

Vocational Education Metaverse: Research Status, Existing Problems, and Development Strategies

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Abstract: The digital strategic action has promoted the high-quality development of vocational education. As an important measure for the digital transformation of vocational education, the application and development of educational metaverse are related to the deep transformation of vocational education and the overall development of smart education. This study first reviews the current research status of the educational metaverse in vocational education from the aspects of technological development, application status, and implementation effects. Secondly, it points out the current practical problems in vocational education metaverse from the perspectives of infrastructure, technical standards system, practical training teaching model, and ethical risks. Finally, it proposes targeted improvements from the following four aspects: first, improve the infrastructure of vocational education metaverse; second, accelerate the establishment of technical standards for vocational education metaverse; explore teaching models and systems of vocational education metaverse; fourth, effectively prevent ethical risks of vocational education metaverse.

Keywords: Vocational Education Metaverse; Infrastructure; Technical Standards; Teaching Methods; Ethical Risks.

1. Introduction

Since the 18th National Congress of the Communist Party of China, our country has issued a number of relevant policies on the digitalization of vocational education, actively promoting the strategic action of vocational education digitalization, and injecting new vitality into the high-quality development of vocational education. For example, the "National Vocational Education Reform Implementation Plan" (20 articles on vocational education) proposes to adapt to the development needs of "Internet + vocational education", use modern information technology to improve teaching methods, promote the construction and widespread application of virtual factories and other online learning spaces. In July 2021, the "Guiding Opinions of the Ministry of Education and other six departments on Promoting the Construction of New Types of Education Infrastructure and Building a High-quality Education Support System" emphasized fully leveraging the advantages of new technologies such as 5G, artificial intelligence, cloud computing, and big data, strengthening the deep application of information technology, resources, and tools in education, and injecting new momentum into the transformation and upgrading of education. In September 2021, the Ministry of Education issued the "Guidelines for the Construction of Exemplary Virtual Simulation Training Bases for Vocational Education", which specifies the construction of exemplary virtual simulation training bases for vocational education to integrate teaching, practical training, training, scientific research, competitions, and popular science, and serve as comprehensive training bases, virtual simulation training teaching resources, school-enterprise collaborative development platforms, virtual simulation training technology achievement exhibition and application promotion platforms, solving the pain points and difficulties of high investment, high loss, high risk, as well as difficulties in implementation, observation, and reproduction in practical training and teaching. In 2022, the Ministry of Industry and Information Technology and other five ministries jointly

issued the "Action Plan for the Integration and Development of Virtual Reality and Industry Applications", which explicitly stated the need to strengthen the organic integration of virtual reality and education and training scenarios, promote "Virtual Simulation Experiment Teaching 2.0", and accelerate the training of scarce talents.

The digitalization of vocational education is both a general trend and an urgent task. In this context, the education metaverse has become a hot topic and focus of discussion. Scholars of the active school believe that as the third technological revolution on the Internet, the metaverse has inevitably entered the field of education and will have a significant impact on future education, promoting deep changes in education. For example, the education field is the main application field of the metaverse[1]. educational metaverse is a new form of Internet education[2], "metaverse + education" requires integrated innovation[3], and the theoretical embryonic form of China's characteristic education metaverse[4]. Scholars of the conservative school believe that the application of metaverse technology should not be trendy but should start from educational and teaching issues, discuss issues related to digital technology application, and emphasize digital risks and ethical concerns caused by the metaverse. For example, the issues of "orphans" and "brains in bowls" in the metaverse, and the meaning of "body" in educational metaverse [5]. Therefore, the judgment on educational metaverse has not been determined.

For the digital transformation of vocational education, it is necessary to answer the following questions: (1) What is the vocational education metaverse? What is the current research status? (2) What are the practical problems of the vocational education metaverse? (3) How to propose targeted development strategies for vocational education metaverse? Based on these questions, this study first reviews the current research status of vocational education metaverse from three aspects: technological development, application status, and implementation effects. Secondly, it puts forward the practical problems of the vocational education metaverse from the perspectives of infrastructure, technical standards

system, practical training and teaching models, and ethical risks. Finally, it proposes targeted improvement strategies from the following four aspects.

