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Research Article

The Design Idea and Implementation Path of VR Teaching in the Perspective of Educational Metaverse

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Abstract
As an important development direction of the combination of education and metaverse, educational metaverse is gradually breaking the restrictions of time, geography and environment in the traditional teaching field. VR teaching, as an important way of expression in the educational metaverse, has a very important exploration and teaching application value. Based on the preliminary resource sorting, this study proposes the VR teaching design and activity organization based on the "Omission" software. Research shows that this innovative teaching method not only broadens the development space of lifelong education, but also brings new possibilities and directions for the development of education in the field of meta-universe.
Keywords: Educational Metaverse, VR Teaching, Virtual Learning Scene, Lifelong Education.

1. Introduction

Meta-universe (Metaverse) is a kind of digital world between virtual and reality, which can produce significant value beyond the real world. Meta-universe derived the game meta-universe, educational metaverse and other lower concepts. Among them, educational metaverse is based on VR/AR, blockchain technology, internet of things, motion control, gesture capture, and other technologies, through the construction of virtual learning scenes, virtual avatar, interactive action, etc., to achieve virtual teaching activities in literature, art, chemistry, physics, history, astronomy, sports and other disciplines. As an important element in the educational metaverse, VR teaching has a very important exploration and application value. VR teaching uses information and communication technology (ICT), which is an important means to realize the goal of educational paradigm transformation. The realization of gamified teaching method through virtual reality (VR) is of great significance for the innovation and transformation of conventional courses (Moral Sanchez *et al.,* 2022).

VR teaching is an important direction of future education development, but there are still some problems such as equipment iteration, fuzzy path and mixed content in its exploration and development. How to solve these problems, on the one hand, the research team first based on Scopus 100 international research literature analysis, found that the exploration of VR teaching is mainly reflected in three aspects: prominent teaching advantages, technical obstacles and implementation problems, and exploration of integration strategies. First, the teaching advantages are prominent. Parong and Mayer, by comparing immersive virtual reality (VR) with desktop slides in teaching scientific knowledge, found that VR can significantly improve students interest, motivation and engagement in learning (Parong and Mayer, 2018).

Swan and Giordano's research shows that VR allows students to feel the complex situations personally and enhance their understanding of abstract concepts (Swan and Giordano, 2023). Lorenzo et al. found that when the activities in the VR environment are interactive and authentic, they are more likely to be accepted by students with autism, providing a new way for special education (Lorenzo *et al.,* 2023). The cross-professional VR simulation learning environment created by others can promote the communication and cooperation between students of different majors (Buitron De La Vega *et al.,* 2022). Second, technical barriers and implementation difficulties. Hanson and Shelton noted that the main barriers to the application

of VR technology in education are the high cost of equipment and software and the complexity of the technology (Hanson and Shelton, 2008). Lamb and Firestone study found that some students who use VR equipment will cause dizziness and other uncomfortable symptoms, which will affect the learning effect (Lamb and Firestone, 2022). Lesch et al. believe that the long-term impact of VR teaching on learning outcomes is still unclear, and there is a lack of sufficient research to determine the best way to use it in different disciplines and learning stages (Lesch *et al.,* 2020).

Third, VR teaching integration strategy exploration. Xi emphasizes that the development of effective VR teaching strategies should closely combine VR with course content, and design appropriate VR teaching activities according to teaching objectives and students needs (Xi, 2024). Dai et al. found that the design and training duration of simulated VR teaching scenarios had an important impact on the teaching effect (Dai *et al.,* 2023). Lowell and Yan suggest that educators adopt a systematic thinking approach, comprehensively consider factors such as teaching content, teaching environment and students individual differences, to ensure that the design and implementation of VR teaching can meet students learning needs, promote students active participation and knowledge construction (Lowell and Yan, 2024).

