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Analysis of the advantages of applying VR to education

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Abstract. In 2021, the concept of Metaverse had become popular globally. VR, as the carrier and business form of the development of the Metaverse, entered the public's perspective; it has been widely applied in high-end technological fields such as new media, aerospace, and military so far. In the future, it will be widely applied as an advanced technological means in the field of education, promoting the digitization of teaching processes. Therefore, this paper analyzes the advantages of applying VR to education in order to enrich teaching methods and create a new educational model.

Keywords: Metaverse; digitization; education; VR.

1. Introduction

With the continuous advancement of digitalization and informatization, the Metaverse has also begun to enter the field of education. The Metaverse can bring new development resources to students. For example, virtual reality can help students achieve cross-border learning.

VR is the computing platform of the Metaverse, as well as an entrance and terminal to the Metaverse. It will become a very common product like mobile phones in the future. VR is to the Metaverse era as mobile phones are to the mobile The Internet Age.[1]

The emergence of VR has solved lots of deep-rooted teaching difficulties. Strengthening the application of virtual reality in education, in order to promote the upgrading of teaching model to autonomous experience, and create a new type of immersive classroom for teachers and students. Moreover, the application of VR in education coincides with the talent cultivation methods in the era of innovation. Virtual parallel spacetime developed by VR can offer multiple learning methods and virtual collaboration to students. Only touching the string of 'students' needs' can VR truly enter students' learning and life, thereby affecting and changing their styles of learning and life, bringing huge changes and excellent teaching effects to education.

2. VR Technical-Related Information

2.1 Conception

The concept of VR emerged as early as the mid-1950s, but it was only in its early stages and did not enter the masses. VR, as the name suggests, is a technology that connects virtual space with the real world. Using electronic devices such as computers to design and produce a realistic virtual world with various sensory experiences such as 3D vision, smell, and touch, thus creating an immersive feeling for people in the real world.

At present, VR can be divided into four categories based on the degree of immersion: desktop VR, immersive VR, distributed VR, and remote sensing VR. The desktop VR provides us with a low level of immersion, and students can only experience it on a flat 2D display, the other three systems can provide us with a high sense of immersion, but the cost and difficulty of development both are relatively high. High immersive VR systems are divided into two types: HMD (Helmet Mounted Display) and CAVE (cave automatic virtual environment), which are currently widely used and suitable for education.

2.2 Characteristics

VR has six characteristics: immersion, interaction, embodiment, intelligence, openness, and presence.1)Immersion, with the aid of HMD, learners can fully immerse themselves in the learning environment, experience the course without being limited by time and space;2) Interaction, providing students with a multi- sensory interaction experience, such as tactile feedback based on handles; 3) Embodiment, the experience that the virtual scene brings to students is concrete and vivid, which is connected with the special senses channel of the body;4)Intelligence, having the ability to perceive and directly sense the external world, utilizing existing knowledge to analyze, calculate and compare a series of actions without the guidance of anyone or machinery; 5)Openness, another manifestation of u-learning, students can access any learning content they need anytime and anywhere when entering a virtual teaching environment;6)Presence, providing students with an immersive feeling, VR creates a realistic environment for us, almost indistinguishable from the real world.

2.3 Comparison of different VR systems

This section briefly compares two immersive VR systems from six aspects: definition, cost, dizziness, immersion, user, and sphere, namely HMD and CAVE, which widely used and suitable for education currently. In the HMD, users can interact with the virtual system through the Head-mounted display; there are two HRI modes for HMD systems, namely CB mode (Controller Button, which controls the virtual environment through a game controller or mouse) and PA mode (Physical Action, which relies on physical movements of the upper limbs to drive the virtual environment). They have different application scenarios: CB mode is suitable for learning theoretical knowledge; PA mode is suitable for students' practice. The CAVE is a projection space formed based on multi-channel stereoscopic display and computer cluster synchronous computing rendering technology. Users can be completely surrounded by three-dimensional virtual environment. With data gloves, position trackers and other interactive devices, users can interact or operate with virtual objects, allowing users to obtain real feelings of vision, touch and hearing.

