The Practice and Exploration of Virtual Reality Technology in Distance Education

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Abstract: With the rapid development of information technology, virtual reality (VR) technology has gradually transformed from the concept of science fiction to reality, and become an important driving force for innovation and development in the field of education. As an immersive technology, VR can break the limitations of time and space in traditional teaching modes and create an immersive learning experience for learners. This technology can not only make the learning process more vivid and interesting, but also improve students' learning efficiency and initiative through interaction and immersion. Especially in the field of distance education, the application of VR technology is redefining teaching methods, increasing the efficiency of educational resource sharing, and enhancing the fairness and accessibility of education. This paper will take VR technology as the starting point, analyze its basic principles and technical characteristics, and deeply discuss the diversified practices of VR in distance education, including teaching scene simulation, interactive experience optimization, other aspects of educational resources equity, etc.

Keywords: Virtual reality technology; Distance education; Immersive learning; Educational equity

1. Introduction

Since its birth, distance education has gradually become an important part of the field of education with its advantages of breaking through space and time constraints. Especially under the background of the development of globalization and information technology, its application scope and audience group are constantly expanding. However, traditional distance education mainly relies on text, video, and audio media, and lacks a sense of interactivity and immersion, which leads to the low participation of learners and the difficulty to guarantee the learning effect. In addition, in subjects with complex teaching content and the need for practical operation, the limitations of the traditional distance education mode are more apparent, which cannot provide a learning environment of reality and dynamic feedback. With the emergence of virtual reality (VR) technology, these problems have been solved completely. VR technology can not only simulate complex teaching scenarios but also significantly improve the learning effect through immersive experience and interactive learning, injecting more possibilities and vitality into distance education.

2. Overview of virtual reality technology

2.1. Basic definition and characteristics of virtual reality

Virtual reality is an advanced technology with computer technology as the core, building a 3D virtual environment through simulation, enabling users to immerse themselves in it and interact with the environment in real time. This technology is based on multi-dimensional sensory interaction, combining visual, auditory, tactile, and even olfactory and motion perception, to bring users an unprecedented experience [1]. Its core characteristics are reflected in the following aspects: immersion is the primary feature of VR technology. With head-mounted display devices (HMD), surround sound systems, and motion capture technology, users can fully integrate into the virtual environment as if they were in it. For example, in the field of education, students can "enter" the ancient battlefield or space to experience the charm of history or science, and this sense of immersion can significantly enhance the interest and focus of learning. Interactivity makes VR technology capable of dynamic control [2].

Users can interact with virtual environments through motion-capture gloves, handles, or even full-body motion-tracking systems, such as grabbing objects, manipulating virtual instruments, or changing scenes. For distance education, interactivity makes up for the lack of interactive experience in traditional online education, so that learners can participate in practice through direct operation and improve the learning effect [3]. For example, in a virtual laboratory, students can "touch" the virtual chemical molecular structure or conduct biological slice experiments, this interaction not only enhances hands-on ability but also reduces the risk and cost of experimental teaching. Imagination gives VR the ability to break physical boundaries, allowing it to simulate difficult scenarios in the real world. For example, learners can explore the deep sea, volcanic interior, and even microscopic cellular worlds through VR technology. This ability to transcend reality provides broader possibilities for education and makes abstract knowledge more concrete and vivid. In addition, VR technology can create completely virtual environments to train complex skills or predict future scenarios.

To sum up, VR technology is reshaping the way that users interact with information, relying on its unique advantages of immersion, interaction, and imaginative information. In the field of distance education, this technology provides a new idea of breaking the limitations of traditional education and brings profound changes to teaching practice [4]

2.2. Main components of virtual reality technology

The realization of VR technology relies on the organic combination of a series of hardware devices, software systems, and data transmission technology, which together constitute the core framework of VR technology, providing users with an immersive and interactive experience.

Hardware equipment is an important foundation of VR technology. The HMD, as the core device, is responsible for presenting users with high-resolution, panoramic virtual worlds, and enabling real-time tracking of head motion through a gyroscope and accelerometer to enhance immersion. Motion capture gloves can accurately capture the user's hand movements and support subtle gesture control, allowing users to naturally interact with the virtual environment. By providing physical feedback, the force feedback device makes users feel the sense of touch and power when operating virtual objects, and further enhances the sense of reality. For example, in a virtual experiment, the user can "perceive" the weight or surface roughness of the object, and this experience brings a higher degree of realistic reduction to practical teaching [5].

