

Research on Online Learning Space Design Supported by VR/AR Technology

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Abstract: At present, online learning information is mainly presented in text, image and video, and information acquisition channels are mainly provided through visual and auditory channels. In order to facilitate online learners to obtain information through multiple channels, VR/AR technology is used to create virtual learning space, improve the information presentation mode of online learning, and give learners a kind of immersive multi-sensory stimulation to obtain information cognition. This paper integrates VR/AR technology into the design of online learning space. Based on the analysis of the research status of online learning space supported by VR/AR technology, combined with the research on the design practice of existing online learning space supported by VR/AR technology. This research analyzed the characteristics of online learning space supported by VR/AR technology, described the design function of online learning space supported by VR/AR technology, and put forward the content framework of online learning space design based on VR/AR technology support from the perspective of teachers and students.

The rapid development of the Internet and information technology has profoundly changed the traditional mode of education and teaching, laying a foundation for teachers and students to create online learning Spaces and carry out independent learning and interactive learning. Nowadays, online learning has become an indispensable way of learning for learners. As online learning space is the basis of online learning environment, the design of online learning space directly or indirectly affects the learning status of online learners. Therefore, with the rapid development of information technology, the online learning space that utilizes new technology to maximize the transformation and reconstruction of online environment and provides multi-channel sensory stimulation has become a current research hotspot. This paper introduces VR/AR technology into the design of online learning space, and studies how to organically integrate VR/AR technology with the existing online space design process, so as to improve the experience of online learners' immersive learning environment, so as to break through the current limitation of online learners' single sensory organ participating in learning, and realize the possibility of multiple sensory sensors sensing knowledge acquisition behavior.

VR (Virtual Reality) is the use of computer technology to generate visual, auditory, touch three senses of the integration of virtual environment, to achieve the combination of virtual and real technical means, users need to use some equipment for experience, giving people a close to the real

feeling. ^[1] Augmented Reality (AR) is the integration of virtual information formed by computers with real life, which is a supplement to the real world, allowing users to enhance their perception of reality in the sense of sight, hearing and touch. ^[2] Integrating VR/AR technology into online learning space can provide immersive online learning environment, bring different experience to learners, and effectively improve the quality of online teaching.

1. Research status of online learning space supported by VR/AR technology

1.1. VR/AR technology in the field of education application status analysis

In the era of education information technology, the development and application of VR/AR technology has gradually entered the field of education, and more and more organizations and enterprises use VR/AR technology to develop a variety of educational virtual software, which has quietly undergone profound changes in educational methods, models and content. In addition, the outline of the 14th Five-Year Plan lists virtual reality and augmented reality industry as key industries of the digital economy, and the Ministry of Education of our country will include VR/AR technology in the medium and long term educational information strategic planning. These measures and development paths promote the application of VR/AR technology in education.

At present, VR/AR technology has been used in many fields such as primary and secondary education, vocational education and higher education, providing online learners with immersive perceptual experience and further revolutionizing education and teaching. Since the outbreak of VR/AR market in 2016, many technology enterprises such as *VRschool*, *Kmax*, *VSVEC* have invested in the VR/AR education market, and developed a series of commercial teaching space products based on VR/AR technology support. VR/AR technology has been widely used in the field of education. On this basis, some qualified colleges and universities will introduce VR/AR technology into school education, infiltrating in the expansion of some learning environments, in order to create a more real scene experience.

The application of VR/AR technology in the field of education broadens the channel for online learners to perceive knowledge and deepens their understanding of learning content. With the help of VR/AR technology, schools have further changed the way of education and teaching, improved the teaching environment experience, and enhanced the learning participation of learners. Especially under the advocacy of lifelong learning, most learners are learning online. With the help of VR/AR technology and virtual simulation environment, they acquire information through multiple channels, not only from sight and hearing, but also from perception. For example, by using the virtual technology environment, some experiments can be conducted online, which can solve the experiment that cannot be carried out in reality for some reasons. ^[3]

1.2. Analysis of the research status of online learning space

At present, online learning space has become indispensable for learners, and the carrier of online learning space is mainly online teaching platform. In recent years, with the development of information technology, the function of online teaching platform has been further improved and perfected. Correspondingly, most learners have become regular users of online teaching platform, and have a greater dependence on the use of online learning platform. At present, the online learning space is rich in resources, learners can not only learn according to their own needs, but also choose the courses of famous teachers or choose the courses of their favorite teachers, so as to promote learners to learn more actively and improve the quality and efficiency of online learning.