On the other hand, based on the study of 52 CSSCI literature on "VR teaching", it is found that the current exploration of VR teaching in China is mainly reflected in three aspects: teaching mode innovation, teaching effect research and subject application expansion. First, the innovation of teaching mode: Jianying's research has found that VR technology has already been used to assist in art teaching in domestic educational institutions in China (Jianying, 2023). Pingping and Rong carried out an exploratory teaching experiment based on the virtual simulation interpretation training platform, and proposed the VR assisted interpretation teaching mode (Pingping and Rong, 2023). Lu et al. use VR to construct real teaching and enterprise scenarios to solve the problem of missing online teaching situation of business administration (Lu *et al.,* 2023). Yijun and Jing proposed the construction idea of constructing immersive situational interpretation teaching mode (Yijun and Jing, 2021).

Second, the research on the teaching effect: Jue-Qi et al. found that the scientific demonstration teaching integrating VR can better promote the junior high school students understanding of scientific concepts (Jue-Qi *et al.,* 2021). Xue et al. used meta-analysis method to conduct quantitative analysis of 38 experiments and quasi-experimental studies from the perspective of teaching design. The results showed that VR had a moderate positive impact on the overall learning effect (Xue *et al.,* 2019). The third is the application expansion of disciplines. The research of Baomin et al. shows that virtual reality teaching has a significant impact on students academic performance (Baomin *et al.,* 2019). Lingli et al. believe that VR, technology can avoid teaching risks and improve quality of teaching (Lingli *et al.,* 2022). Jie and Hongde found that VR can effectively improve scene-based cognition, solve the difficulties of scene recovery, and promote the development of scenario-based online education (Jie and Hongde, 2022). Haiyan et al. studied aerobics teaching and believe that VR technology optimizes the online teaching of physical education (Haiyan *et al.,* 2022). Jie applied augmented reality technology to swimming teaching, realized the enhancement effect of virtual reality through technology integration, improved the teaching experience, and provided a new direction for the combination of physical education teaching and VR technology (Jie, 2018).

Based on the existing research review, the current research affirms the special effect of VR teaching and its important contribution to interdisciplinary fields, and also points out the difficulties in the technology and implementation of VR teaching. In view of this, this research will start with the theoretical framework of teaching mode and teaching strategy, and on the basis of solving VR teaching hardware problems and software organization, implement educational activities based on virtual teaching scene, highlight the interdisciplinary theme, and realize the maximization of VR teaching effect.

2. Design Idea of VR Teaching

2.1. Exploration of VR Teaching Hardware Conditions

Having VR devices is an important hardware condition for entering the educational meta-universe, so the team explored the existing VR devices. VR equipment is divided into three situations. The first type is "mobile phone + VR carton", which takes the mobile Android platform as the main body, and then enters the universe with 3D technology and gravity induction through VR box, and the supporting software includes "accompany planet" and IQIYI VR; the second type is VR all-in-one machine. These devices mainly include the Pico all-in-one VR device under ByteDance, the Quest VR all-in-one device under Meta, and the Apple Vision Pro, performance and professional far more than the former; the third is PCVR type, Arpara, Microsofts VIVE, etc., the performance of the computer, requirements for at least GTX3060.

In the first case, VR glasses construct a virtual reality picture with the help of the left and right eyes; in the second case, take the Quest series VR all-in-one machine as an example. At present, to build a virtual learning scene, the basic conditions include: Qualcomm Snapdragon XR 2,120 HZ high brush frequency, 6G memory, 3D positioning function of audio output, gesture tracking, signal processing ability to support 5G frequency band. If the VR all-in-one equipment encounters insufficient performance, it can also connect to the PC terminal through series technology to realize the seamless connection of VR images. At present, the more mature wireless series technologies are: Pico Link, Air Link, Virtual Desktop and so on. In the third case, the PCVR end is relatively advanced. In this kind of VR equipment, the Arpara-adopts the ultra-short focus multi-lens return technology. As a rookie of PCVR, Pimax has reached 8K display resolution and 200° ultra-wide perspective in terms of picture presentation, which is close to the natural perspective of people. The VIVE has also reached 110°. Virtual reality system based on VIVE, with the help of the Steam VR-supported tracking system, spatial positioning tracking (ROOM-SCALE) capability, can give a better VR experience.