The software system is the logical support of VR technology. Virtual reality engines (such as Unity and Unreal Engine) are used to create highly realistic virtual scenes and complex interactive logic, while

supporting multi-platform deployment to facilitate content development and application. Scene modeling tools (such as Maya and Blender) are used to design and build virtual objects and environments and enhance the authenticity of scenes through meticulous texture processing and light and shadow effects.

In addition, the addition of AI technology enables the software to adjust the virtual environment in real time according to the user behavior, further improving the user's immersion and personalized experience. Data transmission technology is the key to realizing remote interaction. High-speed and low-latency data transmission networks (such as 5G technology) can support real-time synchronization of multi-user interactions, allowing users distributed in different locations to seamlessly share virtual scenarios. For example, in a remote virtual reality class, teachers and students can interact and communicate in real time in the same virtual classroom through data transmission technology. In addition, the application of cloud computing reduces the performance requirements of local hardware and achieves a more efficient and smooth VR experience through cloud rendering and processing.

In short, the coordinated development of hardware equipment, software systems, and data transmission technology not only promotes the rapid maturity of VR technology but also lays a solid foundation for its extensive application in distance education, industrial simulation, medical training, and other fields. In the future, with these technologies being further optimized, VR will bring revolutionary changes to more scenarios.

3. Practical application of virtual reality technology in distance education

3.1. Simulation and construction of teaching scenarios

The application of VR technology in the field of education has created a richer and more vivid learning environment for students with its realistic scene restoration and dynamic construction ability. This technology breaks through the limitations of physical space and resources in traditional teaching and provides learners with unattainable deep experience and practice opportunities [6].

Scientific experiment simulation is an important application direction of VR technology in education. By constructing virtual laboratories, students can conduct a variety of high-risk experiments in a safe, controlled environment, such as dynamic demonstrations of biological anatomy, chemical reactions, or physical phenomena. This not only reduces the safety risks in the experimental process but also greatly reduces the waste of experimental materials. For example, students can dissect a frog in a virtual reality environment and observe its organ structure and function without the anatomical operation of real animals, and this simulation provides a more environmentally friendly and efficient solution for the teaching of biology.

History and culture teaching is a major highlight of VR technology in liberal arts education. Through highly restored historical scenes, students can "cross" travel to specific times and places to experience historical events or cultural sites. For example, students can visit the construction site of the Great Wall through VR technology, observe the workflow of ancient craftsmen, and even interact with virtual characters, enter the ancient battlefield, and experience the formulation and execution of war strategies. This immersive teaching method not only enhances students' understanding of history and culture but also stimulates their interest in learning and the desire to explore.

Vocational skills training is an important breakthrough in VR technology in practical disciplines. With the help of the virtual environment, students can develop difficult skills in simulated scenes. For example, medical students can perform surgical exercises through VR technology. From skin incisions to wound sutures, all

operations can be completed on virtual human models, which not only avoids the potential risks to real patients but also enables students to practice repeatedly and strive for perfection. Similarly, in areas such as architectural design and mechanical maintenance, students can also manipulate virtual devices in virtual scenes for design, testing, and maintenance operations to accumulate valuable practical experience.

3.2. Improvement of teaching interaction

By creating a highly immersive learning environment and real-time interaction function, VR technology significantly improves the interaction of distance education, providing a new way to communicate between teachers and students and between students. This technology allows learners to break through the screen limitations of traditional distance education and participate in the learning process in a more intuitive and dynamic way. Virtual classroom is one of the typical applications of VR technology in distance education.

In the virtual classroom, students enter a three-dimensional virtual classroom by wearing VR devices and communicate "face to face" with teachers and classmates. This environment not only simulates the real classroom scene but also supports teachers in displaying the teaching content through virtual whiteboards, 3D models, and other tools, so as to make the course more vivid. For example, in a physics course, teachers can display the refraction experiment of light in real time in a virtual classroom, while students can observe different angles of the experiment and ask questions and discuss. This real-time interaction can effectively shorten the distance between teachers and students, and enhance students' learning experience and concentration.

Collaborative learning is a highlight of VR technology to promote teamwork learning. Through the multi-person online VR platform, students can achieve high interaction and collaboration in the virtual environment [7]. For example, architecture students can work together to design a building in a virtual construction site, each responsible for designing different modules and adjusting them in real time. With voice, motion capture, and virtual tools, team members can collaborate seamlessly and share the results of real-time modifications. This approach not only exercises students' collaboration skills but also enables them to have a deeper understanding of the learning content and solve problems from different perspectives.