In order to further understand the current research status of scholars on online teaching space, this paper selects the knowledge network database and searches the number of key journal

publications in recent ten years with the keyword "online learning space". The source categories of the retrieved journals were selected as core journals and CSSCI, the retrieved journals were screened, some irrelevant journals were excluded, and there were 90 remaining journals. The summarized journals were grouped according to the publication year, and a chart of the main achievements of the research on online learning space of scholars with short time was constructed from 2012 to 2021, as shown in Figure 1. As can be seen from the figure, the number of published papers from 2012 to 2016 decreased first and then increased, and then decreased again in 2017, and then showed an upward trend from 2018 to 2021, and the number of published papers of related journals reached a peak in 2021, indicating that the research on online learning space is still a hot topic at present.

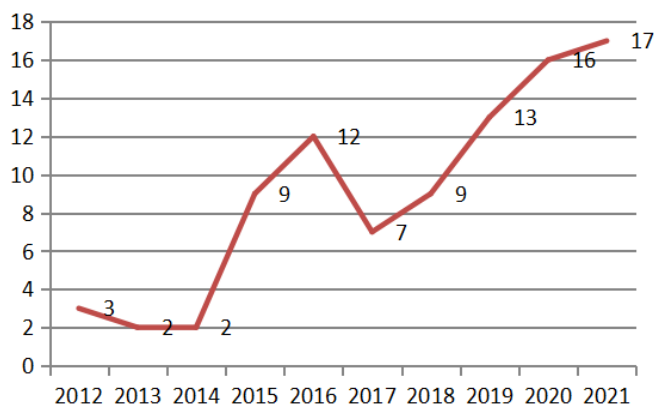


Figure 1: Trend chart of major achievements of scholars' research on online learning space during 2012-2021

Combing through the main research results of online learning space, it is found that scholars have explored the function and essence of online learning space from different perspectives and dimensions. For example, Yang Yuhui, Dong Rong, Zhang Zihui, Zhang Yuyan and Zhang Xue, five researchers from Zhejiang Province, use the three key elements of learning support service to expand the construction of online learning space from three dimensions: management, teaching and evaluation. ^[4] In the management dimension, the online learning space is integrated with the unified identity authentication, educational administration course selection and other support service systems to improve learning quality; In the teaching process, connecting online learning space with live broadcast platform, classroom interactive platform and social platform can not only teach in accordance with traditional teaching methods, but also enable learners to conduct independent learning and stimulate their learning interest; In the evaluation link, the online learning space is connected with the teaching supervision system, the supervisor can check the teacher's online process at any time, watch the teacher's teaching method, and conduct teaching evaluation on the teacher, the teacher can also evaluate the learner's learning through the online learning test, but also prevent the learner from cheating in the exam, and promote the better implementation of online teaching. Song Yifang, a researcher at Shanghai Open University, integrates online learning space into the community. It is an online learning system with an online learning platform as its core and an online learning environment based on Internet technology. ^[5] Using the method of case study, this research is carried out in three dimensions: network platform system, learning environment system and management service system. On this basis, some new thoughts are put forward, including further deepening, further upgrading and further expanding of online learning space. Based on the above researches, it is found that the current research content of online learning space mainly focuses on the exploration of the essence and function of online learning space subsystems such as management system, teaching system and evaluation system.

2. Feature analysis of online learning space with the support of VR/AR technology

As a new form of media, VR/AR technology has changed the way people get information and greatly affected people's lives. In the field of online education, the online learning space supported by VR technology, compared with the ordinary network learning environment, brings a different sense of experience to the learners. In order to explore the different experiences given to learners by the online learning space supported by VR technology, this study on the basis of analyzing the online learning space of "National intelligent education public service platform", it is believed that the virtual learning space supported by VR technology shows different special properties in terms of spatial structure, subject characteristics, functional performance and learning experience.

2.1. The scientific nature of space design

The scientific nature of online learning space design requires that the space design should conform to the objective reality of education and reflect the nature and internal laws of the process of online teaching and learning. The application of VR/AR technology to online learning space should uphold scientific principles, cannot be fabricated out of thin air, and the virtual object and space designed should conform to scientific theories. The application of VR technology in education is different from its application in games, movies and television, etc. In games and movies and television and other applications, some ethereal things can be constructed through people's imagination, but things designed in educational applications must maintain their authenticity to prevent misunderstandings of learners. They can observe things that cannot be seen with the naked eye in daily life in the virtual space supported by VR technology, and can also hear a variety of voices, which provides learners with a rich and diverse personalized learning environment in a way closer to life. It enables learners to enhance their perception of real life through the combination of sight, hearing and touch ^[6].

