
The Formation, Development and Research Prospect of Educational Metaverse

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Abstract: The normalization of the epidemic has accelerated the digitization process of human society, and the education sector has actively deployed new infrastructure for education. During the epidemic, major schools responded to the call “suspending classes without suspending learning”, and have started the online teaching mode. While online education provides students with rich learning resources, it also gradually exposes many problems, such as the blocking of social interaction and emotional communication between teachers and students, and students sometimes feel lonely or even tired of learning, which affects students’ learning satisfaction and learning effect. How to use advanced information technology to further improve online learners’ learning satisfaction and learning effect has attracted more and more attention from researchers. With the maturity of metaverse-related technologies, the educational metaverse came into being. The educational metaverse, also known as the learning metaverse, can be simply understood as the aggregation of cloud education, that is, the application of the metaverse in the field of education. The educational metaverse is regarded as the next generation of new education mode, which will open the prelude to a new era of education. Based on the theme of educational metaverse, this paper combs and analyzes the relevant literature on the educational metaverse, and divides the educational metaverse into three aspects, namely, related technology, education and teaching, and library exhibition. It discusses the origin and connotation, relevant theoretical basis, formation process and development process, and understands the research status of the educational metaverse. Based on the above, this paper summarizes the existing educational metaverse literature, and draws the following conclusions: (1) The research on the educational metaverse is still in its infancy, mainly focusing on three aspects: related technology, education and teaching, and library; (2) The educational metaverse is called an epoch-making new education mode, which helps to meet the needs of lifelong education and personalized education, thus providing a powerful boost to the construction of a learning society. (3) Future research will pay more attention to research at a more macro and micro level. At the same time, this paper also puts forward the problems and challenges that China’s educational metaverse may face, namely, data security and privacy protection, social ethics and morality, addiction and information literacy.

Keywords: Educational Metaverse, Online Education, Lifelong Learning

1. Introduction

In recent years, with the COVID-19 pandemic sweeping the world, traditional education systems in various countries have been hit to varying degrees, and online education has seen an opportunity for development. With the normalization of the COVID-19 pandemic, online education has become an important part of today’s education and teaching forms. Relying on Internet technology, online education breaks the

limits of time and space. Compared with the traditional offline teaching mode where teachers and students interact face to face, online education can provide students with rich learning resources. At the same time, online education has gradually exposed many problems. For example, the social interaction and emotional communication between teachers and students are blocked, and learners sometimes have a sense of loneliness, even weariness of learning, thus affecting learners’ learning satisfaction and learning effect. The metaverse based on digital technology can be applied to the field of education

through wearable devices, brain-computer interfaces, etc., which can realize the deep integration of the virtual and the real, greatly enhance learners' sense of participation, further meet students' personalized needs, and promote students' comprehensive development.

2. Development Overview

2.1. The Origin of the Metaverse

The word “metaverse” first appeared in the book *Snow Crash* written by Neal Stephenson, an American science fiction novelist, in 1992. The book describes that in the virtual digital world generated by the new generation of the Internet, that is, the metaverse, people in the real world can communicate with each other through the form of virtual avatars. Since then, the metaverse has been imagined in many literary and film works, such as the classic movies *The Matrix*, *Ready Player One* and so on. Semantically deconstruct the English word metaverse, where “meta” means “transcendence”, and the root word “verse” means “universe”.

The business and media circles call 2021 the first year of the metaverse, “metaverse” has become a hot word on the Internet and entered the public's vision. The landmark event that exploded the industry was the successful listing of “Roblox” on the New York Stock Exchange on March 10, 2021. The game platform uses 3D and VR technologies to allow users to freely design content and conduct interactive activities. On October 28, 2021, Mark Zuckerberg, CEO of Facebook, announced that the company's name was officially renamed “meta” and vigorously entered the metaverse. Since then, the Internet giants have successively deployed the metaverse business.

