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Effect of Virtual Reality Intelligent Interior Design Platform on Interior Design Education at the Junior College Level

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Abstract

Background and Aim: According to the learning situation of college students, this paper puts forward some problems existing in teaching practical courses for the current situation of modern indoor teaching, and expounds the advantages of the application of Internet VR intelligent indoor design platform. Data is obtained and analyzed by grouping teaching classes and conducting teaching achievement testing experiments using different teaching methods. Determine whether there is a significant difference in the improvement of students' performance in creating interior design renderings between using VR intelligent design platforms and traditional design software. Therefore, this study proposes three research objectives:(1) To compare the performance improvement of learning VR intelligent design platform and traditional design software in creating interior design renderings. (2) To explore the features that VR intelligent design platforms can provide to improve learners' ability to create renderings. (3) To explore teaching methods for interior design vocational education based on VR intelligent design platforms.

Materials and Methods: This study is designed as a quasi-experimental study. The sample consists of 60 sophomore students majoring in interior design. In a rendering course at a college in Chongqing, purposive sampling was used to divide them into two groups: the experimental group learned how to create interior design renderings using a VR intelligent design platform, and the control group learned how to create interior design renderings using traditional design software. This study used performance testing as a research tool to determine whether the performance improvement of two groups of students was significant based on the difference in scores between pre-test and post-test scores.

Results: The average pre-test and post-test scores of the control group were 60.3 and 76.4, respectively, while those of the experimental group were 62 and 84.9, respectively. Compared with the control group (M=16.1, SD=2.96), the experimental group showed a significantly higher average score improvement (M=22.90, SD=2.77). The statistical significance level was P<. 001.

Conclusion: Research has shown that learning based on VR intelligent design platforms can improve students' learning efficiency in creating interior design renderings, achieve better academic performance, and is worth promoting.

Keywords: Virtual Reality; Interior Design; Vocational Education

Introduction

With the arrival of the 5G era and the promotion of emerging computer application technologies such as "big data" and "cloud computing", cloud design, as a new type of shared design platform, will become a new trend in future development. The concept of VR intelligence is the future development model of the interior design industry (Abhinesh, 2021).

The development of the Internet and artificial intelligence technology also affects the teaching mode and teaching form of interior design courses. The requirements of the modern interior design industry for professional and technical personnel are also changing with the development of technology (Zhao & Ko, 2024). Taking the reform of interior design courses in vocational colleges as an example, with the help of VR intelligent interior design platforms, new and effective teaching methods for interior design majors have been explored (Checa & Bustillo, 2020). Based on this, the reform of interior design practice courses is imperative, which requires the integration of interdisciplinary knowledge such as architecture and environmental psychology to broaden students' horizons. The project-based learning model will enable students to enhance their skills through practical operation, while the introduction of the latest technological tools and software can ensure that students master cutting-edge design methods. At the same time, emphasis is placed on cultivating aesthetic and cultural literacy, making design works rich in depth and

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characteristics. In addition, incorporating sustainable design concepts and guiding students to pay attention to environmental protection and ecological balance. In summary, the reform should be comprehensive and in-depth, aiming to cultivate design talents with innovation, skills, and a sense of social responsibility. Therefore, this article will propose an optimized teaching strategy and explore its role in interior design rendering courses.

Research Objectives

1. To compare the performance improvement of learning VR intelligent design platform and traditional design software in creating interior design renderings.
2. To explore the features that VR intelligent design platforms can provide to improve learners' ability to create renderings.
3. To explore teaching methods for interior design vocational education based on VR intelligent design platforms.

Literature review

VR intelligent interior design online platform

Kujiale, as a cutting-edge VR intelligent interior design online platform, has been leading the digital transformation of the interior design industry since its inception in November 2013 (Wang et al., 2018). This platform deeply integrates cutting-edge technologies such as cloud design, cloud rendering, cloud computing, virtual reality, augmented reality, and artificial intelligence, aiming to create an immersive panoramic VR design and decoration experience of "what you see is what you get" (Sinha, 2023).

Kujiale utilizes VR technology and cloud rendering to enable students to intuitively experience design effects in a virtual environment, enhancing spatial perception and design abilities (Heydarian et al., 2015). The platform's rich library of model materials and learning resources provides students with a foundation of practical materials and knowledge accumulation, helping them master interior design skills (Portman et al., 2015). Through online design practice, students can gain valuable project experience by simulating real-life scenarios, paving the way for their future careers (Paes et al., 2021). The community interaction function of "Kujiale" promotes communication and sharing among students, broadens their horizons, and provides a platform for showcasing their works (Natephra et al., 2017). In summary, this platform has created an indoor design growth environment that integrates learning, practice, and exhibition for students.