2.2. Conform to the characteristics of the subject

Due to the different degree of concrete and abstract content of the subject, the virtual space supported by VR/AR technology provides different sense of immersion. VR technology expands the experience for learners by constructing virtual things and learning environments, which can show objectively existing or non-real situations, and provide learners with a broad imagination space.^[7] These imaginary things and spaces present a relatively accurate existence in teaching, which cannot be randomly constructed. It should be consistent with the specific subject learning content, so as not to cause the wrong imagination of learners. In science and engineering and operational disciplines, there are a lot of content is more suitable for the use of VR/AR technology, such as some dangerous or must use expensive instruments to carry out the experiment or operation, you can use VR/AR technology to complete. However, the contents of some liberal arts subjects are relatively abstract, such as some abstract concepts and reasoning caused by concepts, which cannot be restored by building virtual things, which also adds difficulty to the design of the content. Therefore, virtual learning space Settings supported by VR/AR technology should conform to the characteristics of different subject content.

2.3. Learning as the main function performance

Compared with traditional teaching forms such as online live broadcast, virtual space under VR/AR technology supports learning-based teaching process. The ordinary online teaching process basically uses the platform's live broadcast or recorded video to let learners learn. Most of them

continue the traditional teaching method, focusing on the teacher. A long time will make learners tired and lack the spirit of active exploration, and teachers and learners have classes across the screen without face-to-face emotional communication. In this way, learners will have a sense of distance. The online spatial learning supported by VR/AR technology is not only transforming two-dimensional content into three-dimensional form, but also organically connecting virtual space and real teaching space to design a learning form based on self-study from the perspective of students, and at the same time create a good learning environment, so that learners can easily integrate into learning [8].

2.4. Immersive learning experience

Use VR/AR technology to support online learning space to provide learners with a near-real online learning environment in which learners are highly engaged and interactive, in order to achieve the experience of online immersive learning. In the ordinary online live learning, the learning of learners is relatively boring, and there is no good learning atmosphere, and there is no emotional experience of face-to-face communication with teachers. Teaching activities can only be communicated online through voice or message. In the design of online learning space supported by VR/AR technology, the use of virtual reality technology functions to leave a space for learners to create, so that learners can participate in, to give learners an opportunity to participate in the experience independently, to explore and virtual creation. Of course, teachers can also appear in the three-dimensional virtual space in the form of avatars and perceive each other with learners [9]. In this immersive learning environment, learners can not only apply the theoretical knowledge they usually learn into practice, but also check whether their learning is solid through the experiment process and experiment results. Teachers can also determine the operation level of students by observing their independent experiments. In general, the online learning space supported by VR/AR technology provides learners with a close to the real online learning environment, and brings different learning experience to learners.

3. Functional representation of online learning space supported by VR/AR technology

The online learning space serves to complete specific teaching objectives. The purpose of using VR technology in the teaching process is to make learners understand complex and difficult problems more clearly. Therefore, the representation of the function of VR technology space cannot be separated from the key elements of the teaching process. This study considers the key elements of online teaching process, combined with the core issues to be considered in the design of online learning space [10], and believes that the function of learning space supported by VR technology is presented from the key links of online teaching subject, spatial structure, learning content design and teaching practice.

3.1. Transformation of learning-oriented role

Compared with the traditional teaching, the learning subject in the online learning space supported by VR/AR technology has been transformed. The traditional online teaching method is mainly lecture-style, that is, the teacher talks and the student listens, and the teacher plays a dominant role in it. The online learning space supported by VR/AR technology has gradually changed the traditional way of teaching and learning. In the online learning space supported by VR technology, the learning process is mostly carried out in the way of student-oriented and teacher-assisted. Therefore, when applying VR technology to present the functions of online learning space, students should be considered as the main role, and teachers should distinguish between teaching

and learning, and pay more attention to "how to better help students learn effectively".^[11] In virtual space learning, students are allowed to study independently, explore independently and experiment independently. Teachers can guide students when they encounter difficulties and urge them to better complete their learning goals.

3.2. Diversified spatial structure

The structure of online learning space based on VR/AR technology should be diverse and clear, able to adapt to current and future teaching and learning, and can be easily reconfigured.^[12] As online learning space is the most important exclusive territory of students' online learning at present, the structure of online learning space should integrate VR/AR technology and should be student-oriented, pay attention to students' personalized learning needs, and build a diversified interactive space structure. The diversified learning space built based on VR technology can realize knowledge sharing and enrich the learning experience of learners, so as to make up for the shortcomings of previous teaching methods, mobilize the enthusiasm and initiative of students, cultivate their independent learning ability and independent exploration ability, and create a good online learning environment.