2.2. The Connotation and Characteristics of the Metaverse

At present, the research on the metaverse is still in the exploratory stage, and there is still no unified definition of the concept of the metaverse. Wikipedia describes the metaverse as a three-dimensional virtual space that can connect human perception and realize sharing. With the increasing popularity of the metaverse in recent years, its concept has attracted more and more attention from the academic community. From the perspective of communication, Yu Guoming and Geng Xiaomeng believed that the metaverse is the ultimate digital media, which integrates all current and future digital technologies into one. It will realize the revolution of connecting the real world and the virtual world, and then become a new world of higher dimensions beyond the real world [1]. From the perspective of information technology development, Fang Lingzhi and Shen Huangnan believed that the metaverse is the ultimate product of Internet development and an inevitable trend in the development of social informatization and virtualization. The driving force behind its emergence and evolution is the transfer of the functional center of the Internet from information to people. And in the artificial virtual world of the metaverse, people use digital avatars to communicate with each other and interact with the world, forming virtual communities based on this [2].

Lee proposed that there are three stages in the development of the metaverse, that is, digital twin, digital native, and co-existence of physical-virtual reality. In comparison with the real world and cyberspace, the metaverse has the following characteristics: (1) Technology integration. The metaverse involves 5G and 6G technologies that can perform high-speed wireless transmission, the Internet of Things technology that connects the virtual world with the real world, and cloud computing, fog computing, and edge computing technologies that can provide powerful computing power to process data [3]. The metaverse cannot be realized by a single technology, but by taking the network communication technology and algorithm technology as its infrastructure, including the rational application of various software and hardware technologies, so that the metaverse can be realized; (2) Highly immersive. With the help of VR, AR and MR technologies, metaverse realizes the unification of vision, hearing, touch and even smell in the virtual and real world through wearable devices, brain-computer interfaces, and device identification and judgment technologies, providing users with a highly immersive experience [3]; (3) New economic system. The metaverse can form a new digital economy based on blockchain technology, where new digital assets exist in the form of NFT or NFR, and digital identity provides a new economic model for the production and consumption of digital assets [4]; (4) The integration of virtuality and reality. The digital virtual body and virtual embodiment have greatly enriched and developed the self-world of human beings [5]. Digital avatars enable people in the real world to carry out production and entertainment activities in the metaverse, forming a new social civilization system.

2.3. The Rise of the Concept of Educational Metaverse

In the field of education, the metaverse is considered as a new form of online education model development, which will open the prelude to a new era of education. The educational metaverse, also known as the learning metaverse, can be simply understood as the collection of cloud education, namely the application of the metaverse in the field of education. Hua Zixun and Huang Muxiong proposed that the educational metaverse is the application of the metaverse in the field of education. It creates digital identities for teachers, students, administrators and other stakeholders, opens up formal and informal teaching places in the virtual world, and allows teachers and students to interact in the virtual teaching places [6]. Liu Geping *et al.* constructed the online learning environment of the educational metaverse from the aspects of the technical architecture, system structure, constituent elements and training objectives of the metaverse, and proposed that the educational metaverse will enter the innovative development stage of experiential learning and immersive interaction, and become the innovation singularity of the transformation and upgrading of online education [7]. Li Haifeng and Wang Wei believed that the educational metaverse is to build a smart learning space with resource ecology, social interaction, inquiry learning, and evaluation system as the core, form a learning model that integrates virtual reality and

cross-border exploration, and finally realize a future education form in which the educational metaverse and interstellar civilization coexist with the physical world as the core [8].

To sum up, the educational metaverse is based on advanced information technology means such as VR, AR, MR, 5G, 6G, artificial intelligence, blockchain, Internet of things, digital twin, etc., to build an immersive teaching and learning environment in which virtual reality and reality coexist. Teachers, students, administrators, platform providers, and other direct participants or content organizers of teaching activities can freely enter the field of teaching in the form of digital avatars to create, carry out and participate in teaching activities, and promote communication and interaction between teachers and students. It maps the teaching activities in the real world to the virtual world of the educational metaverse, realizes the sharing of educational resources across time and space, and finally realizes the integration of virtual and real life in the field of education.