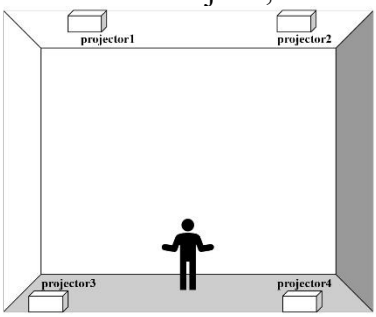

Fig. 1 Semi closed system

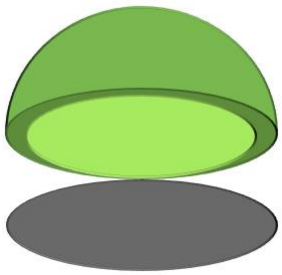

Fig. 2 Closed system

CAVE is divided into two types: closed and semi closed. Semi closed systems are usually composed of three to five rectangular screens, as shown in Fig.1; Closed systems are usually composed of six sided screens or semicircles, as shown in Fig.2. The stereoscopic image is projected onto the corresponding screen by a projector, and the user stands in the space, wears stereoscopic glasses, and can interact with the virtual system. The CAVE also includes equipment such as spatial position trackers and data helmets.

Table 1. Two Systems comparing

	HMD	CAVE
Cost	relative low	relative high
Immersion	low clarity	high clarity and strong stereoscopic effect
Dizziness	low	high
user	single user	single/multiple user(s)

sphere	not constrained	constrained

From Table 1, it is evident that there are differences between HMD and CAVE. Therefore, we should choose them based on specific teaching scenarios. Students or teachers use headsets to enter the virtual world, no longer constrained by time and space, that is, they can perform remote manipulation, saving unnecessary distance and time, and achieving anytime, anywhere interaction.

3. The Advantages of VR in Education

In the context of digital transformation of education, students' learning and teachers' teaching cannot be supported only by ordinary two-dimensional teaching, but also need to be supported by advanced learning resources and tools such as VR. Thus, it is necessary to use VR to carry out teaching activities. This section discusses the advantages of applying VR to education, considering concrete educational scenarios and the characteristics of VR.

3.1 Break the monotony of traditional classrooms and enhance students' interest in learning.

The traditional teaching mode is single, and students' cognitive abilities are limited and their attention is difficult to concentrate, resulting in some students' low interest in learning and greatly reducing the quality of teaching.

VR can create various teaching scenarios, and students can choose scenarios according to their needs; Meanwhile, virtual space can bring students a sense of immersive substitution, breaking the boredom of traditional classroom. On the one hand, VR has created a series of experiential courses for students, so that after entering the virtual space, students can fully immerse themselves in it, not easily distracted, and effectively solve the problem of students' lack of concentration in class; On the other hand, it can visualize the abstract concepts, presenting them in an intuitive form, which to some extent weakens students' aversion to knowledge.

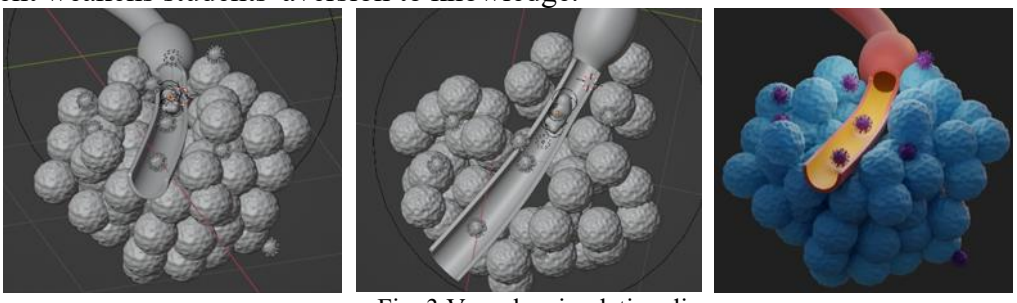

Fig. 3 Vascular simulation diagram

In biology courses, when learning vascular knowledge, students only statically learn it through pictures and videos; With the assistance of a virtual reality system, students can enter the learning system (as shown in Fig.3) and can quickly grasp this part of the content through personal experience, increasing their interest and passion for learning. They no longer rely solely on rote to learn knowledge.