3.3. Suspense teaching content design

In the online learning space supported by VR/AR technology, in order to improve students' independent learning ability, the suspense design of teaching content is essential. In the teaching process, in order to attract students' attention, teachers often raise questions before learning related content and run the questions through the whole class to guide students to quickly enter the learning state and then achieve the learning goal. This process is called suspense design. The suspense design of teaching content can not only fully mobilize students' learning initiative, but also consolidate and deepen the ideological nature of teaching content. Therefore, when using VR/AR technology for online teaching, teachers can set the teaching content in suspense, stimulate students' curiosity, and make students actively explore and operate in the virtual space. In the process of problem solving, with the purpose of obtaining the answer to the question, understanding and learning the teaching content, in order to improve the quality of classroom teaching.

3.4. Real-time interaction and collaboration

Interaction is the two-way flow of teaching information between teaching subjects, and interaction and cooperation are essential information transmission methods in the teaching process. The real-time interaction and cooperation of online learning space supported by VR/AR technology should realize multi-dimensional interaction methods such as human-computer interaction, teacher-student interaction and student-student interaction. Based on the consideration of this function, the design of online learning space supported by VR technology should consider the construction of a student in the process of learning automatically record and analyze the learning situation of students, teachers can put forward problems and monitor students through real-time observation, and students discuss and exchange their ideas with each other. The system can form an online collaborative team for the same learning goal between students, give play to their respective abilities, and work together to complete certain learning tasks.^[13] In addition, teachers and students of this system can also discuss and communicate with each other online, and students can ask teachers for help, and teachers can provide targeted guidance to students as assistants, so as to improve learners' learning motivation, learning ability and level through communication and interaction^[14].

4. Feature analysis of online learning space with the support of VR/AR technology

VR/AR as can create and experience the virtual world emerging technology, the technology applied to education will bring different learning experience to teaching. It shapes the traditional paper media into a more abundant multi-modal space-time system, bringing learners psychological immersion experience from visual, auditory, tactile and other sensory channels, making learners feel like being in the scene [15]. Combined with the basic teaching theories and the practical experience of online learning space, the design of VR/AR technology-supported learning space is divided into online teacher space design and online student space design, and each space design corresponds to the corresponding content design, as shown in Figure 2.

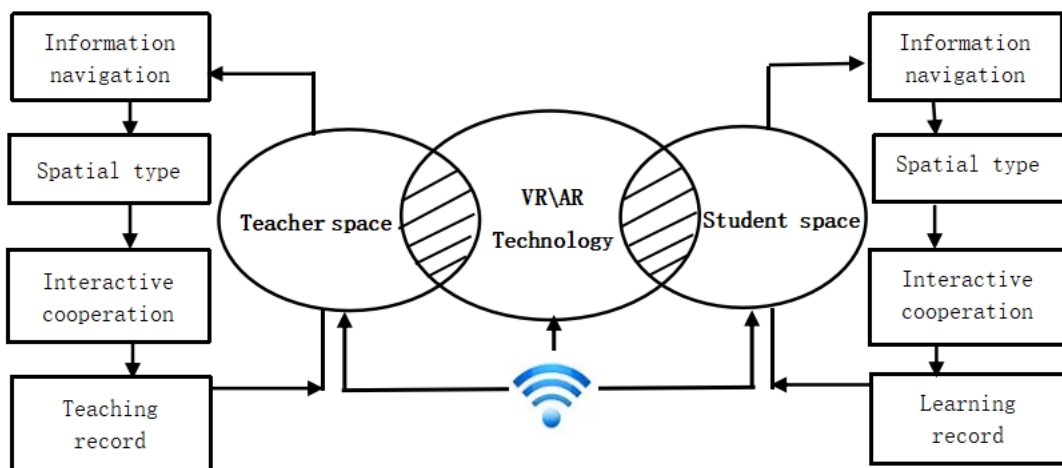


Figure 2: Design of online learning space supported by VR/AR technology

4.1. Student space design

The purpose of setting learning space is to better meet the needs of students in different learning styles, different learning contents and different learning goals, promote students' learning and help students actively construct new knowledge. Therefore, the student space based on VR/AR technology is designed into four parts, which are information navigation, space type, interaction and cooperation and learning record.

