

Research and Analysis of VR in the Field of Education

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Abstract. VR education is still in the stage of development after a long time of experiments and tests. Many countries have launched VR classes successively, trying to make educational resources more comprehensive and equal, but VR requires an amount of device support, at the same time, the effect of VR input into education is uncertain. VR education needs a lot of time and data to determine the effect. This paper attempts to analyze the positive effects of VR in education. For example, in art education, VR eliminates the geographical restrictions on the dissemination of traditional art and culture shadow puppetry; in medical education, high-precision VR medical model enables medical students to have a more comprehensive understanding of medical knowledge; in game education, VR creates an appropriate educational environment for students to learn more immersive. By analyzing the role and development progress of VR, people can use VR technology to explore more possibilities and practicability in education, and bring more talents to the society by utilizing the advantages of VR.

Keywords: VR, education, art, medical, game.

1. Introduction

Through mid-1980s, the word “virtual reality” (VR) appeared in people’s lives and attracted worldwide attention after the film Ready Player One be on in 2018, VR brings more immersion and interaction than usual screen application and people try to explore more possibilities in VR’s function by developing kinds of simulation and immersive environment. VR began to use in military, games, art, especially in education [1], people are considering use VR technology in education, students can use VR simulate the environment what they can’t or hard to meet in usual life. In China, U.S.A, French, some schools or platforms try using VR education and compare with the same level student to check whether VR helps or not [2]. VR education can provide same education resource and chances, students can also save their time on their way to school especially the day meet with the snow weather. However, immature VR technology keeps VR education in the experimental stage. VR education needs more time, data, equipment and control experiments to support the result, VR software requires a lot of data and technology to make, it takes a lot of time to create, remove errors, and verify results, so VR education is still developing.

This research will pay more attention on three parts in VR education in order to analysis simply and completely the function of VR in art education, medical education and games education, and describe the possibilities of VR in the future of education, and the technologies and features that VR might improve or add, allow VR to reach a wider audience and increase the diversity of education methods so that VR and education complement each other.

2. The application of VR in art education

With the development of science and technology, VR technology has been widely used in art education. Art education has a strong humanistic atmosphere, integrating virtual reality technology, creating infinite possibilities for the popularization and innovation of art education. The contribution of VR technology can be seen in exhibition, music, and other fields.

2.1. VR and Exhibition

In terms of exhibition, in order to shift the audience from "viewing" classical art into "experiencing" it, Chinese museums have started to use virtual reality technology to interact with their collections during exhibitions.

Innovating museum exhibitions in China has become popular thanks to this combination of collection display and audience interaction. The interactive experience software of the VR shadow play "Tianji Horse Racing" has been created based on a mix of the living inheritance of intangible cultural heritage in the museum, the cultural environment of contemporary society, and the aesthetic psychology of the audience. This program is a shadow play display system that integrates virtual reality technology with shadow play art in a tangible and interactive way (Fig.1). It maintains the qualities of the shadow play itself while also satisfying the audience's aesthetic expectations. The realistic display mode of traditional shadow play art has been broken by VR technology, and the conventional performance form and communication channel of shadow play can no longer keep up with the pace of the times. It makes use of digital technology to create a virtual world, enhance its artistic expression and information carrying capabilities, and offer options for immersive involvement with shadow play art. The shadow play art is converted from the original two-dimensional plane display content to three-dimensional display content with the aid of 3D animation technology, allowing the experienter to interact with the multi-dimensional information environment, feel the shadow play world in all directions, and further improve the interactive effect of the shadow play art in general [3].



Fig 1. The inheritor of intangible cultural heritage is carving the cattle shadow [1]

Shadow play's venue and prop requirements are another hindrance to its development, however VR technology can fully make up for this flaw since it eliminates the montage lens transition form and gives the audience far more control over their visual choices (Fig.2). There is no physical location, yet pertinent performance scenes can be pulled up whenever and anywhere you like. Without physical props, player can closely comprehend and experience the subtleties of virtual props.



Fig 2. Screenshot of VR Shadow Play "Tianji Horse Race"[1]

In conclusion, instead of severing the connection between shadow play and its surroundings, the introduction of virtual objects and performance scenes reinforced it both in terms of time and space. In addition to recapturing and innovating the distinct artistic charm of traditional culture in museum exhibits, this virtual interactive experience mode also allows visitors to experience the influence and fission communication effect brought about by the fusion of new media technology and intangible cultural heritage [3].

2.2. VR and Music Education

In the case of music education, through the use of 3D simulation systems and immersive VR technology, music activities can engage with users both visually and aurally, providing a novel viewing format that allows learners to fully immerse themselves in the virtual environment.