Based on the comparison of cost performance, portability and functional strength, VR all-in machine was selected as the basic equipment for research, mainly involving Pico 3, Pico 4, Pico4 Ultra, Quest 2, Quest 3, Quest 3S, etc.

2.2. Software Exploration of Virtual Teaching Scene

In virtual teaching scene software, after investigation, found based on Metas Oculus home platform and Pico store virtual reality education software currently has 55 education software, the construction of VR wisdom learning courses including medicine, geography, vocational skills training, astronomy, biology, foreign language, mathematics, music, psychology, tourism, educational education, physics, chemistry, neuroscience, fire, history, food, social. Based on the analysis of the software of the two platforms, it is not difficult to find that the disciplines involved in the software are mostly located in medicine, safety education, astronomy and tourism geography. In comparison, the number of astronomy and vocational skills training software is also large, because panoramic learning and simulated planets and void learning is very suitable for learning astronomical knowledge. The use of VR teaching in the field of vocational skills training can not only avoid the danger of operation, but also reduce the high equipment costs. The five major anatomical VR courses developed by VictoryXR can replace the school biological laboratory function. When teachers need to design the anatomy series, they need to guide learners into the immersive virtual reality experience. Learn the basic knowledge of the anatomy of canines, cats, frogs and other creatures. National Geographic (National Geographic Explore VR) is available to lead learners to visit the world with panoramic pictures. In this course design, teachers should consider which virtual scene we are in, and guide how to use the interactive props in the software, such as virtual digital cameras. In addition, the development degree of VR software in tourism geography, music and language learning is also high, which will not be repeated here.

However, the above software has some disadvantages, such as not having multiple participants, more program BUG, poor sociability, poor compatibility, single content (one software only corresponds to one course), weak operability, strong region, etc., which are not suitable for VR teaching tools. Two other virtual reality social software, such as VRCHAT, Omission, with their own virtual avatar (avatars) in virtual parallel world interaction, their particularity is to realize the universe under the background of education, social activities, and in the world of the universe, watching movies, class, playing games, tourism can be in the same space. After comparison, VRCHAT still dependent on network, too gamification, poor portability, and China Xiamen Omission Co., Ltd., developed by the Omission the software can play panoramic view, dynamic capture, implanted 3D modeling, computer screen to realize the construction of virtual learning scene, thus in the learning scene, realize the immersive teaching experience. It has the advantages of good compatibility and expansion, simple operation and easy login, which better avoids the problems of the above software in VR teaching. It is very suitable for becoming the main carrier of VR teaching, and can also provide independent communication and learning for learners virtual learning scenarios make use of.

2.3. Exploration of VR Teaching System

In the real class environment, the teaching environment of teachers and students is generally ordinary classroom, physics laboratory, music classroom, chemistry laboratory, etc., while in the virtual teaching scene of "Omission", teachers and students appear in the space with virtual image. Teachers and students can realize perceptual symbiosis in the virtual intelligent situation they live in, so as to help the experience learning in the meta-universe. The virtual intelligent situation constructed includes both the learning situation (picture form) and the stereopsis (GLB) in the environment. The simultaneous information flow between learners and teachers is realized. Learners cognition of learning scenarios and dynamic models will be fed back to teachers in time. According to the feedback, the teacher will reset the teaching scene and the

dynamic model in the next class to realize a dynamic combination process. In this dynamic learning process, digital resources are constantly accumulated, learners learning characteristics will be recorded by data, and teachers teaching process is also changing from time to time. The combination of knowledge presentation, scene performance, path optimization and intelligent analysis can realize the crossing of cognitive boundary, and then improve the learning efficiency.

The above exploration of the hardware conditions, software conditions and teaching system of VR teaching process helped the research team to finally determine the VR teaching form based on VR all-in-one machine, "Omission" software and virtual teaching system, which is of great benefit to the promotion of VR teaching.