2. The Current Status of Vocational Education Metaverse Research

2.1. Current Development Status of Education Metaverse Technology

The concept of the metaverse was first introduced in the science fiction novel "Snow Crash" published in 1992. In the book, Neal Stephenson describes the metaverse as a virtual space that can be accessed through a computer simulation parallel to the real world by wearing headphones and goggles. Even before the concept of the metaverse emerged, its related technologies had already been connected to education. Virtual reality technology is one of the key supporting technologies of the metaverse. In 1990, Qian Xuesen translated it as "spiritual realm," meaning "immersive experience." Today, the metaverse is more commonly built on technologies such as 5G and virtual reality. As stated in the "2020-2021 Metaverse Development Research Report" published by the New Media Research Center of Tsinghua University's School of Journalism and Communication, the metaverse is based on augmented reality technology to provide immersive experiences, generating a mirrored image of the real world based on digital twin technology, and establishing an economic system based on blockchain technology. Liu Zihan (2021) believes that building an educational metaverse requires the development of infrastructure, including the physical, software, data, rules, and application layers[6]. Liu Geping (2022) believes that the educational metaverse is a smart education environment that combines virtual and real elements, connects humans and machines, and enables comprehensive interaction between schools and society, using emerging information technologies such as VR/AR/MR, digital twins, 5G, artificial intelligence, and blockchain[7]. The research results of the "Guangdong Province Intelligent Education Key Laboratory" at Guangdong Second Normal University propose the field architecture and key technical solutions for the educational metaverse, including the physical, software, application, and analysis layers. Therefore, in terms of technological aspects, metaverse technology is constantly evolving. For vocational education, it is important to have a deep understanding of metaverse technology dynamics, construct a technical framework for vocational education metaverse from the perspective of problems and needs, rather than pursuing a comprehensive approach solely based on technology.

2.2. Current Applications of Education Metaverse Scenarios

The architecture of the educational metaverse can be understood as a super field, referring to a system platform that integrates all metaverse elements. The application of the educational metaverse is first reflected in the construction of teaching environments. Hua Zixun et al. (2021) believe that the educational metaverse creates an immersive interactive teaching environment for teachers and students, simultaneously meeting their needs in both real and virtual teaching [8]. Liu Geping et al. (2021) propose a construction model for an intelligent online learning environment based on the metaverse from the perspectives of technical architecture, system structure, components, and training objectives [9]. A

study conducted by Kyungyun University in Korea successfully built a metaverse system that synchronizes physical and virtual campuses by connecting facial recognition technology with teaching management data. Zhejiang University has connected crowdsourcing hybrid clouds, scientific research data platforms, simultaneous interpretation, and remote sensing technology to create a metaverse platform called "Research@ZJU2.0," which replicates real conference scenes with high precision and has been promoted nationwide. Secondly, the application of the educational metaverse is also reflected in different teaching scenarios. Zhong Zheng et al. (2022) analyze the potential application of the educational metaverse in scenario-based teaching, gamified learning, personalized teaching, and the risks and challenges it faces[10]. Lu Lili and Xu Xin (2022) study the chaotic teaching model from the perspective of the metaverse, using the Cloud Exhibition Hall curation course at East China Normal University as an example[11]. Zhu Ke et al. (2022) attempt to construct a large-scale trans-domain collaborative learning system in the learning metaverse and explore the practice path of large-scale trans-domain collaborative learning[12]. Therefore, in terms of scenario applications, the research and application scope of the metaverse is broad, including teaching environment layers, specific teaching processes and methods. Scholars have explored various aspects, but for vocational education metaverse, the scope of scenario applications still requires further practice and exploration.

2.3. Effects of Education Metaverse

The metaverse cannot stay at the conceptual framework level, but needs to see specific implementation effects. Existing research has experimentally verified the teaching effectiveness of educational metaverses in a few cases. Huazi Xun and Huang Muxiong (2021) constructed an educational metaverse and used the "library," "campus," and "classroom" scenes to verify students' immersive learning experiences, capturing and analyzing their brainwave data during the student experience process. The study found that the educational metaverse can promote learners' learning effectiveness, improve learners' sense of interaction, immersion, and cognition[11]. Fu Wenxiao et al. (2022) constructed an immersive and quasi-realistic environment based on virtual reality digital twin technology and collected and analyzed the subjects' interactive learning process data. Then, using multiple regression and structural equation modeling, they explored the impact mechanism of embodied learning engagement, teacher digital literacy, and school digital environment on positive ecological behavior [13]. Hu Chenyang and Yu Changli (2022), through the analysis of the South Korean educational metaverse, believe that the educational metaverse effectively solves the problem of students unable to complete their studies on campus during the epidemic, facilitating online teaching for teachers [14]. Foreign scholars have conducted metaverse teaching experiments based on platforms such as Minecraft and Roblox, and found that teachers are the most important factor in preventing students from losing focus in learning activities. Therefore, in terms of implementation effects, there are currently few empirical studies on the teaching effectiveness of educational metaverses, and the few existing literature mainly combine the construction of virtual environments for experimentation and then analyze the implementation effects of metaverses. Therefore, further empirical testing is needed."