The first one is information navigation. Information navigation is not only a kind of information service concept, but also a kind of information service technology and method. The function of information navigation design is to help students understand the space they are in and guide the space they will go to. When students enter a strange learning space and do not know how to operate it, they can start the information navigation. Under the guidance of the navigation, students can quickly enter the space they need, saving time and improving learning efficiency.

The second one is space type. Online learning space based on VR/AR technology is a virtual space, which can be set into three links, namely learning content, experimental operation and feedback. In the learning content of this link, you can set the students are currently learning the course and the video of the teacher lectures, students can choose their favorite content according to their own style and hobbies. In the part of experiment operation, experiments related to learning content are set up, and when students conduct experiments in virtual space, they can also have access to experiments that cannot be carried out in daily life due to danger or expensive equipment, which stimulates students' curiosity and deepens students' memory of VR/AR knowledge. Learning feedback is an indispensable part of effective learning. Students can express their summarized learning content, suggestions or questions in this part after completing the content learning or

experimental operation, which lays a foundation for better learning in the future.

Besides, interaction and collaboration are also indispensable in online learning based on VR/AR technology. The application of advanced interactive media and rich interactive tools and interactive organizational forms is conducive to the establishment of a learning community. At the same time, the collision of thinking between teachers and students, and between students and students, also helps students to think about problems from multiple perspectives. Therefore, after the completion of each stage of learning, students can exchange their own experiences in this space, learn from each other, learn from each other, for their own problems that cannot be solved, they can also seek the help of other study partners or teachers, solidarity and cooperation to solve together.

The last one is learning records. Compared with traditional teaching, online learning is more casual, and teachers are unable to pay attention to students' learning situation all the time. Therefore, the purpose of setting learning records is to record students' learning, observe whether students conscientiously attend class or do experiments, whether they timely complete the tasks assigned by teachers, and urge students to develop good learning habits.

4.2. Teacher space design

Teacher space is a special digital working platform for teachers. Teachers use the space to strengthen the development and arrangement of teaching resources and optimize the teaching process. The teacher space corresponds to the student space one by one, including information navigation, space type, interaction and cooperation, and teaching record.

The first one is information navigation. Teachers can design the information navigation content according to their own teaching needs and students' needs, so as to facilitate students to quickly enter the required space, prevent learners from deviating and wasting time in the learning process, accelerate the teaching progress, improve teachers' teaching efficiency and students' learning quality.

Secondly, teachers can design and manage the space types. In the learning content, teachers set relevant teaching content according to the teaching objectives to ensure that students complete the learning content in the corresponding time. In the part of experiment operation, teachers can design and manage their experiments, and point out the problems in the process of students' operation in time, so that students' experiment operation is more standardized. In the feedback link, teachers can check the problems summarized and raised by students, understand the learning situation of students, guide students to solve problems, and the suggestions put forward by students can be modified appropriately to meet the learning needs of students.

Interaction and collaboration is the stage requirement of the current development of online education, and it is also the intrinsic requirement of course development. Its main purpose is to promote the discussion and communication between teachers and students, students and students. In the process of teacher-student interaction, teachers should play a guiding role, and at the same time communicate with students, answer students' learning problems or help them overcome difficulties; In the process of student-student interaction, teachers should play a guiding role to ensure that the topics discussed and exchanged between students conform to the teaching content, so as to achieve meaningful interaction and collaboration.

Lastly, when teaching, teachers can not only check their own teaching progress and other relevant records, but check the learning situation of students at any time, and analyze the time rule of students' learning, the correct degree of experimental operation, and the enthusiasm to participate in learning activities. Teaching records can help teachers find problems, provide basis for timely teaching intervention, and provide reference for subsequent teaching adjustment and optimization.

5. Conclusion

With the continuous development of VR/AR technology, perhaps in the near future, VR/AR devices will be as popular in the field of education as computers, and will be widely used in teaching. ^[16]This research is the application of VR/AR technology to online learning space, the application of VR/AR technology in the field of education and online learning space in the past ten years were studied. Based on the analysis of the research status of online learning space supported by VR/AR technology, combined with the research on the design practice of the existing online learning space supported by VR/AR technology, the characteristics of the online learning space supported by VR/AR technology are analyzed, and the functional presentation of the design of online learning space supported by VR/AR technology is described. And from the perspective of teacher and student space, this research put forward the content framework of online learning space design based on VR/AR technology support. It is hoped that it can provide some reference for the improvement of the research and teaching quality of online learning space.

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