



# Virtual Simulation in Practical Teaching of Environmental Design: A Comparative Study of Domestic and International Applications

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**Abstract.** This study compares virtual simulation technology in environmental design education at domestic and international institutions, highlighting differences in equipment, teaching methods, and student feedback. Findings show that while Chinese universities have made progress, gaps remain in resources and instructional design compared to international standards. Recommendations include increasing VR equipment investment, refining teaching methods, and improving student feedback mechanisms to enhance virtual simulation education in China.

**Keywords:** Virtual Simulation, Environmental Design, Practical Teaching, Domestic and International Comparison, Teaching Model.

## 1 Introduction

In recent years, the application of virtual simulation technology in higher education, especially in environmental design teaching, has grown significantly. This discipline emphasizes the cultivation of students' design thinking and practical skills, but traditional teaching methods face limitations regarding space, resources, and time, which hinders students from gaining sufficient hands-on experience. Virtual simulation helps overcome these obstacles by allowing students to explore and adjust designs in a 3D virtual environment, enhancing their spatial perception and creativity<sup>[2]</sup>. However, the implementation of virtual simulation teaching varies between domestic and international universities. This study compares virtual simulation practices in environmental design programs at domestic and international institutions, exploring differences in equipment, teaching models, and student feedback to provide insights for enhancing its effectiveness in Chinese universities.

## **2 Overview Of the Development Of Virtual Simulation Technology In The Teaching Of Environmental Design**

In the 1990s, western colleges and universities took the lead in applying virtual simulation technology in teaching to enhance students' spatial perception and design decision-making ability through virtual design scenarios. In the 21st century, virtual simulation technology has gradually matured and has been widely adopted by colleges and universities around the world, with students adjusting their designs in real time through display devices and interactive tools, which improves learning participation and design efficiency. Since 2010, Tsinghua University, Tongji University and other Chinese universities have introduced virtual simulation technology and developed virtual laboratories to enhance students' practical and innovative capabilities. In recent years, with the combination of BIM technology and 3D modeling, the application of virtual simulation in environmental design teaching has further promoted the change of teaching methods.

The environmental design program emphasizes the cultivation of students' design thinking and practical ability, but traditional teaching is limited by venues, resources and time, making it difficult for students to get adequate fieldwork and design experience. Traditional design software also has limitations in interactivity and immersion, and cannot simulate complex design effects. The introduction of virtual simulation technology solves these problems, and students can explore the three-dimensional space and adjust the design scheme in real time in the virtual environment, which not only improves the design ability, but also stimulates innovative thinking. The virtual environment design system developed by Jun Li <sup>[10]</sup> (2021) allows students to optimize the design through feedback, which significantly improves the teaching effect. Nevertheless, there are still differences in virtual simulation teaching models in China and abroad. Comparing the practice cases in China and abroad helps us to recognize the advantages and disadvantages of each more clearly and provide a basis for teaching reform. Next, the similarities and differences of virtual simulation teaching models in China and abroad will be analyzed, including teaching methods and student feedback.

## **3 Domestic and Foreign Virtual Simulation Practice Teaching Application Comparison**

### **3.1 Case Study of Virtual Simulation Practice Teaching in Foreign Colleges and Universities**

Virtual simulation practice teaching in foreign colleges and universities through virtual simulation equipment and interactive tools, such as Oculus Rift, HTC Vive, etc., students are able to adjust the design program in real time, which significantly improves the degree of learning participation and design efficiency. At present, virtual simulation technology is not only applied to architecture and interior design, but also widely used in history, art and other disciplines, the course content is flexible and

rapidly updated with technological progress. At the same time, foreign colleges and universities have established a perfect student feedback mechanism to ensure that the virtual simulation teaching mode is constantly optimized to improve the quality of teaching. The Table 1 shows some studies of virtual simulation teaching practice in some foreign universities.

**Table 1.** Case study of virtual simulation practice teaching in some foreign universities

University	Experimental Theme	Equipment Used	Experimental Content	Educational Model	Experimental Results
University of Cagliari <sup>[3]</sup> (2018)	Virtual Simulation Experience in Interior Design	HTC Vive Pro, Oculus Rift, Unity 3D	Users interact with a virtual interior design, moving and adjusting elements.	Immersive Simulation	VR enhances spatial perception and design interaction, boosting presentation quality and customer satisfaction.
University of Oklahoma <sup>[4]</sup> (2021)	Remote application of virtual simulation in the teaching of architectural history	HTC Vive, Oculus Rift, Unity 3D	IVR technology teaches architectural history, using the Roman Pantheon as a case study.	Remote and Immersive Learning	Virtual simulation helps students grasp architectural concepts, increasing interest and engagement.
University of Oklahoma <sup>[9]</sup> (2021)	3D Virtual Field Trips as an Alternative to Site Visits	360° Camera, Oculus Rift	360° VR replaces on-site visits for interior design education.	Virtual Field Trips	360° VR improves students' spatial planning, material selection, and overall design performance.
Eastern Michigan University <sup>[5]</sup> (2022)	Perception of virtual simulation by interior design students	Homido V2, Oculus Rift, XPAND Edux3	33 students experienced three VR formats to assess impact on perception and design skills.	Passive Virtual Simulation Display, Student-Centered Learning	VR improves design perception, especially spatial understanding and presentation.
Ball State	Immersive	Oculus	Students	Immersive	VR enhances