3.2 Increase students' participation and overcome their communication fears.

The traditional model lacks interaction between teachers and students, and students have almost little time for independent thinking, thus their participation is extremely low. When learning language courses, many students are afraid to speak up and communicate with others due to face saving, which leads to low applicability of knowledge.

The VR interactive learning experience has the fun of online games, using realistic scenarios to attract students to participate in the classroom, stimulating their learning motivation and enthusiasm, and overcoming their communication fears. Creating a strong learning atmosphere and experiential learning experience for students, strengthening cooperation and communication between students, and changing the traditional cramming teaching mode.

For example, in the learning of language subjects such as English, it is important to create authentic language situations and immersive communication environments for students, enabling them to gain a rich and colorful language communication learning experience. Teachers can design targeted teaching tasks and knowledge links that are closely related to students' daily learning and life in the English language and cultural environment, based on the English teaching syllabus. By implementing teaching interaction in virtual simulation teaching scenarios, students can better immerse themselves in it, increase interest and motivation in English learning, and effectively improve English teaching efficiency and quality.[2]

3.3 Deepen students' understanding of knowledge and reduce teacher workload.

As the increasing of the learning difficulty and gradient, a lot of knowledge needs to be learned deeply. For some obscure knowledge, teachers often spend a lot of time explaining, and students also need time to understand, sometimes not achieving the desired results.

The teaching resources developed by VR will immerse students in realistic three-dimensional scene modes, and to some extent replace physical operations, allowing students to put their theoretical knowledge into practical operation, thereby improving their practical ability.[3] In the entire VR experience, students can instantly share real-time information, questions and interesting content with teachers and peers, stimulating sparks of thinking collision, and achieving a deep grasp of knowledge.[4] By learning in the VR system, students can relatively easily understand abstract knowledge and improve learning efficiency; Using VR devices repeatedly for learning can reduce teachers' workload.