Jury theory

Given the high complexity and subjectivity inherent in design, evaluating design quality often becomes a highly challenging task, and different individuals may produce vastly different evaluation results due to differences in preferences (Bohart et al., 2011). To overcome this challenge, this study introduced the jury evaluation mechanism, a methodology originating from the field of psychotherapy and aimed at addressing subjective evaluation difficulties, which is now cleverly applied in the field of art and design (McLaren, 1997). Based on the professional abilities of all experts, reach a relatively objective consensus.

Bohart et. al. (2011) argues that the jury method not only requires members to have a deep professional knowledge background but also emphasizes balancing individual biases through collective decision-making, thereby improving the accuracy and credibility of evaluations. Johnson and Shaub (2005) argue that in academic research, this method involves forming a jury composed of experts from multiple fields, user representatives, and industry analysts to collectively examine and evaluate the research object. This diverse membership ensures that the evaluation process covers all aspects of the research subject and receives in-depth and detailed consideration. (Kliment, 1995). Specifically for this study, multiple senior experts in the design field were convened to independently evaluate the rendering effects of models created by students using VR intelligent interior design platforms and traditional design software. By calculating the average score of the judges, the overall impression and preference of the expert group towards the two design methods can be quantified and reflected.

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Measurement of rendering quality

Juan et. al. (2021) argues that in the field of interior design, renderings serve as an important medium for designers to showcase their design proposals to clients. Its quality is directly related to the communication effect of design concepts and customer acceptance (Schofield et al., 2018). To judge the quality of interior design renderings, a comprehensive evaluation needs to be conducted from three dimensions: authenticity, precision, and innovation (Zhang, 2019). Johnnie (2016) believes that when evaluating interior design renderings, authenticity, precision, and innovation must be viewed as an inseparable whole. Only renderings that perform well in all three aspects can effectively convey design concepts and promote the smooth implementation of design schemes (Hozan et al., 2020). Meanwhile, these three dimensions interact with each other. While pursuing innovation, the requirements for authenticity and precision cannot be ignored. In the process of enhancing authenticity and precision, attention should also be paid to the integration and embodiment of innovation (Juan et al., 2021). Only in this way can excellent interior design renderings that meet customer needs and have artistic value be created. Therefore, the factors that affect the quality of the rendering can be divided into three aspects.

(1) Authenticity: Ivson et. al. (2019) found that designers need to pay attention to accurately grasping materials and textures, light and shadow effects, color reproduction, size ratios, and physical laws when creating renderings.

(2) Fineness: Portman et. al. (2015) found that refinement requires attention to image resolution, material, and texture, lighting effects, furniture, and furnishings, as well as rendering quality and time.

(3) Innovation: Innovation can be reflected in the innovation of design style, the novelty of color matching, the uniqueness of spatial layout, the creativity of material application, and the use of light and shadow art (Iverson et al., 2019).

Conceptual Framework

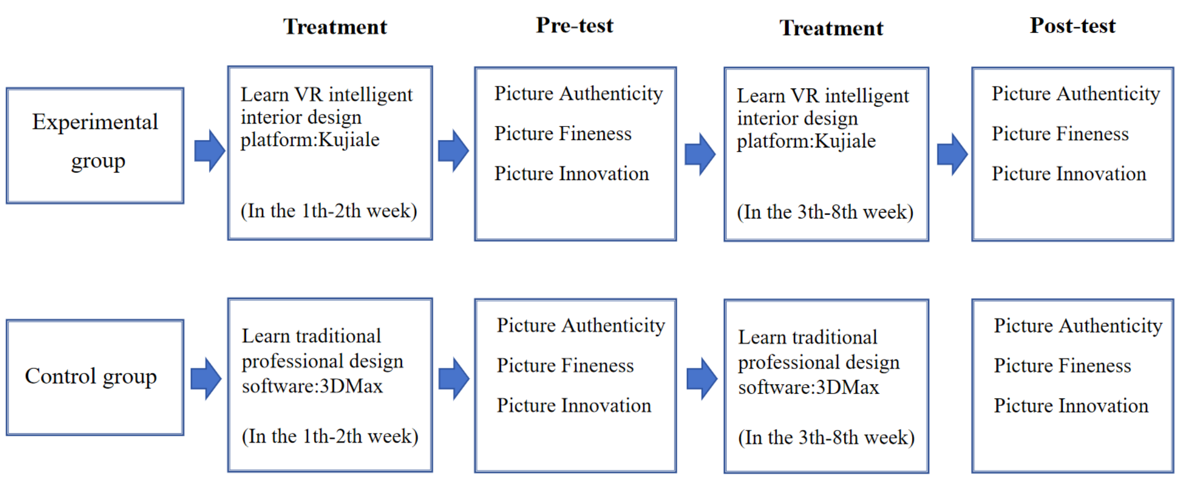

Figure 1 Research Framework

Methodology

Population and Sample

The target audience is second-year students majoring in interior design at a vocational college in Chongqing, China. This experiment involved a total of 60 students, who were divided into an experimental