Firstly, music education with VR technology is more experiential. Activities for teaching music online should make use of a variety of cognitive abilities, including voice memory, hearing, and visual processing. The instructional activities in the virtual environment can give students a virtual experience and allow them to combine interactional experience with music theory. The use of virtual scenes in VR games allows learners to deepen their understanding by allowing students to answer questions in VR games to review their music knowledge, this enhances their learning interest and participation [4].

Secondly, music education with VR technology is more flexible. VR technology is learner centered. For students, it can recreate any virtual setting in accordance with what they have studied. Because of this, students are not limited to the traditional music classroom and can choose the best time and location for their own learning. For instance, students desire to learn the Yellow River Cantata along the Yellow River in order to better grasp the music by experiencing the Yellow River's raging momentum. This is easily accomplished using VR technology by replicating the Yellow River scene. In this way, students can experience the Yellow River and comprehend the emotions depicted in this song without actually visiting the Yellow River (Fig.3).



Fig 3. Music Resources VR Production Seminar and "Music and Painting Fashion" Achievement Exhibition were held at Xinghai Conservatory of Music in China [5]

3. The application of VR in medical education

3.1. VR in Medical Practice Research

In these days, the discussion about the use of VR in medical education is becoming more and more popular. Over time, medical training and surgical experiments with VR virtual reality devices have also gained industry recognition. Through market researches, the education market for VR in medicine is expected to reach \$2.317 billion by 2026, with a 36 per cent rise in CAGR (Compound Annual Growth Rate).

For example, in the training of surgeons, it takes a considerable amount of time to train a qualified surgeon due to the cost and time required to observe live surgery (5 years from the start, 15 years is normal for the average surgeon) [6]. VR technology can solve the problem of observing surgery on a technical level, as doctors can use VR glasses to view HD VR footage of the surgery (Fig.4). In 2019, Taipei Medical University also had great success with VR medical. At that time, Taipei Medical University partnered with HTC to create a software for anatomy learning that uses VR to operate. It recorded more than 4,000 highly detailed 3D models of anatomy for doctors to learn and supported up to 300 online users [7]. As a result, it was later called "the world's largest VR anatomy course," and students at the university said the software helped them solve a lot of difficulties and will certainly help the development of medical education in the future.



Fig 4. VR medical training practice

Meanwhile, at Ohio State Medical University. They developed VR software using artificial intelligence technology. The software allows students to hone their practical and clinical skills by talking to virtual patients from around the world. The software has been well received by the school's medical students and has solved many practical training problems. With this software, it can be concluded that VR not only helps students save time, but also increases their opportunities to practice in their lives.

One survey showed that at Case Western Reserve University School of Medicine, 81% of students who had used VR technology said that the VR anatomy course was equal to or more interesting than a face-to-face anatomy course; 58% of students actually preferred a VR learning environment to a face-to-face classroom [8].

3.2. VR Provides Ideal Medical Environment

Compared to traditional medical education, VR technology can provide physicians with an ideal medical simulation environment anytime, anywhere. Doctors can interact with medical scenarios in an immersive manner and can observe surgical scenarios from multiple perspectives to better understand medical issues. And VR can allows doctors to earn the competency earn the competency in a non-threatening environment. As we know, performing a live VR surgery simulation does not create the risks associated with observing the surgery in the field, nor does it interfere with the real surgery while observing, what's more the doctor can also replay it for secondary learning if he or she does not learn it or master it.

3.3. VR Offers Additional Learning Opportunities

VR provides educational, efficient and effective training chances during the learning process and reduces the dependence of education on the time. VR also provides an easy opportunity to experience healthcare-specific situations without spending time waiting for rare cases to present themselves, providing opportunities for further learning and diagnostic training. VR provides unique opportunities for students or doctors to understand and transfer knowledge that benefits better understanding concepts, performance, and reduces errors. In conclusion, simulation education using VR is a promising opportunity for knowledge upgrading and sharing, which is very important and of great value for medical education.

4. The application of VR in games education

Educational Virtual Reality Games are emerging technologies that promote rapid changes in the field of education. These are gradually being used to provide highly interactive, attractive, and contextual learning experiences for more and more learners. It is increasingly used to improve the learning experiences of interaction, participatory and context for learners in other risk-prone settings.

4.1. Educational VR Game is More Efficient

Educational VR games are designed to help users master specific concepts, expand knowledge and promote the participation. The GridLockedED created by Tsoy et al. in 2019 is a good example [9]. This is a learning game to train medical students' operation ability. The purpose of the game is to let medical students learn how to treat and classify patients. Cutting-edge educational games usually use VR environments or high-end video technologies such as stereoscopic 3D [10]. All these technologies have provided users with the rich learning experience through using the spatial depth of the screen. Students passively acquire knowledge from teachers' lectures is a typical way of traditional education, which makes learning boring.