3. Problems in the Metaverse of Vocational Education

3.1. The Metaverse Infrastructure of Vocational Education Has Not Yet Been Established

Previous scholars have discussed the application of basic teaching facilities or teaching scenarios in the metaverse of vocational education [15]. This paper further studies that there are still deficiencies in the demand and use of basic facilities in the metaverse of vocational education. First, infrastructure needs. Before purchasing the infrastructure of the metaverse of vocational education, it is necessary to conduct a full needs analysis, including the understanding and analysis of the needs of teachers and students, the characteristics of disciplines, and the teaching objectives. However, there may be insufficient demand analysis at present, resulting in the purchase of facilities that cannot meet the actual demand. In addition, when purchasing the infrastructure of the metaverse of vocational education, we need to consider the future expansibility and upgrading to meet the needs of the future development of the college. However, there may be a lack of long-term planning at present, resulting in the purchase of facilities that cannot meet the needs of future development. Secondly, from the perspective of the use of vocational education metaverse, although some vocational education metaverse infrastructure has been put into use, the application scenarios are relatively limited, mainly concentrated in some specific disciplines or fields, which may lead to the low utilization rate of facilities, unable to give full play to their role and value. In addition, in the process of using the infrastructure of the metaverse of vocational education, professional technical support is needed to ensure the normal operation and effective application of the facilities. However, there may currently be insufficient technical support, resulting in the failure of facilities or performance issues that cannot be resolved in a timely manner.

3.2. The Technical Standard System of Vocational Education Metaverse Has Not Yet Been Formed

In the past, the issue of metaverse technical standards for vocational education has been widely discussed [16]. This study further explores the current problems from three aspects: the current standards of the metaverse of vocational education, the technical standards, the unity of standards, and the internationalization of standards. First, from the point of view of technical standards, first of all, technical standards are not uniform. metaverse technology standards cover many fields, including virtual reality, augmented reality, artificial intelligence and so on. There may be differences in technical standards in different fields, which makes it difficult to unify the technical standards of the metaverse. The second is the lack of flexibility in technical standards. Some meta converse technology standards may be too rigid to adapt to changing needs. This may lead to difficulties in the construction and application of the metaverse system, which cannot be flexibly adjusted according to the actual situation. Secondly, from the point of view of the unity of standards, first of all, there is a lack of unified interface specifications. Data interaction and information sharing are needed between different systems in the metaverse, but the lack of a unified interface specification leads to poor interoperability between different systems.

Secondly, the data format is not uniform. metaverse involves a lot of data interaction and information sharing, but the lack of a unified data format specification leads to difficulties in data exchange and sharing between different systems. Thirdly, from the perspective of international standards, first, there is a lack of standardization mechanism in line with international standards: there may be a gap between the formulation and updating mechanism of domestic vocational education metaverse standards and the standardization mechanism in line with international standards. This may make it difficult for domestic standards to keep pace with international standards and affect the effectiveness of international cooperation and exchanges. Secondly, there is a lack of international talents and experience. Talents with technical background and standardization experience in relevant fields are needed to participate in the internationalization of standards in the metaverse of vocational education. However, at present, there is relatively little talent reserve and experience in this field in China, which affects the process and quality of internationalization.

3.3. The Technical Standard System of Vocational Education Metaverse Has Not Yet Been Formed

In view of the current vocational education metaverse training mode, this paper points out the current shortcomings from the aspects of training system, teaching methods and teaching effect [17-18]. Firstly, from the point of view of the training system, the current vocational education metaverse training content may be out of touch with the actual needs, which cannot meet the actual needs of the industry and enterprises. This can result in graduates being uncompetitive in the job market and unable to adapt quickly to the work environment. In addition, the current metaverse training project may lack integrity and cannot cover the whole business process in the actual work. This may result in students not being able to fully understand and master the skills and knowledge in practical work. Secondly, from the perspective of teaching methods, metaverse training teaching requires teachers to have a certain level of skills and professional background. However, at present, some teachers may lack relevant skills and experience, resulting in the failure to effectively carry out practical teaching. From the perspective of teaching effect, a good feedback mechanism is an important means to promote the quality of teaching. However, the current evaluation of metaverse training teaching may lack an effective feedback mechanism, which makes teachers unable to understand and improve the problems in teaching in time.