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group and a control group, with 30 people in each group, accounting for 50% of the total population. In terms of age distribution, students are mainly concentrated in the age group of 19, accounting for 46.7%, followed by 18-year-old students, accounting for 23.3%. However, students aged 20, 21, and 22 are relatively few, accounting for 16.7%, 10%, and 3.3% respectively. From a gender perspective, female students make up the vast majority, with a total of 48 students, accounting for 80%, while male students only have 12 students, accounting for 20%. Finally, in terms of their place of origin, students mainly come from Chongqing (60%), followed by Sichuan (23.3%), Yunnan (10%), and Guizhou (6.7%). There was no significant difference in general data between the experimental group and the control group (age, gender, place of origin, etc.). (P >0.05).

Study Design

This study is designed as a pre-test and post-test, with the course taught by the same instructor and the same course content. Two groups of students used different tools to study for two weeks and then created renderings according to the school's existing exam standards. Experts scored the quality of the students' renderings to obtain pre-test data, to obtain their proficiency in creating renderings. After completing an eight-week learning period, students are asked to create renderings according to a unified exam standard, and experts score the quality of the renderings to obtain post-test data. Rate each rendering based on three key dimensions: authenticity, precision, and innovation. Students study for 6 hours per week. The experimental group used a VR intelligent design platform for teaching, while the control group used traditional design software for teaching. The 8-week teaching plan is shown in Table 1.

Table 1 Lesson Plan(8Week)

timeline	participant	Teaching content and activities	Using Kujiale VR Intellig ent Online Design Platfor m/Experimental Group 1	Using traditional modelin g software 3dmax/control group 2
Week 1	Teacher (tea ching, operat ion)	Introduction to soft ware and operation interface.	Introduction to online desig n platform, no need to dow nload, can be operated thro ugh web port.	Understand the 3Ddmax int erface and software downlo ad and installation.
	Student (Op eration)			
Week 2	Teacher (tea ching, operat ion)	Learn the basic cre ation of 3D models and master the pro cess of creating ren derings.	Learn the operation comma nds of the Intelligent design platform	Learn how to create a Recta ngular cuboid model, and m ake a living room wall thro ugh a Rectangular cuboid
	Student (Op eration)			
Week 3	Teacher (tea ching, operat ion)	Basic modeling, co mpleting classroo m space design	Quickly create classroom w all models and desk models using an intelligent materia l library.	Create classroom wall mod els and desk models.
	Student (Op eration)			
Week 4	Teacher (tea ching, operat ion)	Making door and window models	Quickly create door and wi ndow models using an intell igent material library.	Using rectangular tools to c reate door and window mod els
	Student (Op eration)			
Week 5	Teacher (tea ching, operat ion)	Create wall models for living room an		Draw a wall model of the li ving room and dining room

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timeline	participant	Teaching content and activities	Using Kujiale VR Intelligent Online Design Platform/Experimental Group 1	Using traditional modeling software 3dmax/control group 2
	Student (Operation)	d dining room spaces	Quickly generate spatial models using an intelligent material library.	composite space using rectangular and linear tools.
Week 6	Teacher (teaching, operation) Student (Operation)	Design lighting layout	The intelligent platform automatically generates lights through placed lamps.	By setting the shape, color, and brightness of the light.
Week 7	Teacher (teaching, operation) Student (Operation)	Setting parameters for rendering renderings	Intelligent platform one-click rendering without setting rendering parameters.	Use rendering tools to adjust appropriate data for model rendering, achieving realistic results.
Week 8	Teacher (teaching, operation) Student (Operation) Student (Operation)	Rendered an interior living space rendering (including three bedrooms, one study, one living room, one dining room, one kitchen, and one bathroom).	Rendered an interior living space rendering (including three bedrooms, one study, one living room, one dining room, one kitchen, and one bathroom).	Rendered an interior living space rendering (including three bedrooms, one study, one living room, one dining room, one kitchen, and one bathroom).