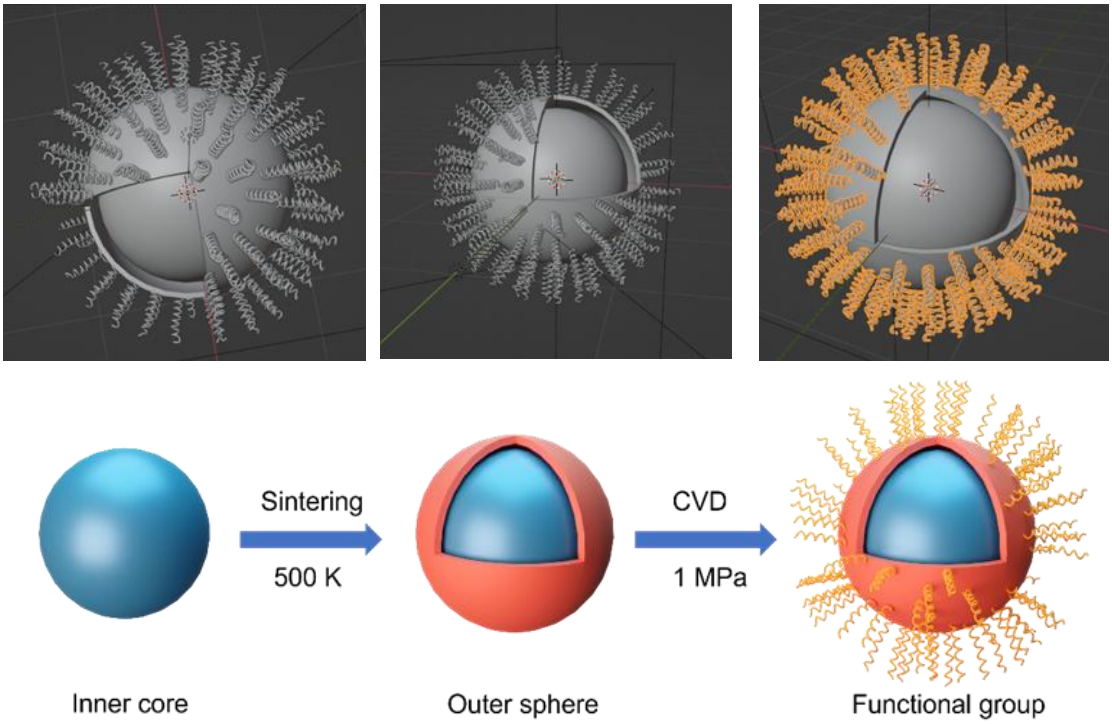

Fig. 4 Functional group simulation diagram

In organic chemistry, functional groups are responsible for the unique chemical reactions of a substance in organic chemistry. Therefore, using a virtual laboratory, students can fully understand and learn the structure of functional groups through mouse clicks (as shown in Fig.4), achieving a clear understanding of the internal structure of functional groups and facilitating subsequent learning of organic chemical reactions.

3.4 Cultivate students' high-order thinking and establish innovative awareness.

At present, the quality of cultivating innovative talents in various universities in China is still not high, and students' fixed thinking is severe, with a general lack of innovation awareness and

insufficient practical skills. In order to better adapt to the information society, schools should focus on cultivating students' higher-order thinking and helping them establish innovative awareness. The immersive learning method of VR fundamentally stimulates students' learning interest, cultivates their divergent and convergent thinking and provides rich experiential support for students' learning through background architecture, storyline arrangement, task setting, HRI, and in-depth exploration.

VR can allow students to experience scenarios that may be too dangerous, expensive, difficult, or impossible to experience in real life. Zero risk experience environment encourage them to dare to think, and cultivate their innovative thinking. Fully utilizing the advantages of VR to tap into learning potential has high application value for cultivating innovative talents. The cultivation of innovative talents involves various aspects such as teaching concepts, teaching methods, teaching content, and teaching conditions. Any one of these factors will have an impact on the cultivation effect of innovative talents. The application of VR can promote universities to change teaching concepts, change teaching methods, update teaching content, and enrich teaching platforms, creating good conditions for the cultivation of innovative talents.[5]

As shown in Fig.5, students enter the virtual experimental system, combine different molecules according to their own ideas, and observe the final experimental results through the VR system to explore new chemical substances.

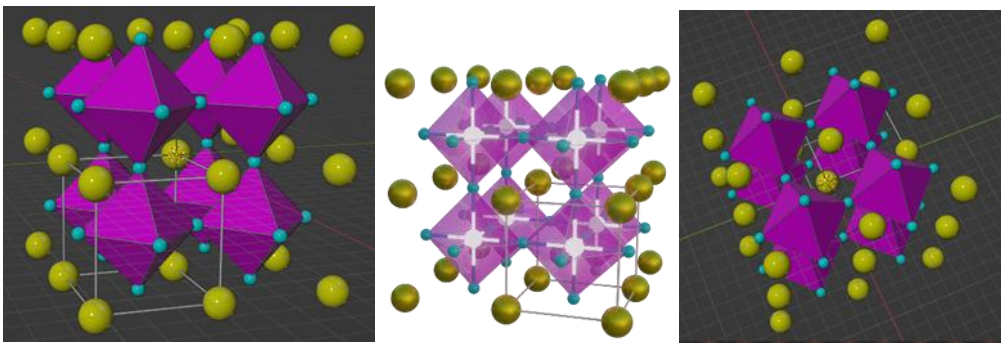

Fig.5 Molecular simulation diagram

3.5 Create an experiential classroom and enhance students' hands-on abilities.

At present, the training system for applied talents is single. First, the teaching content lags behind and teaching equipment is outdated; There is a serious disconnect between theory and practice. Practical classes can only be conducted by watching videos, and the teaching effect is not ideal. In addition, courses in biology, chemistry, and other disciplines have high experimental difficulty, high risk factors, and certain safety hazards. This results in most students having more theoretical skills, weaker practical abilities, and a lower sense of classroom experience.