3.4. The Metaverse Ethical Risk of Vocational Education Has Not Been Effectively Prevented

In view of the problem that it is difficult to prevent the risks of the current vocational education metaverse, scholars have conducted in-depth discussions from various technical perspectives [19-20]. This study is interpreted from the following aspects: First, the risk of indulging in the virtual world. metaverse is a virtual world, if students are excessively immersed in it, it may lead to addiction to the virtual world, affect normal learning and life, and even lead to psychological problems. Second, the risk of information disclosure and privacy disclosure. In the metaverse, students

are required to provide personal information and data, which, if improperly used or disclosed, may pose a risk to students' privacy and security. Third, the risk of cyber bullying and violence. In the metaverse, students may be at risk for cyberbullying and violent behavior that may lead to psychological trauma and social problems for students. Fourth, the risk of moral conflict. Moral concepts in the metaverse may conflict with the real world, for example, there may be moral indifference or moral judgment ambiguity in the virtual world, which may affect students' moral concepts and behavior.

4. Metaverse Development Strategy of Vocational Education

4.1. Gradually Improving the Metaverse Infrastructure of Vocational Education

The metaverse of vocational education is gradually emerging and becoming an important force to promote educational innovation. In order to build this cutting-edge education model, we must make an in-depth analysis from the two dimensions of infrastructure needs and application scenarios. Infrastructure is the cornerstone of the metaverse of vocational education. In order to provide an immersive virtual learning environment, high-performance virtual reality (VR) and augmented reality (AR) devices are needed to ensure that students can have an immersive experience. A stable network connection is also crucial, which ensures the smooth transmission of educational content and real-time interaction. In addition, powerful computing resources and efficient data storage and analysis systems provide support for dealing with complex educational content and analyzing students' learning behavior. At the same time, network security and data protection mechanisms are also essential, which protect the privacy and rights of every student. The application scenario shows the vast world of the metaverse of vocational education. Simulation practice is one of the highlights, which allows students to train their skills in a highly simulated environment, so that they can master key technologies before actual operation. Distance collaborative learning breaks the geographical boundaries, so that students can communicate with their peers and teachers in real time and explore the mystery of knowledge together wherever they are. Innovative education model encourages students and educators to try new teaching methods together to make learning more interesting and efficient. For specific industries, metaverse technology is a powerful training tool, which can provide enterprises with a highly simulated practice environment to help employees improve their skills, reduce costs, and reduce risks.

4.2. Accelerating the Establishment of Metaverse Technical Standards for Vocational Education

The formation of the standard system of vocational education metaverse is a complex and important process, which needs to build a perfect, unified and internationalized standard system from three aspects of technical standards, standard unity and standard internationalization. The formulation of technical standards will help to improve the technical level and user experience of the metaverse, and promote the innovation and development of vocational education. At present, the National Association for

Educational Technology (NECST) has issued a series of technical standards for the educational metaverse, including standards and guidelines for technology infrastructure, virtual reality technology, network security and so on. The Ministry of Science and Technology of Korea has issued a technical white paper on the educational metaverse, proposing a series of standards and norms on virtual reality, augmented reality, artificial intelligence and other technologies. China's Beijing University of Posts and Telecommunications released the Research Report on the Development of Educational metaverse, which also mentioned the technical standards of Educational metaverse. Generally speaking, the formulation of metaverse standards for vocational education is not yet known. Therefore, it is suggested that we should first clarify which technologies are suitable for vocational education. Secondly, the unity of standards is the core of the metaverse standard system of vocational education. In a diversified technology ecosystem, it is essential to ensure the unity of standards. In order to achieve this goal, we need to promote the widespread adoption and implementation of standards, establish certification and auditing mechanisms for standards, and ensure that all participants can follow the same set of standards. Through unified standards, we can reduce technical barriers and promote the popularization and development of the metaverse of vocational education. In addition, unified standards also help to improve the quality and efficiency of vocational education and provide learners with a better educational experience. Finally, the internationalization of standards is an important direction of the metaverse standard system of vocational education. Under the background of globalization, the development of the metaverse of vocational education needs to be in line with international standards and follow international norms and standards. By participating in the formulation and promotion of international standards, we can enhance the international competitiveness of the metaverse of vocational education and promote technical exchanges and cooperation on a global scale. At the same time, the adoption of international standards also helps to reduce technical differences, promote the internationalization of vocational education, and provide strong support for the cultivation of talents with international vision and cross-cultural communication ability.