3. Implementation Path of VR Teaching

3.1. VR Teaching Design

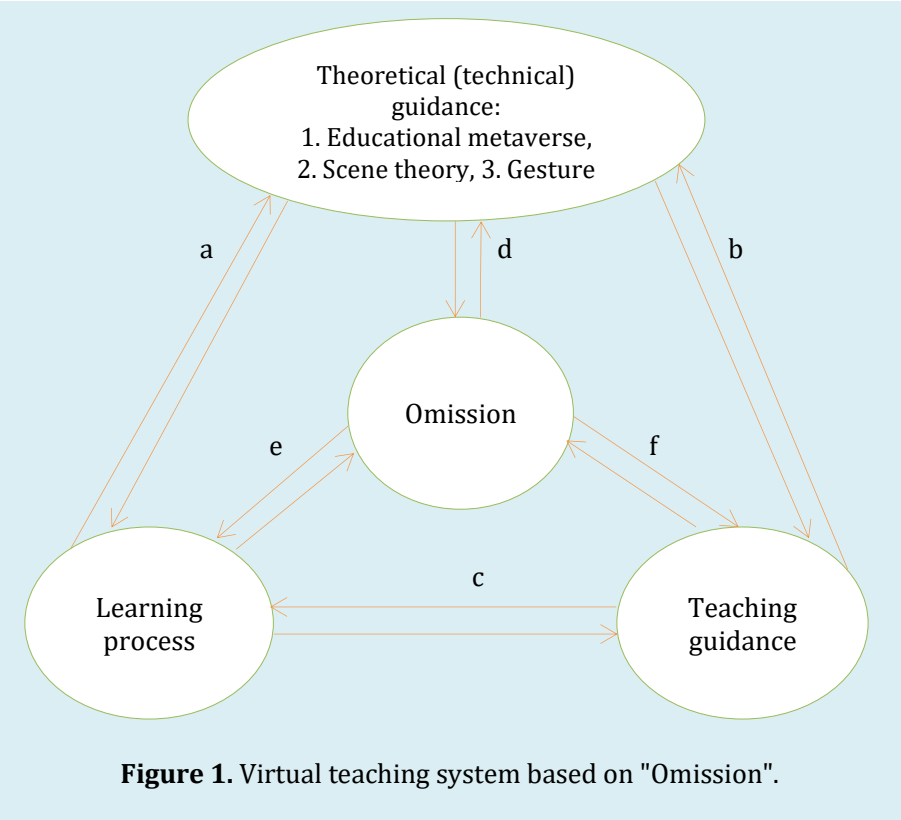

Figure 1. Virtual teaching system based on "Omission".

a: Theoretical introduction flow; b: Technical application flow; c: Teaching guidance flow; d: Space assurance flow; e: Space experience flow; f: Space design flow

3.1.1. Teaching Process Design

The education model based on VR creates a new type of teaching scene, and also creates a new way of learning. To this end, it is suggested to formulate a master plan for the construction of VR teaching application scenarios, and build a teaching theory of "theory + VR simulation + feedback" (Yan *et al.,* 2022) based on process theory. In the virtual teaching scene, learners only need the network and VR equipment, so that learners can enter the virtual space and interact with the virtual image of teachers. Because of the immersive experience, the realism of learning is greatly improved. The meta-universe greatly extends the digital learning space and forms a digital learning scene that integrates virtual and real learning, thus forming flexible and diverse teaching and learning methods (Song Yifang, 2022).

3.1.2. Virtualization and Avatar

Learners have virtual bodies, and teachers also have virtual bodies. This kind of teaching activities using virtualization will give learners a sense of psychological equality. Under the background of equal status between learners and teachers, learners can freely interact with teachers. Because the communication mechanism in immersive experience is not mature, we still need to use existing social tools to communicate, such as WeChat group and QQ group. In addition, the motion capture system can also be used to set up a virtual digital person to replace my image, or become a double body of the body. In the Omission, the image

of learners is distinguished by the body images of various colors. Body in the head, hand image, can accurately simulate the head movement, such as head up, head flat, head movement (instead of the body movement), with the help of the all-in-one VR handle can realize the precise simulation of hand movements-can achieve thumb, index finger bending, can realize fist, flat palm, pointing to hand movements. The virtual hands in the Omission can also emit a laser up to 300 meters, convenient for teachers to point out the scene to pay attention to.