University <sup>[1]</sup> (2022)	Virtual Simulation in Architectural Spatial Experiences	Rift, HTC Vive	explore and redesign architectural spaces in VR vs. traditional methods.	Design Experiences, Collaborative Design	spatial perception and improves design quality and collaboration.
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### 3.2 Virtual Simulation Teaching Exploration in Chinese Universities

The development of virtual simulation training in China started late, but it has developed faster under the impetus of policies. In recent years, a number of policies have been introduced at the national level, such as the Education Informatization 2.0 Action Plan and the Action Plan for the Integration and Development of Virtual Simulation and Industry Applications, which have promoted the application of virtual simulation technology in the field of education. The application of virtual simulation training system in China has been widely involved in undergraduate education, vocational education, continuing education and other levels, especially in the field of vocational education has been widely used. Domestic research is mainly focused on the development of virtual simulation training system, the construction of virtual simulation training base and teaching applications in three aspects, the research and construction of related fields have achieved significant results, but there is still room for further improvement, especially in the system openness, sharing and the combination with artificial intelligence technology [13]. The table 2 shows some studies of virtual simulation teaching practice in some Chinese universities.

**Table 2.** Case study of virtual simulation practice teaching in some Chinese Universities

University	Experimental Theme	Utilization Equipment	Experimental Content	Educational Model	Experimental Results
Tongji University <sup>[15]</sup> (2018)	Landscape Scale Sense Teaching	Oculus, Computers, 3D Software	Students experience different scale landscapes virtually to judge spatial features.	Immersive VR, Interactive Learning	Improved accuracy in perceiving scale, especially vertical height.
Southwest University <sup>[11]</sup> (2020)	Virtual Simulation in Assembly Building	VR, BIM, AR	Learn construction of assembled buildings virtually, including operations.	Flipped Classroom, Immersive Learning	Boosted independent learning and practical abilities.

Harbin Institute of Technology <sup>[14]</sup> (2020)	Interactive Design in Commercial Interiors	VR Headsets, Sensors, Platforms	Simulate commercial interior spaces for user interaction and design optimization.	Interactive VR Learning	Enhanced design accuracy and user satisfaction.
Zhejiang University <sup>[12]</sup> (2020)	Real-Time Roaming in Virtual Architecture	Layer Iterative Drawing, Pre-fading Techniques	Develop a system for efficient 3D building model roaming.	Virtual Immersive Roaming	Improved representation and user experience of built environment.
Dalian University of Technology <sup>[16]</sup> (2023)	Lighting Simulation in Interior Design	Maya, Lightwave, AutoCAD, 3D MAX, Simulation Software	Explore lighting simulation in interior design teaching and practice.	Combination of Simulation and Traditional Teaching	Improved spatial perception and practical skills in lighting design.

## 4 Comparative Analysis of Virtual Simulation Practice Teaching in China and Abroad

### 4.1 Similarities in Virtual Simulation Practice Teaching in China and abroad

Through literature research, it is found that domestic and foreign teaching models reflect a high degree of consistency in teaching objectives and technology application, and the teaching objectives are committed to utilizing VR technology to enhance students' design ability, spatial perception and practice level; applying VR technology in the fields of architectural design, landscape design, indoor design, and cultural heritage preservation, etc., and enriching the means of teaching.

### 4.2 Differentiation of Teaching Facilities

In other aspects there are more differences, compared with foreign universities, domestic universities still have obvious gaps in virtual simulation practice teaching, especially in the investment of equipment and technical resources. Foreign colleges and universities are usually equipped with advanced equipment such as CAVE systems, high-precision 3D scanners, large-scale immersive virtual simulation systems, etc., which provide students with highly immersive learning environments, support the construction of full-size virtual scenes, and help students to learn interactively in the virtual space. In addition, foreign universities also use a variety of advanced technologies, such as HTC Vive Pro, Oculus Quest, and Unity3D engine, etc. These hardware and software combinations are not only able to support complex 3D modeling and real-time rendering, but also enable multi-user collaborative operations. In

contrast, the domestic virtual simulation teaching has made great progress, and many famous universities have established more mature virtual simulation teaching laboratory centers, but the vast majority of ordinary universities have smaller virtual simulation laboratories, and the investment in equipment and resources is still insufficient to meet the needs of large-scale teaching and learning, and the human-computer interaction in some colleges and universities is not friendly enough, and the application of the virtual simulation technology needs to be strengthened in terms of depth and breadth.