If students are not active and enthusiastic enough, they often cannot obtain good learning results, and it is difficult to better imagine the artistic conception and graphic space structure. Students can combine the interactivity and immersion of computers with VR education to commit themselves to the three-dimensional virtual environment built by computers. VR education enhances students' interest and imagination to perceive the environment through auditory, visual and behavioral interaction.

In traditional education, students are just an audience. Unlike traditional education, VR makes students become part of teaching practice and provides students with an immersive experience. Therefore, VR education is more participatory than traditional education.

4.2. Educational VR games Produce a Mental Flow Experience

The concept of mental flow is introduced here to explain the advantages of educational VR games. The initial concept of Mental Flow originated from the famous psychologist Csikszentmihalyi. He found that people were almost absorbed in the work when working and often filtering all irrelevant perceptions. And he also found that this kind of immersion came from the process of activities [11]. This mental flow experience generated by concentration is regarded as the best experience. The designer builds the mental flow model to further explain the immersive experience the game brings to the players. Therefore, the purpose of designing educational VR games is to involve learners in the path of flow experience as much as possible.

The experiential learning mode promoted by Kristian also advocates learners to involve in the simulated real environment as an independent individual. The experiment shows that learners have gradually become the core of the whole VR learning environment community from the original peripheral participation, and they had dealt with the virtual and real problems by VR technology [12]. Meanwhile, the theory is helpful for game designers to view the design and development of games from a coordinated and unified perspective. It is very important to developed the sensory and motor

system, the embodiment of the body and neural structure. It not only determines the game players for getting flexibly and fully experience and making subjectivity operation from the VR environment through virtual avatar, but also affects the user's cognition, knowledge acquisition motivation and the overall learning effect under VR environment [13].

4.3. Examples of Educational VR Games

This paper focuses on exploring the current educational VR. We summarize the previous research on educational VR and its related fields in the form of tables. Table I are the details.

Table 1. Related research on educational VR games

Review	Year of publication	Focus	Number of studies	Annual range of previous studies
Educational game applications and development prospects based on virtual reality and augmented reality	2017	VR and AR in education	54	2002-2017
Immersive VR serious game for education, training and research	2018	VR Serious Games for Evacuation Training	15	2007-2017
Literature review on their immersive VR in education: current situation and perspectives	2015	Advantage of using VR in education	93	2013-2014
Using VR in Education	2017	Review VR headsets	2	2012-2017

These are examples of VR educational games in steam in 2021: The Body: Cellular Journey is a VR experience game that brings players into the human body (Fig.5). Players can wander in the blood to understand how blood cells deliver oxygen throughout the body. They can also learn how organelles fight against deadly viruses by entering billions of living cells in our body [14]. Cosmic Sandbox creates with an unimaginable scale (Fig.6). This is a software that simulates the universe. It can simulate the interaction between gravity and climate of different planets at any time. Players can experience the mystery of the universe and the fragility of the earth in many ways. Titans of Space provides an in-depth trip into space through a realistic simulation of a miniature solar system. Every tour destination provides enough games to have fun. Nefertari: Journey to Eternity empowers people to explore Queen Nefertari's tomb in VR, getting closer to the ancient Egyptian queen and understanding the history and culture of ancient Egypt. Space Engine presents the first science-based, photo-realistic, interactive 3D planetarium in the world which simulates the entire known and unknown universe using process generation technology (Fig.7).