3.1.3. Virtual Teaching Scene

In the virtual teaching scene, the original teaching PPT is replaced by the spatial panorama. In the learning space, learners can freely feel the knowledge points to be learned in the four directions, and can also feel the interaction of the teacher in close range through the means of hand holding and touch in the mold created with the teacher. Teachers, learners, virtual teaching scene and meta-universe technology are the key elements supporting the flow of teaching information in the background of educational meta-universe. Teachers lay a good foundation for the creation of a virtual classroom by learning the constantly updated meta-universe technology. According to the curriculum design, teachers make panoramic maps and 3D teaching tools for the virtual teaching scene, and such a virtual teaching scene provides almost infinite possibilities for teachers teaching design. Metaverse technology provides learners with a 3D interactive platform for learning and communication, so as to learn and encourage each other and make progress together in educational social networking. Of course, the shortcomings and shortcomings of virtual teaching scene in teaching can also be timely feedback to the developers of metaverse technology, so as to help metaverse technology more perfect.

At present, a series of metaverse courses such as "VR Mental Healing", "Metaverse Mental Theater", "VR Painting", and "VR Tourism" have emerged on the platform. These courses are based on the switching of 720° panoramic images, enabling immersive experiences in tourist attractions, art paintings, dreamlike environments, etc., and stimulating learners' learning potential and motivation. For example, in the "VR Meditation" course, the teacher led the students to visit the rings of Saturn, the Glass Church in Hainan, and abstract oil paintings. By learning in the virtual teaching scene, learners can experience the virtual teaching scenarios. At the same time, learners can also assist teachers in designing panoramic images and 3D teaching models. In addition, there are virtual intelligent scenarios including the Brazilian tropical rainforest, the Potala Palace in Tibet, medieval-style oil paintings, cinemas, etc. The 3D dynamic models that have been created (mostly completed with Google Drawings) include the Sydney Opera House, meditation classrooms, aerial platforms, and cartoon avatars.

3.2. VR Teaching Activities

Team to promote virtual teaching scene learners embodied cognitive effect as the main purpose, in Shanghai Chongming District Community College young and middle-aged teachers as the core staff, joint of Shanghai Normal University researcher, postdoctoral experts, “Xiamen White Technology Company” technical personnel, Elderly University wisdom scene construction personnel to form a project push team. Research team reference to the existing VR course resources and design ideas, with the help of Omission software (Omission), dynamic capture technology, GLB modeling technology, panoramic scanning technology, 5G or WIFI 6 transmission technology, etc., respectively, set up the Virtual “Tai Chi Teaching”, “Metaverse-inspired Fashion”, “Ecotourism” courses, each course in Omission has the only virtual room. Learners enter the corresponding virtual classroom (room) number in their "all-in-one", which can enter the learning space to participate in learning. On the basis of the construction of virtual classrooms in the early stage, the research group organized three series of teaching activities, namely "Taijiquan VR Teaching Activity", "Metaverse-inspired Fashion: Styling for a Wonderful Tour in Shanghai " and "World-class Ecological Island, Humanistic Walking".