Data Collection and Analysis

Collect expert ratings on the quality of student renderings to obtain data. After obtaining the pre-test and post-test data of the two groups, subtract the pre-test score from the post-test score of each group to obtain the score improvement of each student in the experimental group and control group. Use Jamovi software to identify statistical data for data analysis. Conduct descriptive analysis, use independent sample t-test to compare the improvement scores of two groups, and determine whether there are significant differences in using different teaching tools. $P<0.05$. The difference is considered statistically significant.

Results

The scoring results of the first and second group participants are shown in Table 2. The results showed that the average score of the experimental group before the test was 62 (SD=1.44), and the average score after the test was 84.9 (SD=3.26). The average score of the experimental group's rendering improved by 22.9 (SD=2.77). The average score of the control group before the test was 60.3 (SD=1.44), and the average score after the test was 76.4 (SD=3.47). The average score of the control group's rendering improved by 16.1 (SD=2.69).

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Table 2 The Results of Scores between Group 1 and Group 2

Type Group	Pre-test		Post-test		Improvement of score	
	1	**2**	**1**	**2**	**1**	**2**
N	30	30	30	30	30	30
Mean	62	60.3	84.9	76.4	22.9	16.1
Std.Deviation	1.44	1.44	3.26	3.47	2.77	2.69

This experiment conducted an independent sample t-test to compare the performance improvement effects of learning VR intelligent design platforms and learning traditional design software. As shown in Table 3, the results show that there is a significant difference in the average pre-test scores between the two groups (t=4.49, P<0.01). The average post-test scores of students in the group learning VR intelligent design platform are significantly higher than those in the group learning traditional design software (t=9.76, P<0.01). The average improvement level of the group learning VR intelligent design platform to create renderings is significantly higher than that of the group learning traditional design software to create renderings (t=9.23, P<0.01).

Table 3 The Independent Sample T-test between Group 1 and Group 2

	Student' t	**df**	**P**
Pretest score comparison of two groups	4.49	58	<0.01
Posttest score comparison of two groups	9.79	58	<0.01
Improvement of score comparison of two groups	9.23	58	<0.01

Discussion

The results indicate that both learning traditional design software and learning VR intelligent design platforms have improved the performance of creating interior design renderings. Compared with traditional design software, learning based on a VR intelligent design platform is more effective in improving students' ability to create renderings. This can be seen from the significant differences in the mean, standard deviation, and independent sample t-test comparison between the two groups.

The results are consistent with previous studies, and from the statistical results, it is pointed out that there is a significant difference in the improvement of rendering scores between the experimental group and the control group. This result echoes the views of Abhinesh (2021) and Zhang (2019) that authenticity is the primary criterion for measuring the quality of renderings, and VR technology, with its immersive experience, is likely to play a key role in improving the authenticity performance of student models. The studies by Gębczyńska-Janowicz (2020), Fukuda et. al. (2017), and Schmohl et. al. (2020) all indicate that high-precision renderings require unparalleled attention to detail in these areas. VR technology provides realistic material feedback and dynamic light and shadow changes, allowing students to simulate real scenes more realistically and pay more attention to the presentation of these details in design. Ivson et. al. (2019) described that innovation can be reflected in multiple aspects, such as innovative design styles, novel color combinations, unique spatial layouts, creative material applications, and the use of light and shadow art. VR technology, characterized by its immersive experience and high interactivity, provides students with a broader creative space and more intuitive design feedback.

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When exploring the impact of VR intelligent design platforms on improving the ability to produce interior design renderings, this study not only observed their significant positive effects but also had to acknowledge their limitations.

Positive effects

1. Significantly improve the ability to create interior design renderings: Research results show that compared to traditional design software, VR intelligent design platforms are more effective in improving students' ability to create interior design renderings. This is thanks to the immersive experience and high interactivity of VR technology, which allows students to more intuitively feel the design effect in a virtual environment, thereby adjusting and optimizing the design scheme more finely.

2. Enhance design authenticity and detail expression: VR technology provides realistic material feedback and dynamic light and shadow changes to help students simulate real scenes more realistically, thereby paying more attention to detail expression in design. This is consistent with previous studies emphasizing authenticity as the primary criterion for measuring the quality of renderings, further verifying the advantages of VR technology in enhancing design authenticity.

3. Inspire innovative thinking and creative space: VR platforms provide students with a broader creative space and more intuitive design feedback through their unique immersive experience and high interactivity. This helps stimulate students' innovative thinking, prompting them to constantly explore and experiment with design styles, color matching, spatial layout, material application, and light and shadow art.

limitations

1. Short research period: The current research has a limited period and may not fully reflect the long-term impact of VR platforms on student learning outcomes. Long-term tracking research is crucial for revealing the long-term educational value of VR technology.