3. Theoretical Foundations

3.1. Constructivism Learning Theory

In the 1990s, Constructivism learning theory was listed as the three major learning theories, along with behaviorist learning theory and cognitive learning theory. Constructivism originated from the theory of children's cognitive development proposed by psychologist Piaget, which advocates that individuals continuously assimilate and adapt to the surrounding environment on the basis of congenital genetic diagrams, thereby gradually constructing their own knowledge system (Figure 1). Among them, assimilation is the accumulation of individual knowledge about the outside world, while adaptation is the qualitative leap of individual cognitive structure. Constructivism learning theory holds that the process of continuous learning is the process of learners' active construction of knowledge systems, which should give full play to learners' subjective initiative and be student-centered. In the learning process of constructivism, teachers should guide and help students to learn, and create learning situations for students, so that students can acquire knowledge by meaning construction through communication and cooperation with others in certain learning situations. Therefore, constructivism learning theory can be used to guide the instructional design supported by the metaverse, and map the real scenes in real life to the educational metaverse. It can also be used to stimulate learners' learning motivation, using the existing knowledge system to complete the learning task, so as to transform knowledge into ability.

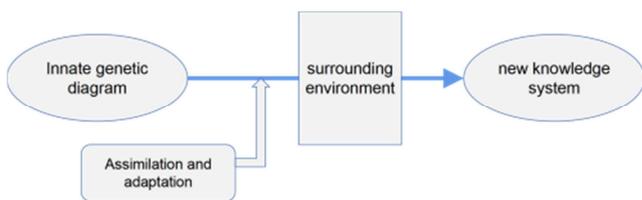


Figure 1. Constructivism Learning Theory.

3.2. Flow Theory

Immersion theory is also known as flow theory. This theory was first proposed by Csikszentmihalyi (1975), mainly used in the field of psychology. Immersion theory refers to that when people are engaged in certain activities in daily production and life, they are fully immersed in the situation, and their attention is highly concentrated. They are not affected by other factors such as the external environment, and completely filter out all irrelevant feelings. It describes the psychological state of people entering immersion [9]. In the early research on immersion theory, "challenge" and "skill" are considered as the main factors affecting immersion. Some scholars have found that when the challenge faced by people is higher than the skills possessed by individuals, they will experience anxiety and restlessness. On the contrary, an experience of relaxation and boredom occurs; An experience of immersion occurs only when the level of both the challenge one faces and the skill the individual possesses is high, and the experience of indifference results when both are low (Figure 2) [10]. With the rapid development of information technology, immersion theory has begun to be used in the field of human-computer interaction. At present, some studies have begun to focus on the immersion of learners in educational games. According to the research of Yang Wenyang et al., the sense of immersion of learners in educational games is manifested as their instantaneous attention to games, exploration consciousness, and expectation of obtaining higher academic performance [11]. In a word, immersion theory can be used to explain the immersion state of learners when they participate in formal or informal teaching activities, and can provide a theoretical basis for the goal setting, project design, and teaching implementation of education and teaching activities in the field of the educational metaverse, so as to improve learners' learning motivation and interest.

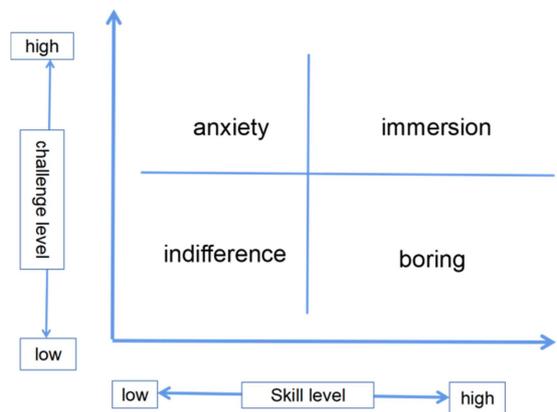


Figure 2. A four-interval model of immersion theory.

4. The Formation and Development of Educational Metaverse

4.1. The Formation of Educational Metaverse

Before the emergence of the educational metaverse, due to

the outbreak of the epidemic, major schools responded to the call “suspending classes without suspending learning”, and started online teaching mode. At the same time, the sense of social presence and immersion have become important concepts in online learning academic research. Compared with the traditional face-to-face offline teaching mode, the sense of social presence and immersion of teachers and students in the online classes presented in the form of text is lower. Social presence and immersion are important factors affecting the effect of online learning. Therefore, more and more scholars are studying the influencing factors, measurement methods, effects and strategies for enhancing social presence and immersion. With the development of metaverse-related technologies, metaverse has begun to be applied in the field of education, bringing teachers and students a highly immersive experience from the perspective of technology.

