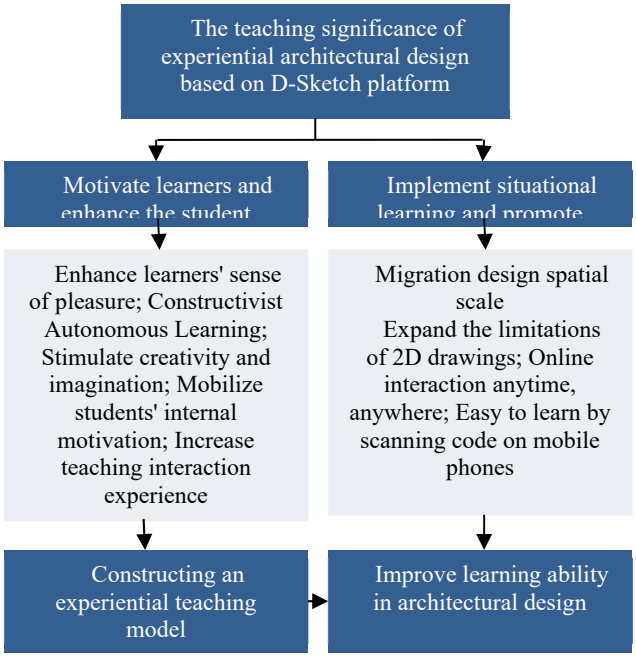


Figure 1. Experiential learning stimulates learners' creativity and imagination

(3) The teaching mode of "integration of theory and reality"

The creation of the building component resource library is completed through D-Sketch technology, which can display the building components vividly in the teaching process, and use virtual models to explain knowledge points, which helps students understand. After the completion of classroom theory teaching, the simulation platform built based on D-Sketch technology conducts after-class practical training. On this platform, students can use the knowledge learned in the classroom to complete interactive modeling on the simulation platform, and strengthen the training of the key points and difficulties of the course. In the practical part of the course, the D-Sketch technology is used to complete the complete building model on the simulation training platform, so as to achieve the basic vocational skills training of proficient reading of construction drawings and construction drawing. Through the " integration of theory and practice " teaching mode in the alternating environment of classroom and virtual simulation platform, it can not only solve the problems of teaching venues and teaching environments in colleges and universities [11], but also promote the improvement of students' professional quality and vocational skills.

3. The Teaching Practice of D-Sketch Technology in the Course of Building Construction

The course of architectural construction has strong practicality and professionalism. The virtual model of architecture created based on D-Sketch technology is intuitive and realistic, with real information, and can be viewed and roamed from multiple angles. Applying the model to teaching can effectively simulate teaching scenarios, making it easier for teachers to explain and students to understand. Therefore, in the teaching practice of the course, typical engineering projects are integrated throughout the entire process of course theory and practice, and the teaching practice of the course is completed in a "theory practical integration" mode.

(1) Theoretical link based on BIM technology

In the explanation of the knowledge points in the theoretical section of the course, teachers can use D-Sketch technology to create a standardized component model resource library, enrich the visual teaching resources of the course, and effectively alleviate the current problems of insufficient teaching resources and poor student acceptance. At the same time, using D-Sketch technology to form a three-dimensional information model of previous linear planar components for teaching display, it has a good visual effect, achieving the "what you see is what you get" teaching process, and arousing students' interest in learning. Figure 2 shows a three-dimensional model of building components and a two-dimensional plan and elevation view. During the teaching process, students can simultaneously view the three-dimensional entities and two-dimensional planes of door and window components, deepening their impression of component planes. The model based on D-Sketch technology can not only achieve visual simulation of three-dimensional geometric shapes, but also contain a large amount of non-geometric information, such as material information and component information, making the teaching content more vivid and intuitive. When explaining parallel double running stairs, you can use the property bar of the 3D model created by D-Sketch technology to view the width, number of treads, depth of treads, and other related information of the stairs, as shown in Figure 3.

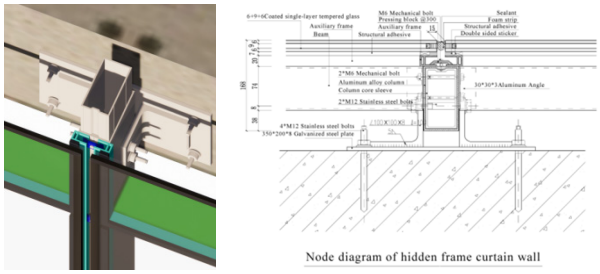


Figure 2. 3D Model and 2D Plan of Building Components

The simulation platform using D-Sketch technology can enable students to practice and operate in a timely manner in the post class consolidation stage after teaching relevant knowledge points, which is conducive to students' understanding of the knowledge points. Strengthen students'

ability to experience the application of knowledge points in the process of creating basic components based on D-Sketch technology. If the wall needs to be set with a structural hierarchy first, then the layout of the wall is carried out, as shown in Figure 4; Components such as open channels, aprons, and steps need to have their two-dimensional contours made before they can be created.