2. Difficulty in self-learning monitoring: In VR platform learning, students may rely more on self-learning, and teachers may find it difficult to comprehensively monitor their learning process. This may result in some students lacking necessary guidance and feedback, affecting their learning outcomes.

3. Technical barriers and costs: Although VR technology has many advantages, its high technical barriers and costs may also become obstacles to popularization. Especially for schools and educational institutions with limited resources, how to balance the relationship between technology investment and teaching effectiveness is an urgent problem to be solved.

In summary, VR intelligent design platforms have shown great potential in improving the ability to produce interior design renderings, but at the same time, they also face challenges such as short research cycles, difficulty in self-learning monitoring, and technical barriers and costs. Future research should focus on addressing these limitations to more comprehensively evaluate the application value of VR technology in interior design education.

Conclusion

This study provides strong evidence to support the introduction of VR technology in the field of interior design education. The VR online design platform has significant advantages in improving the quality of student rendering production. Future research could consider combining other teaching methods and technological means to more comprehensively evaluate the application effectiveness of VR technology in design education.

The practical application of the research results in the field of interior design education has significant significance. For students, the introduction of VR intelligent design technology has completely changed their learning experience. Students can now use VR platforms to personally experience the three-dimensional spaces they design. This immersive environment not only deepens their understanding of spatial relationships but also greatly inspires their design inspiration and innovative thinking. VR tools simplify the design process, lower the technical threshold, and enable students to invest more energy in creative ideas rather than tedious technical operations. At the same time, the real-time feedback mechanism

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provided by VR platforms helps students quickly identify and correct design issues, thereby continuously improving design quality. In addition, VR technology provides students with a simulation platform that is close to a real work environment, enhancing their practical abilities and laying a solid foundation for their future careers.

For teachers, VR intelligent design technology has become an innovative teaching method. Teachers can use VR platforms to design rich and diverse teaching cases, assign challenging assignments, and make the teaching process more vivid and interesting. This teaching method not only enhances students' interest and participation in learning but also promotes close interaction between teachers and students. Through VR platforms, teachers can more intuitively display abstract concepts such as design principles and spatial layout, improving the quality of teaching. At the same time, VR technology also provides teachers with the opportunity to explore new knowledge in the field of design with students, which helps to establish a more harmonious teacher-student relationship.

In summary, the application of VR intelligent design technology in interior design education not only provides students with efficient and intuitive learning tools but also creates a rich and flexible teaching environment for teachers. The application of this technology not only promotes the modernization process of interior design education, but also lays a solid foundation for students' future career development, and provides useful reference and inspiration for educational reforms in other fields.

Recommendation

1. To comprehensively understand the long-term impact of VR platforms on students' learning outcomes, researchers should design long-term tracking studies that span different learning stages and continuously monitor the role of VR technology in enhancing students' design abilities, innovative thinking, and career preparation. This will help reveal the long-term educational value of VR technology.

2. In response to the problem of teachers' difficulty in fully grasping students' extracurricular learning behavior, future research should utilize advanced data collection and analysis techniques, such as learning analysis, to more accurately track students' usage and learning outcomes on VR platforms. At the same time, by combining qualitative research methods such as interviews and questionnaire surveys, we can gain a deeper understanding of students' motivations, challenges, and experiences in extracurricular learning, providing more detailed evidence for the application of VR technology in extracurricular learning.

3. To reduce the influence of external factors on research results, future research designs should be more rigorous, strictly controlling confounding variables such as teaching methods, curriculum design, and student background through methods such as randomized controlled trials. This will help to more accurately evaluate the educational effectiveness of VR platforms under specific conditions and reveal their applicability in different contexts.

4. Interdisciplinary collaboration and multi-perspective research are also important directions for future research. By introducing knowledge and methods from different fields such as psychology, educational technology, and human-computer interaction, we can comprehensively explore the potential and challenges of VR technology in interior design education. This interdisciplinary perspective will help discover new research questions, propose innovative solutions, and drive the overall development of design education.

5. Provide some new perspectives and directions for future research. For example, further exploration can be conducted on how to improve students' acceptance and adaptability to new technologies; Study the complementarity and synergistic effects between different design tools; And explore the role of non-technical factors in enhancing design innovation. These studies will provide a more comprehensive understanding of the current situation and challenges of design education, and provide strong support for cultivating designers with innovative spirit and practical abilities.

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