4.3. Explore the Teaching Mode and System of the Metaverse for Vocational Education

In view of the problems existing in the teaching mode of vocational education metaverse training, this paper puts forward specific countermeasures and measures from the aspects of optimizing the training content system, improving teachers' teaching skills and strengthening the feedback mechanism of teaching evaluation. Through the implementation of these measures, we can effectively solve the problems such as the disconnection between the training content and the actual needs, the lack of teachers' teaching skills and the lack of feedback from teaching evaluation. Specifically, first of all, in order to solve the problem that the training content system is out of line with the demand, it is necessary to optimize and update the training content system of the metaverse of vocational education. This includes in-depth research on industry needs and professional standards to ensure that the training content is closely linked to the actual job. At the same time, we should also actively introduce industry experts and enterprises to participate in content design, and jointly develop training projects in line with the

development trend of the industry. In addition, a dynamic adjustment mechanism should be established to update the training content in time according to the development and changes of the industry and technological updates, so as to ensure its practicability and foresight. Secondly, in view of the lack of teachers' teaching skills, a series of measures can be taken to improve teachers' professional quality and teaching ability. This includes organizing regular metaverse technical training and research activities to help teachers familiarize themselves with and master the use of metaverse training and teaching platform and teaching skills. At the same time, teachers should be encouraged to participate in industry exchanges and academic research to broaden their horizons and knowledge. In addition, an incentive mechanism should be established to encourage teachers to actively try and innovate teaching methods and stimulate their enthusiasm and creativity in teaching. Finally, in order to strengthen the feedback mechanism of teaching evaluation, we can establish a perfect student evaluation system and teaching feedback mechanism. This includes formulating clear evaluation criteria and index system to guide students to evaluate the training process and results objectively and comprehensively. At the same time, timely teaching feedback channels should be established to encourage students to put forward opinions and suggestions on teaching content, teaching methods and teachers' performance. In addition, the evaluation results are analyzed and summarized regularly to find out the existing problems and shortcomings, and to adjust and improve the teaching program in time.

4.4. Effective Prevention of Ethical Risks in Vocational Education Metaverse

To prevent ethical risks in the metaverse of vocational education, we need to start from many aspects, including limiting the use time of the virtual world, strengthening data security protection, combating cyberbullying and violence, and establishing ethical guidelines that adapt to the metaverse environment. Specifically, in order to prevent students from indulging in the virtual world, we should first establish a strict time management system to limit the continuous use time of students in the metaverse environment. Secondly, we should carry out mental health education to enhance students' self-control ability and educate them to rationally view the relationship between the virtual world and real life. In addition, schools should provide a variety of offline activities to guide students to actively participate in real-world social and physical exercise, and balance the relationship between virtual and reality. In terms of information leakage and privacy leakage risks, the data security protection mechanism of the metaverse platform needs to be strengthened. This includes using advanced encryption technology to protect user data, strengthening the platform's security audit and vulnerability detection to ensure that user information is not illegally obtained. At the same time, raise users' awareness of privacy protection, educate them to properly keep personal information, and avoid disclosing sensitive information in public. In addition, establish a strict privacy protection policy, clarify the rules for collecting and using user information, and ensure that user rights and interests are not violated. In response to the risk of cyber bullying and violence, strict supervision mechanisms and punishment measures should be established. Platforms should set up special reporting channels to promptly investigate and deal with bullying and violence reported by users. At the same time, strengthen the

education of user behavior norms, clearly prohibit cyber bullying and violence, and guide users to surf the Internet in a civilized manner and communicate amicably. In addition, strengthen cooperation with relevant departments to jointly combat cybercrime and maintain the safety and order of cyberspace. In terms of the risk of conflict of moral concepts, the establishment of ethical codes and codes of conduct adapted to the metaverse environment should be promoted. This includes reasonable constraints on virtual behavior to prevent bad behavior in the virtual world from having a negative impact on the real society. At the same time, strengthen moral education, guide students to establish correct moral concepts, and clarify the bottom line of behavior in the virtual world. In addition, establish a diversified moral discussion platform, encourage users to conduct in-depth exchanges and discussions on ethical issues, form consensus, and jointly maintain the harmony and stability of the metaverse environment.

5. Conclusion

The metaverse of vocational education is an important carrier for the high-quality development of vocational education, and the key to the digital transformation of vocational education. Firstly, this study combs the current research status of the metaverse of vocational education from three aspects of technology development, application status and implementation effect. Secondly, it explores the practical problems of the metaverse of vocational education, such as infrastructure, technical standard system, training teaching mode and ethical risk; Finally, the paper proposes the following four aspects to improve: firstly, improve the infrastructure of vocational education metaverse; secondly, speed up the establishment of technical standards of vocational education metaverse; Thirdly, explore the teaching mode and system of vocational education metaverse; fourthly, effectively prevent the ethical risks of vocational education metaverse.

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