Fig 5. The Body: Cellular Journey

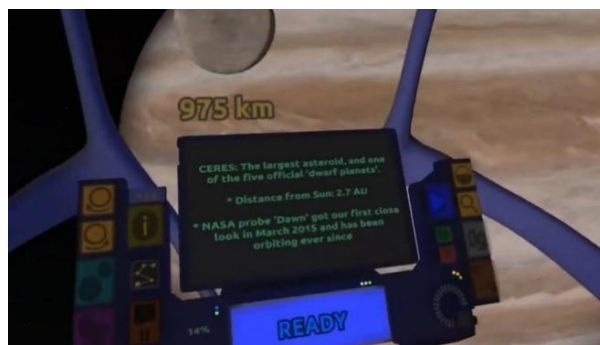


Fig 6. Cosmic Sandbox

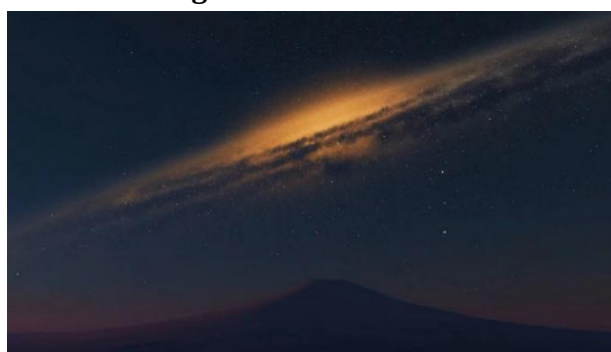


Fig 7. Space Engine

The development trend of educational VR games shows that the integration of VR and games enables students to better interact with the scene according to their subjective choices. VR has changed the previous unique form of education, making it possible to better education by stimulating students' curiosity and using their creativity. The VR enables students to acquire the ability to travel in space, dig deep under the sea, and travel through the past and present in the game. The intuitive acquisition of knowledge and information is only one advantage of VR education. VR simulates the real environment to allow students to engage in simulated operations, which has broad application prospects for some vocational education fields that are expensive or dangerous in actual operation.

Compared with practical teaching in high-risk real environment, VR may be a simpler, cheaper, safe and effective way to accumulate relevant knowledge [14]. VR educational games can be effective complements or alternatives to traditional pedagogies. It can be predicted that this technology will effectively support students' career development and enable students to simulate the skills required in the future workplace.

5. Conclusion

Above all, in order to provide and explore more possibilities in education, this essay provide art, medical, game three parts to let user know that VR technology can enhance the interest, diversity and equality of education, VR use in art education, through VR interaction, visitors can understand more about the meanings and significance of artworks, such as shadow puppet has displayed the views from 2d to 3d. VR use in medical education, anatomical learning software operated by VR allows medical students to observe and understand 3D models more comprehensively, this VR software increase students' clinical experience and knowledge. VR use in game education, games make education more interesting. Through virtual perspective to create a suitable learning environment, this environment mobilize students' learning initiative and enthusiasm. VR can provide more educational resources, but it needs hardware equipment and technical support. Users can experience the VR environment but only use the headset VR equipment.

In the future, VR equipment can be updated, become lighter and more flexible, and can move the perspective more freely and obtain clearer pictures. The use of VR in education enables students to obtain more high-quality educational resources, so that every students have access to get in touch of

the same courses or environment, and produce more high-quality talents for the society. The development of VR technology also requires more time and knowledge from researchers. With the development of science and technology, AR, MR and other technologies have also appeared in people's vision. Combining science and technology in daily life, in the future, VR hardware and technology may no longer be the problems, and people can get more and better quality of life through VR.

References

- [1] Wohlgenannt, I., Simons, A. Stieglitz, S. "Virtual Reality". *Bus Inf Syst Eng* 62, pp.455–461 2020.
- [2] Z. Cao, J. Zheng, F. Li, J. Xie, "Application of Virtual Technology in Cultivating College Students' Moral Personality", 2021 3rd International Conference on Machine Learning, Big Data and Business Intelligence, pp.557-560, 2021.
- [3] Zhang Q.. "Interactive expression and language transformation of virtual reality technology used by Chinese museums in exhibitions -- Taking the development and application of VR shadow game "Tianji Horse Race" as an example". *Chinese Museum*, (02), pp.121-126, 2020
- [4] Zhang L., Zeng Z.. "Application of immersive VR technology in music teaching". *Education Informatization Forum*, (04) pp.50-51, 2021.
- [5] <https://www.xhcom.edu.cn/info/1122/8316.htm>
- [6] <https://baijiahao.baidu.com/s?id=1594256593910455547&wfr=spider&for=pc>
- [7] <https://www.scnsoft.com/virtual-reality/healthcare/medical-education#challenge>
- [8] <https://www.itechart.com/blog/virtual-reality-in-medical-education/>
- [9] Tsoy, D., Sneath, P., Rempel, J., Huang, S., Bodnariuc, N., & Mercuri, M. "Creating GridlockED: A serious game for teaching about multipatient environments". *Academic Medicine.*, 94(1), pp.66–70, 2019.
- [10] Solomon Sunday Oyelere1. "Exploring the trends of educational virtual reality games: a systematic review of empirical studies". Oyelere et al. *Smart Learning Environments*, 7: 31, 2020.
- [11] Csikszentmihalyi M. Play and Intrinsic Rewards". *Journal of Humanistic Psychology*, 15(3), pp.41-63, 1975.
- [12] Y. Wang. "Research on the application of VR educational games in junior high school English teaching". Liaoning: Liaoning Normal University, 2020.
- [13] W. Gao, Y. Wang, Q. Wu, C. Wang. "The application and development prospect of educational games based on VR technology in English teaching". *Software*, 39 (05), pp.60-65, 2018.
- [14] Chioma Udezor, Ryo Toyoda, Fernando Russo Abegão and Jarka Glassey. "Perceptions of the use of virtual reality games for chemical engineering education and professional training". *Higher Education Pedagogies*, .6(1), pp.175-194. 5, 2021.