At present, the metaverse is trying to be applied to the field of education. For example, in China, due to the epidemic, graduates cannot gather together to participate in the graduation ceremony. In order to draw a satisfactory end to the students’ college careers, Communication University of China rebuilt a virtual campus in the sandbox game “Minecraft” to carry out the graduation ceremony, and students were invited to participate in the game image. In South Korea, Seoul University has successfully built a virtual library that is identical to the real world library, so as to continuously provide services for students; Soongsil University uses the “Gather Town” platform to carry out campus celebrations; At the 29th academic conference of cardiovascular and thoracic surgery in Asia, Seoul University Hospital in Korea shared real-time AR / VR surgery. In the United States, Professor Bailenson of Stanford University in the United States has opened a metaverse course called “VirtualPeople”, where students can wear VR headsets to enter classrooms for learning remotely. Based on the application of the metaverse in the field of education, researchers put forward the concept of educational metaverse and conducted research on it.

In the post-epidemic era, human society has accelerated its march toward the digital era. In the field of education, it is proposed to do a good job in the new infrastructure of education, and the educational metaverse emerges as the times require. Before 2021, there is little research literature related to the educational metaverse. Since 2021, the academic community has paid more and more attention to the research in the field of the educational metaverse, and the research on the educational metaverse is still in its infancy.

4.2. The Development of Educational Metaverse

Current research on the educational metaverse mainly focuses on the following dimensions: relevance technology, education and teaching, and library exhibition.

4.2.1. Research on Related Technology

First of all, as far as the educational metaverse is concerned, it is self-evident that the relevance technology is

important for the construction of the education field in the context of the metaverse. Regarding the division of the field structure of the educational metaverse, different researchers have put forward different hierarchical divisions. Based on the methodology of cognition, Liu Zihan proposed that the infrastructure of the metaverse should be divided into five layers: physical layer, software layer, data layer, rule layer and application layer [12]. Hua Zixun and Huang Muxiong continuously improved and integrated the field structure of the educational metaverse, and proposed to divide it into four layers: physical layer, software layer, application layer and analysis layer [6]. At present, the correlation technology of the metaverse itself is still in continuous optimization and evolution. For example, Zhang Yanli *et al.* compared the correlation and difference of the two technologies from the perspective of digital twin and holographic technology, so as to explore the evolution of the future place, content, evaluation and teacher-student interaction, and explored the learning landscape under the integration of the two technologies [13]. Cheslack postava *et al.* believed that the existing metaverse platform makes the virtual world visible to users with distance limitations and poor user experience. Therefore, on the premise of not sacrificing performance, the sirikata metaverse server is designed, which allows users to view the whole world, with strong visibility and interactivity [14]. According to the comprehensive analysis, it is found that the researchers mainly explored the related technologies of the educational metaverse from the perspectives of field construction, technology integration and server construction, and actively promoted the development and maturity of the key technologies of the educational metaverse.

4.2.2. Research on Education and Teaching

In the context of the metaverse, the application of new technologies in the field of education requires new teaching models to match it. Lu Lili and Xu Xin believed that the development of virtual reality interaction technology will gradually blur the boundaries between virtual reality and reality, online and offline. Therefore, taking the curatorial course in the cloud exhibition hall of East China Normal University as a case, a chaotic teaching model is proposed, which presents the “natural” concept of the metaverse, and breaks the boundary of the oppositional relationship between teaching and learning, teachers and students [15]. Chen angxuan and Jia Jiyong discussed from a macro perspective that the educational metaverse allows teaching designers to freely design the teaching environment and change the scene of the traditional offline teaching mode. From the microcosmic point of view, they also discussed that learners’ access to knowledge in the educational metaverse is more diversified, which greatly promotes learners’ ability to communicate, interact, and collaborate [16]. In addition, the knowledge transfer mechanism under the metaverse field will also change. Based on the traditional virtual education knowledge transfer mechanism, Guo Yajun *et al.* constructed the education knowledge transfer mechanism under the metaverse field. After the educators and resource builders