3.2.1. VR Teaching Activities of Taijiquan

"Taijiquan Virtual Classroom" takes "Wudang Mountain in China" as the learning scene, on the basis of "Omission" display, with the help of "Three D Pose Tracker" whole-body dynamic capture technology, to build virtual digital people based on real-time capture data, which has been one of the important ways to realize VR teaching. In the VR teaching activities of Taijiquan for the elderly, Figure 1 shows the virtual teaching scene of the ancient Chinese palace, in which the red box area is the teaching area for teachers. Through the introduction of virtual digital people and whole-body motion capture technology, learners can see virtual digital people walking around themselves and perceive the order and rhythm of the movements of virtual digital people in the process of walking. Figure 2 shows the virtual digital people used. Every Tai Chi movement is clear and standard. Scholars interest in learning will be increased, the difficulty of imitation

will be reduced, and the movements of Taijiquan will naturally be more standard and smooth. This is conducive to breaking through the key movements in the traditional physical education teaching. The result of this teaching activity also confirms Tang Haiyan's experimental results, that is, virtual reality technology can optimize the diversified development of online physical education teaching.

Figure 2. Ancient Chinese palace: Virtual teaching scene (Note: the red box area is the teacher teaching area).

Figure 3. Virtual digital person (used for teachers).

3.2.2. Teaching Activity of "Metaverse-inspired Fashion: Styling for a Wonderful Tour in Magic Capital"
"Magic Capital" refers to Shanghai, China. This teaching project takes panoramic pictures of Magic City as the entry point and uses panoramic scanning software to draw relevant models. The virtual space of the course is code-named "cml". Teachers wearing Quest 2 can communicate with all parts of China (but also international learners) in the virtual teaching scene, and teachers can teach by switching between the panorama in the same room. In the virtual space, the corresponding content is also presented in the form of space PPT. By switching the panorama, the teacher made different changes in the "Oriental Pearl" (Figure 3) "Shanghai Bund", "Tavern" and other scenes. When adjusting different GLB models, different clothes should be introduced under different spaces. The teaching activity mode is conducted in a physical and cognitive way. Learners can realize the understanding of wearing knowledge by intuitive viewing and experiencing touch.

Figure 4. Virtual profile picture and virtual scene of Shanghai Oriental Pearl Tower.

3.2.3. "Walking in the World-Class Ecological Island: A Humanities Experience" Teaching Activity

In this activity, the code for the virtual classroom space in the "Omission" is set as "MetaVR". The world-class ecological island refers to Chongming District, Shanghai in China. This is because this area is located on Chongming Island, which is the third largest island in China. In this virtual classroom space with the code "MetaVR", panoramic views of "Chongming Confucian Temple", "Xisha National Wetland Park", "Dongtan Wetland Park", "The 10th China Flower Expo", "Lotus Expo Garden", "Exhibition Hall of the 10th China Flower Expo (Aerial View)", "Chongming Pearl Lake" and other places are set up. The teacher will invite the learners to put on the headsets and enter the code "MetaVR" of the virtual classroom in the blank space. After entering the space, the learners will participate in the study tour activity following the teacher's explanation. Every time the teacher explains a place on the world-class ecological island of Chongming District, Shanghai, the environmental scene where the learners are located will also change accordingly.

3.3. Feedback and Evaluation of VR Teaching Activities

Based on the teaching feedback of the Omission software, the research group implemented the relevant investigation and testing. This survey has collected 89 valid questionnaires for learners who have participated in VR teaching activities online in all over China, and a total of 89 valid questionnaires were collected. Among them, men accounted for 47.19% and women accounted for 52.81%; in terms of age distribution, respondents aged 20-29 had the highest proportion of 64.04%; most were 39.33% and 41.57% respectively; from the income range, the largest number of 10 0,000-15 0,000, accounting for 48.31%.

Table 1. Reliability analysis of variables related to VR teaching feedback.