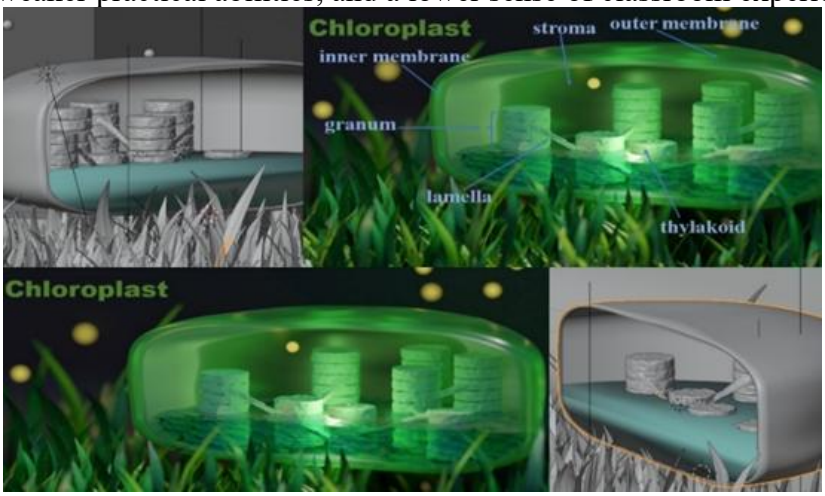

Fig.6 Chloroplast simulation diagram

As shown in Fig.6, in the experiment of "observing chloroplasts", students can enter a virtual system to observe the appearance and morphology of black algae chloroplasts under different

magnification of the microscope. By clicking with the mouse, they can learn and understand each part of the chloroplast in detail.

Through the above 5 points, we can conclude that VR has the characteristics of efficiency and practicality in education. Its emergence will further promote the transformation of education and teaching, bring students an immersive experience, attract students to actively learn and promote innovative breakthroughs, thereby improving teaching efficiency, promoting the development of students' learning ability and innovative thinking.

It's no doubt that VR has broad application prospects in education, especially in vocational education and higher general education. As the connection between campus and society, the two pay more attention to cultivating students' operation abilities; so widely apply virtual reality technology in teaching, which not only saves a lot of space and costs, but also enhances students' sense of experience. Overall, VR plays an immeasurable role in promoting students' learning and educational development, both in terms of technology and resource utilization.

With the rise of technology empowerment, the country has begun to focus on training students' information literacy and data processing ability. Highlight the use of information technology to solve problems in learning and daily life, and create an autonomous, cooperative, and exploratory learning environment for students, as well as a growth environment that integrates knowledge, emotion, intention, and action.

4. Conclusion and Future Work

The VR environment can achieve seamless integration between virtual and real environments, therefore it helps students to explore independently in a simulated environment and gain new cognition and experiences.

Through the analysis above, we can clearly know that VR has obvious advantages in promoting the development of education and teaching. The virtual simulation learning environment can create a happy and relaxed learning atmosphere for students, stimulate their curiosity and make them actively participate in the classroom, activating the classroom atmosphere; Meanwhile, it can also guide students to apply and transfer the knowledge they have learned, and promote the development of students' ability of autonomous learning and cooperative learning.

The rapid development of 5G, AI and other technologies has accelerated the development of VR, and society's awareness of VR has also significantly improved. Virtual reality has gradually integrated into our daily life, such as VR viewing, VR shopping, VR experience halls, and VR medical treatment; Moreover, VR has also brought new teaching models to education and the pattern of educational reform, alleviating the separation of teaching and learning.

At present, the application of virtual reality in education is limited to exploratory teaching work with strong research nature, and has not yet reached the level of popularization.

It is the trend of the situation that building classrooms and laboratories led by VR, which can strengthen students' abstract thinking and imagination, continuously meet the demand for talent in the digital age and promote educational reform further.

The education mode will switch between virtual and reality in the future, in order to better apply VR to education, we need to focus on solving the dizziness caused by head displays, and bring better experiences and scene effects for teachers' teaching and students' learning.

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