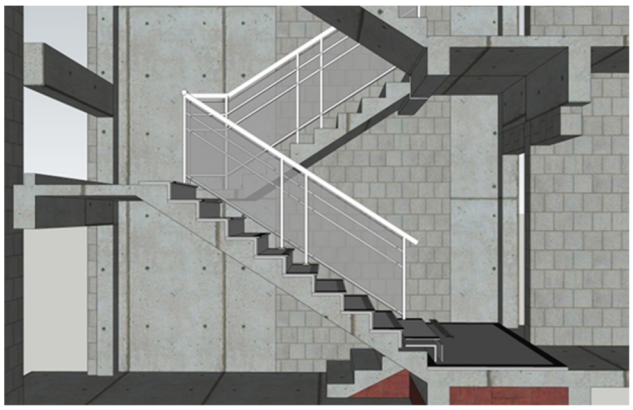


Figure 3. 3D Model of Stairs

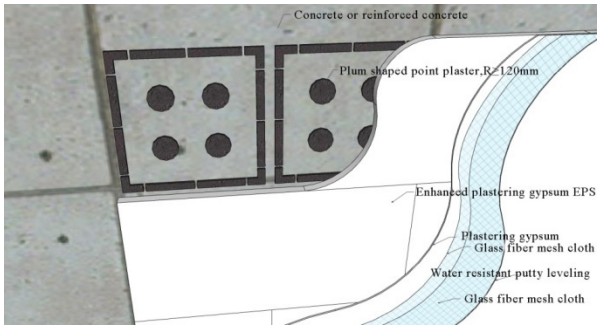


Figure 4. Editing and Layout of the Structural Hierarchy of the Wall

After explaining the basic theoretical knowledge points, combined with D-Sketch technology related software operations, complete the creation of components in the engineering project. Improve students' initiative in learning through hands-on operation. Not only does it strengthen students' application of theoretical knowledge, but it also exercises their operational skills in modeling software. In this process, the project teaching method is introduced. By providing the construction drawings of typical projects, students can use the D-Sketch technology simulation platform to create basic components such as walls, columns, slabs, aprons, open ditches, steps, doors and windows, and then import them into the architectural model of typical projects to achieve the project model creation process from local to overall, so that students can establish a relatively complete concept of housing construction and have the ability to read construction drawings.

(2) Practical steps based on D-Sketch technology

In the course practice section, the project-driven teaching method of typical engineering is adopted, allowing students to complete the creation of project building information models on a simulation training platform based on D-Sketch technology; During the creation process, complete the drawing of building plans, elevations, sections, and schedules.

Through this practical session, students will experience the correlation and consistency between graphics and information, achieving the teaching goal of equipping students with the ability to draw construction drawings, and preparing for subsequent courses.

Taking Wenzhou Vocational and Technical College as an example, the specific tasks of the architectural construction training course are as follows: conducting research and measurement on a typical building on campus, creating a building information model, and completing the drawing of building construction drawings; Create a preliminary model based on classroom teaching content, and deepen the model as the course teaching progresses; Based on the characteristics of D-Sketch technology that can produce drawings, a complete set of construction drawings for the building can be further designed through the exported drawings. The specific training results are shown in Figures 5 and 6.



Figure 5. Rendered rendering in the building information model (student work)

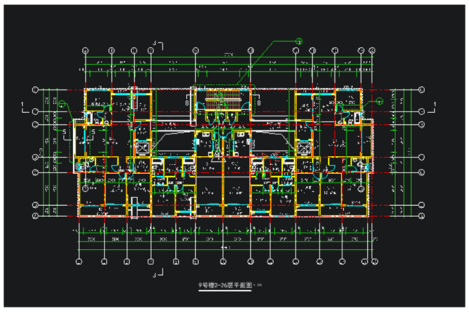


Figure 6. Architectural floor plan (student work)

(3) Practice Effect

By exploring the teaching practice of building construction courses based on D-Sketch technology for students in the modern architecture major group of Wenzhou Vocational and Technical College, the teaching model of "integration of theory and practice" has been practiced, strengthening students' practical abilities and deepening their understanding of building construction knowledge. Students' willingness to learn has significantly strengthened, and their professional skills have significantly improved. The test results on the engineering drawing recognition software show that students' ability to recognize construction drawings has been enhanced; Student performance has also significantly improved compared to before, with a higher pass rate.

4. Conclusion

In traditional teaching, teacher speaking and student listening are the lowest level of indoctrination teaching methods. Comenius emphasizes that experiential learning should be advocated and efficient, and traditional university education models should shift towards experiential teaching.

On the one hand, it is the intervention of D-Sketch+VR. This project utilizes the D-Sketch plugin and combines it with the dreamcheck platform developed by Beijing Deck Smart Technology Co., Ltd. Enable designers to truly immerse

themselves in three-dimensional space and immerse themselves in the spatial effects of architecture and design; The specific steps to achieve an immersive experience are as follows: select the desired building, import the model, and set appropriate viewpoints; Set reasonable resolution as required, and use D-Sketch plug-in to generate panorama QR code; Then share the QR code with students, and you can use your mobile phone to scan the QR code for panorama experience; You can also immerse your phone in a cardboard box for an immersive experience; You can also use professional VR devices for interactive virtual reality experiences.

On the other hand, it is a comparison of teaching effectiveness. Through the comparison before and after the use of the D-Sketch platform, teaching effectiveness analysis and student evaluation analysis are conducted to draw conclusions on teaching reform. The project can form a complete teaching model experience library, allowing students to experience construction sites, appreciate world classic architecture, and the composition of building structures. In the future, this platform can be promoted to other majors, and the experience library content can be continuously expanded to carry out information-based teaching on a larger scale.

Acknowledgments

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