Cronbach confidence analysis			
Name	**Correction total corcorrelation (CITC)**	**Item deleted α coefficient**	**Cronbach α coefficient**
VR teaching satisfaction	0.612	0.591	0.735
VR acceptance willingness	0.621	0.576	
VR teaching audience scope assessment	0.459	0.777	
Note: Standardized Cronbach α coefficient = 0.742			

Table 1 shows the reliability analysis of the variables related to VR teaching feedback, and the reliability coefficient value is 0.735, greater than 0.7, thus indicating that the reliability quality of the study data is good. For the "α coefficient that has been deleted", the reliability coefficient will not increase significantly after any item is deleted, so it means that the item should not be deleted. For the "CITC value", the CITC value of the analysis items is greater than 0.4, which indicates a good correlation between the analysis items and a good reliability level. In conclusion, the reliability coefficient value of the study data is higher than 0.7, which comprehensively indicates that the data reliability quality is high and can be used for further analysis. The average score of VR teaching satisfaction was 4.37, 62.92% of respondents were satisfied, and only 5.62% were dissatisfied. The average score of VR teaching willingness was 4.47 points, and 71.91% said that they were very willing to accept VR teaching. 19.1% indicated that their acceptance was average. As for whether VR teaching can be spread to a wider audience, the average score is 3.63 points, with a low score and relatively scattered views. 26.97% considered it very fit, 33.71% general, 25.84% unfit, 2.25% considered it impossible, and 11.24% uncertain. This reflects the need to further consider the characteristics and needs of different stages in VR teaching group application to improve applicability. This feedback survey was found to be tested personnel maintain good satisfaction with VR teaching and the willingness to continue to accept the course, but the audience scope of VR teaching is still narrow, for example, it is difficult to be promoted in the elderly group.

4. Conclusion and Suggestions

4.1. Conclusion

Virtual reality (VR) teaching, as a key way in the educational meta-universe, is committed to realizing the transformation of the educational paradigm, highlighting its flexibility and innovation. Compared with the traditional learning model, VR teaching breaks the constraints of time, distance and space, provides students with virtual scene simulation, and helps them develop long-term experience. Virtual courses based on "Omission" can effectively improve the enthusiasm and satisfaction of learners. In addition, virtual reality technology has been able to initially integrate the whole-body dynamic capture technology and virtual digital human technology, and its application in the field of education has attracted more and more attention from scholars. This will provide strong support for the construction of new scenarios and new paths of lifelong learning for citizens.

4.2. Suggestions

4.2.1. Strengthen the Efforts to Promote VR Equipment and Improve the "Omission" Teaching Software

VR all-in-one enterprises should increase their market share through various channels and methods, including reducing the cost of equipment, making it more accessible to the people, and improving the ease of use and comfort of equipment, so as to increase the opportunity for users to contact and use VR equipment. By adopting more economical materials and simplifying manufacturing processes, the price of equipment can be reduced, making the technology affordable to more people. In addition, Omission Limited should make the learners feel more natural and comfortable by optimizing the user interface design and reducing the difficulty of operation. These improvements will help expand the audience of VR technology and make more people willing to try and consistently use these devices, thus driving the entire virtual reality industry.

4.2.2. The Publicity and Demonstration Work of VR Teaching Should be Strengthened

Strengthen the publicity and demonstration work of the education universe to ensure the extensive application and in-depth development of VR teaching in the field of education. Through practical cases, it can show its significant advantages in improving teaching effect and optimizing learning experience, so as to improve the recognition and acceptance of educational meta-universe in the field of education. At the same time, through holding seminars, workshops and online courses and other forms, actively promote the concept and technology of the educational universe, so that more educators and students can understand and master this emerging technology.

4.2.3. Develop VR Teaching Strategies or Applications that are More Suitable for the Elderly Group

To better serve the elderly, efforts should be made to developing specialized VR teaching strategies and applications that need to be designed and optimized for the specific needs of the elderly. Considering the challenges that the elderly may face when using modern technology products, such as vision and hearing loss, and weak adaptability to new technologies, the development process should focus on how to simplify the operation interface and make it more intuitive and easy to understand. In addition, adding auxiliary functions such as voice guidance and interactive tutorials can help older users to master them more easily, thus reducing the barriers in the learning process. Through these customized VR teaching modes or scenarios, it is hoped to help the elderly group to more easily integrate into the digital learning environment and enjoy the convenience brought by technology. This will not only help promote equity in education, but also promote the wide application of technology, allowing the elderly to become active participants in the digital age.

Declarations

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