establish the knowledge source as a whole, the learners choose the scene to internalize the knowledge, then go to the decentralized knowledge innovation, sharing and storage, and finally return to the total social knowledge to form a closed loop [17]. Yao zhanlei and Xu Xin believed that the construction mode of knowledge in the metaverse is the deep integration of scenarios, so as to reconstruct the knowledge resources, that is, knowledge contextualization. And they outlined the construction path of situational knowledge, that is, teaching demand identification, teaching resource integration, situational knowledge modeling, and finally teaching scheme design [18]. In the empirical study of the educational metaverse, researchers actively explore ways to improve the quality of education based on the teaching practice of the metaverse in the field of education. Hu Chenyang and Yu Changli took Metaverse foreign language teaching in South Korean universities as an example, and concluded that the metaverse is effective in foreign language teaching. Specifically speaking, the metaverse can improve the interaction between teachers and students, increase students' interest in learning, become more student-centered, and achieve remarkable results in foreign language education [19]. Barry et al. introduced the avatar blink system in the metaverse class. By recording the blink times of the virtual avatar, it can effectively analyze the learners' reaction to the class and evaluate the learning effect [20]. Tang Yuxi and He Weiguang introduced the experience of Georgia State University's metaverse education, including the adaptive platform to promote classroom teaching, the use of an intelligent enrollment assistant to help students with accurate enrollment, and the use of an intelligent management system to help students with academic guidance and academic alerts [21]. The comprehensive analysis found that the researchers mainly explored the educational metaverse in the aspects of education and teaching from the perspectives of teaching mode, teaching method, teaching environment, knowledge construction and so on, and actively promoted the sustainable development of education.

4.2.3. Research on Library Exhibition

The library has a certain educational significance to the visitors through exhibitions and conveys specific information. In the study of libraries in the context of the metaverse, Li Hongchen et al. explored the relationship between "people, fields and things" in the metaverse library based on the perspective of immersion theory, from passively receiving services to receiving services and actively participating in construction coexist, thereby enhancing the user's immersion, and they also proposed an architectural model of the metaverse library [22]. Guo Yajun et al. analyzed the application of the metaverse in American university libraries from the perspective of empirical research, and proposed that libraries can use virtual simulation technology to optimize reference services, pay attention to space construction, facilitate resource acquisition and improve teaching experience [23]. Choi and Kim proposed to connect the beacon in the exhibition hall to the head-mounted display

device, and deploy the exhibition content of the metaverse exhibition hall, so that users can better understand the exhibition content and enrich the experience [24]. From the perspective of service mode, Li Mo proposed that the metaverse service of the library has been improved. Users can enjoy an immersive service experience, experience the intelligent learning space integrating time and space, create information resources, realize three-dimensional social interaction, and enjoy multi-cultural scenes [25]. The comprehensive analysis found that researchers mainly explored the educational metaverse in library exhibitions from the perspectives of information service, information consultation, information creation, and information transmission, and actively promoted the development of smart libraries.

5. Discussion and Suggestions

Nowadays, we are in an era of great changes in information technology, coupled with the normalization of the epidemic, so we should actively carry out scientific and technological innovation to empower education development and improve quality. With the maturation of metaverse-related technologies, the metaverse will be widely used in the field of education in the near future. By combing the relevant literature, it can be found that the research on the educational metaverse is still in its infancy, mainly focusing on three aspects: related technology, education and teaching, and library exhibitions. Online learning has provided us with many conveniences for lifelong learning. However, researchers should actively explore the new educational model of metaverse applied to the field of education, guide practice with theory, and explore new teaching theories, teaching principles, teaching methods, teaching design, etc. in the metaverse, so as to improve learners' interest in learning, actively absorb knowledge and skills, and ultimately transform them into abilities. We should establish the concept of lifelong learning, and then build a learning society.