The immersive environment and real-time interaction function of VR technology solve the problem of insufficient interaction and participation in traditional distance education, enable learners to participate in the course content more deeply, and improve the efficiency of teacher-student interaction and team collaboration. It not only provides more innovative teaching methods for educators, but also brings a richer learning experience for learners and opens a new chapter of distance education.

4. Advantages and challenges of virtual reality technology in distance education
4.1. Advantages

The application of VR technology has brought many unique advantages to the field of education, and these characteristics have significantly optimized the teaching effect, broken through many bottlenecks of the traditional education mode, and become an important driving force to promote distance education and innovative teaching.

An immersive learning experience is one of the core advantages of VR technology. By building realistic and vivid virtual scenes, learners can fully integrate into the learning environment, thus significantly improving their learning interests and concentration. For example, students can "operate" complex chemical experiment instruments in a virtual laboratory to observe the dynamic changes in molecular structure without worrying about safety risks. This immersive experience not only makes abstract knowledge more intuitive, but also

strengthens students' understanding and memory effects, especially in the fields of scientific experiments, historical and cultural experience, and vocational skills training.

Flexibility and scalability are one of the highlights of VR courses. The content of virtual courses can be adjusted and updated at any time according to the teaching objectives and student needs, offering high flexibility. For example, teachers can design multi-level teaching content for students at different learning stages, from the explanation of basic knowledge to the training of advanced skills, without the need to change equipment or add additional venues. At the same time, VR technology can accommodate multiple people to participate in learning at the same time, and support cross-regional and cross-cultural educational collaboration. This scalability provides a broad space for teaching innovation and global educational resource sharing. Cost saving is a significant advantage of VR technology in long-term applications [8].

Although the initial investment of VR equipment is higher, compared with traditional education, its cost is more advantageous in the subsequent operation. For example, in vocational training, the use of VR technology can completely replace some high-consumption, high-risk practical operation training, such as pilot simulation training, surgical operation practice, etc. This not only reduces material consumption and equipment loss but also avoids potential safety accidents and reduces the comprehensive teaching cost. In addition, for distance education, VR technology can realize the unified management of large-scale students and the learning content update, and further optimize the resource allocation and maintenance expenditure.

4.2. Challenges

Technical threshold and cost are the primary problems in the popularization of VR. Currently, VR devices are relatively expensive, especially high-end head-mounted displays and motion capture devices, which are a large expense for educational institutions. At the same time, the operation of VR technology requires high-performance computers and high-speed network support, especially in the multi-user real-time interaction scenario, these hardware requirements pose obstacles to schools with low equipment configuration and economically underdeveloped areas.

The cost of equipment maintenance and upgrading has also further raised the technical threshold, restricting the widespread popularization of VR education. Technical stability and security issues have put forward higher requirements for the application of VR in education. In a scenario of real-time interaction, the delay or lag of data transmission may seriously affect the user experience, and the existing network infrastructure does not guarantee efficient and stable connectivity in all regions.

The wide application of VR technology also involves the collection and storage of a large number of user data, such as learning behavior, voice recording, etc. Protecting these data from leakage and abuse is a security issue that necessitates attention. The lack of privacy protection mechanisms may lead to lower user trust, further limiting the promotion of technology.

User experience and health issues are also important obstacles in the application of VR education. Wearing VR devices for a long time may cause eye fatigue, dizziness, and sports disease symptoms, especially for teenagers and sensitive people. These discomforts may affect the learning effect and even cause health risks.

There is still room for improvement in terms of wearing comfort and adjustment to better adapt to the needs of users of different ages and body types, thus improving the overall user experience. The lack of teacher training and content development further limits the educational potential of VR technology.

As the core of teaching, teachers' skilled operation of VR equipment and teaching software directly determines the teaching effect. However, many teachers currently lack systematic training opportunities and are

unfamiliar with the design and implementation of VR teaching. In addition, the development of VR teaching content needs a lot of resources and technical support.

5. Conclusion

The introduction of VR technology is promoting the transformation of distance education from traditional passive learning to active and interactive learning modes. However, in the wide application of technology, challenges such as high equipment costs and difficult content development still need to be solved. In the future, with the further development of technology and policy support, VR technology is expected to become the core driving force of distance education, providing new solutions for global education equity and resource sharing.

Disclosure statement

The author declares no conflict of interest.

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