### 4.3 Differentiation of Teaching Mode

The effectiveness of virtual simulation teaching not only depends on advanced technology and equipment, scientific and reasonable teaching mode is also highly dependent on virtual simulation teaching. The design of virtual simulation courses should be interactive, contextual and task-driven<sup>[2]</sup>. In the virtual simulation teaching design of foreign universities, project-based learning is usually combined with contextual teaching. For example, Carleton University, in its design course, integrates virtual simulation technology with project-based learning, requiring students to complete a complete architectural design project from conceptual design to construction simulation in a virtual environment, with all aspects carried out on a virtual simulation platform<sup>[7]</sup>. This teaching mode not only enhances students' design ability, but also develops their skills in project management and teamwork. In addition, the Massachusetts Institute of Technology (MIT) enables students to interact and evaluate designs in a virtual environment in real time by introducing Immersive Virtual Reality (IVR) technology. This approach strengthens students' ability to perceive space and materials, which in turn improves the feasibility and innovation of design solutions.

Domestic universities are also actively exploring the application of virtual simulation technology in teaching. Taking Tsinghua University as an example, its environmental design course adopts a task-driven teaching mode, in which students complete digital reconstruction and design projects of cultural heritage through a virtual simulation platform. For example, the use of virtual simulation technology for three-dimensional modeling and innovative design of historical buildings such as the Potala Palace provides an in-depth understanding of the combination of cultural heritage protection and environmental design, through which students not only enhance their knowledge of cultural heritage, but also cultivate the ability of innovative design. However, there is still a gap between the teaching methods of domestic universities and those of foreign universities. The virtual simulation courses of some colleges and universities are deficient in context, interaction and other aspects, and the teaching content is relatively single, which fails to bring all the potential of virtual simulation technology into play. Therefore, while focusing on students' practical participation and innovation ability cultivation, domestic colleges and universities also need to further improve the teaching design and learn from international advanced teaching experience.

#### 4.4 Student Feedback and Learning Effectiveness

Student engagement and feedback are important criteria for measuring the effectiveness of virtual simulation teaching. Research has shown that virtual simulation technology can significantly improve students' sense of participation, immersion experience and learning effect. In foreign colleges and universities, students generally have a positive attitude towards virtual simulation teaching. For example, in the design course at the Massachusetts Institute of Technology (MIT), students use virtual simulation technology to simulate the architectural design and continuously modify and optimize it according to the real-time feedback provided by the platform [8]. This learning approach not only improves students' engagement, but also enhances their independent learning ability and design thinking. A survey on virtual simulation teaching shows that 85% of students believe that virtual simulation technology has improved their spatial perception ability, and 78% of students report that their teamwork ability has improved [6]. These data show that virtual simulation teaching has significant results in improving students' comprehensive ability.

In China, students in colleges and universities also show great interest in virtual simulation teaching. For example, in the environmental design course of Tongji University, students completed several real projects through the virtual simulation platform, and 90% of the students' feedback claimed that this kind of teaching improved their practical ability and design innovation consciousness. However, due to the lack of an effective student feedback mechanism in some universities, the teaching effect failed to meet expectations. Problems encountered by students in the learning process cannot be solved in time, which in turn affects their motivation and effect of learning. Therefore, the establishment of a perfect feedback mechanism and timely understanding of students' learning needs and difficulties are the key links to enhance the effectiveness of virtual simulation teaching.

## 5 Conclusion

This study compares the application of virtual simulation practice teaching in environmental design majors in China and abroad, and finds that despite the progress made by domestic universities in this field, there is still room for improvement in terms of VR equipment input, teaching design, student feedback and learning effect. Suggestions include, firstly, strengthening technical input, optimizing the VR interactive teaching environment, and enhancing students' interactivity and problem-solving ability by optimizing teaching design and adopting project-based learning and contextualized teaching. Secondly, promote interdisciplinary integration, utilize VR technology to cultivate innovative thinking, and at the same time, strengthen school-enterprise cooperation so that students can improve their practical skills through actual projects. Once again, improve the feedback mechanism to make the teaching content more in line with students' needs. Finally, strengthen teacher training to enhance teachers' mastery of virtual simulation technology in order to better instruct students. These measures aim to improve the effectiveness of virtual simulation teaching and enhance students' practical experience and innovation ability.

The application of virtual simulation technology in environmental design teaching has a broad prospect, and in the future, with the development of multi-modal interaction and artificial intelligence technology, virtual simulation will bring more innovative possibilities for environmental design teaching. Colleges and universities should strengthen the multi-sensory learning experience, enhance the interactivity of the virtual simulation environment, provide students with richer learning methods, and then effectively improve the teaching effect.

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