The educational metaverse is known as an epoch-making new model of education, which helps to meet the needs of lifelong education and personalized education, thus providing a powerful boost to the construction of a learning society. However, the rapidly developing new technology will also face many problems and challenges that need to be solved. At present, China's metaverse education mainly faces the following problems and challenges.

At the national level, it mainly faces supporting technical issues, data security and privacy protection issues. First of all, with the rapid development of information technology in recent years, data security and privacy protection issues have emerged one after another, which has attracted widespread attention from countries around the world. In essence, the educational metaverse is an educational field constructed by the ultimate Internet form. The collection and analysis of massive data is the basis. The data information and personal privacy information involved in it are larger than those of the traditional Internet. Therefore, in the educational metaverse,

the protection of personal privacy and data security of teachers, students and other relevant personnel, the formulation of data collection restrictions and the introduction of corresponding laws and regulations should be put on the agenda. Secondly, at present, the educational metaverse is still facing the problem of a lack of unified standards and protocols for the connection between the underlying supporting technologies of different ecosystems. The educational metaverse is a huge and complex system, and its operation requires the support of data systems, computing power systems, communication base stations and other related technologies. The interconnectivity and intercommunication between each metaverse subsystem and the educational metaverse also require a matching standard protocol, so as to ensure the formation and perfection of the educational metaverse ecosystem.

From a social perspective, it mainly faces moral and ethical issues. In the field of the educational metaverse, teachers, learners, managers, etc. enter the metaverse in the form of digital human and virtual avatars to teach or learn knowledge and skills. In the educational metaverse, people can share massive educational resources, and people can directly interact with knowledge content. With the help of the powerful technical means of the metaverse, people in the society formed by the metaverse can try identities, careers, lives, etc. that cannot be realized in real life by using the image of virtual humans, so as to open a second life. On the one hand, it is necessary to establish a social order based on the actual situation of the educational metaverse, and form a set of social moral and ethical norms. Whether it is cyberspace or the metaverse, it has never been a place outside the law. On the other hand, machine intelligence can reflect the progress of science and technology, but education cannot ignore the subjective initiative of people and rely too much on digital people. Technology serves human beings and cannot replace human life.

From the personal level, it mainly faces addiction and information literacy problems. First of all, with regard to the Internet, the government has set up the youth mode on all major software platforms, aiming to prevent teenagers from being addicted to the Internet. So compared with the Internet, for a more scenario-oriented and more immersive educational metaverse, how to prevent teenagers from indulging in it, or how to prevent individuals in the real world from indulging in the virtual world for a long time, which affects their physical and mental health, is one of the problems facing the educational metaverse. Secondly, teachers, learners and platform managers are also facing the requirement of improving their own information literacy. Nowadays, in the digital era, science and technology are changing with each passing day. Educators should change their thinking, actively understand and adapt to the knowledge and technology related to the educational metaverse, improve their own information literacy, and actively explore the teaching design, teaching methods and so on that match the educational metaverse. Learners should also improve their information literacy, strive to adapt to the new education mode, find suitable learning methods, and make joint efforts to promote the modernization

of education.

6. Conclusion

At present, the research on the educational metaverse is still in its infancy, and the relevant research is not sufficient at home and abroad. With the maturity of metaverse-related technologies, the educational metaverse is regarded as a new type of education mode for the next generation, and has attracted more and more academic researchers' attention. Compared with foreign research, the research related to the educational metaverse in our country is mainly qualitative research, focusing on technical architecture, application scenarios, etc., while the relevant quantitative research is less or the sample size is insufficient, resulting in insufficient research. In addition, there is very little more macro-level research on digital divide, education governance, ethics, and micro-level research on teachers and learners themselves. Therefore, with the deep integration of the application of metaverse technology and educational practice, the future research on educational metaverse will pay more attention to the classroom reaction of teachers and learners, the influencing factors of learners' satisfaction, the strategic research of education governance, and the reconstruction of education ecology. In short, the metaverse cannot replace the real world, and the future will be a symbiotic world where the virtual and the real converge. The educational metaverse is just an educational tool, which will help form a new education ecology in the future, but will not change the essence of education. We should seize the development opportunities of the educational metaverse, respond to problems and challenges, and layout the educational metaverse in advance.

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