

# The Development and Application of the Metaverse in Smart Education in Chinese Universities

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**Abstract:** Education metaverse is a new form of future education under the development of metaverse technology. The application of metaverse in the education industry is gradually carried out from 2022. The industry generally believes that the arrival of the metaverse will reshape the future of education, and even call 2022 the first year of the education metaverse. This research intends to study the origin, current situation and development, key technologies of the metaverse, explore the current focus, potential applications and future directions of the education metaverse, analyze the application scenarios of the education metaverse, and explore the opportunities and challenges of the development of smart education in colleges and universities in the metaverse era, so as to promote the application of technology and teaching innovation in the education metaverse.

**Keywords:** Metaverse, Smart education, Higher education

## 1. The Origin and Development of The Metaverse

The metaverse first appeared in Neil Stephenson's science fiction novel "Snow Crash" in 1992, proposing that it is a virtual world born out of the real world, parallel to the real world, interacting with each other, and always online. Before 2021, the metaverse has always existed as a concept in the fields of games and social networking. In 2021, with the deployment of the metaverse industry by major Internet companies around the world, such as Microsoft, Nvidia, Qualcomm, as well as famous Chinese enterprises Baidu, NetEase, Tencent, iFLYTEK, ByteDance, etc., the metaverse industry ushered in explosive growth. Especially when the famous Internet social company Facebook announced to change its name Facebook to Meta on October 28, 2021, and launched the All In Metaverse concept, which has triggered a global heated discussion on the metaverse. Facebook founder Mark Zuckerberg pointed out that the metaverse is the next generation of the Internet, and he is ready to spend 5 years to turn Facebook into a metaverse company. Bloomberg News predicts that the global metaverse market will reach \$800 billion in 2024<sup>[1]</sup>.

In China, Shenzhen was the first to establish the Metaverse Association, and at the same time landed scenes such as the Metaverse Museum. Relying on its advantages in the IT industry, software industry and e-commerce fields, Hangzhou promotes the landing and scenario application of the metaverse industry. On the basis of the blockchain layout, Chongqing has established the Chongqing Metaverse Industry Innovation Center. Beijing Urban Sub-Center launched the "Eight Measures on Accelerating the Innovation and Development of the Metaverse in the Beijing Urban Sub-Center" in early 2022, the "Measures" pointed out that it is necessary to vigorously promote demonstration applications, accelerate the deep integration of metaverse-related technologies with various industries, promote industrial transformation and upgrading, focus on culture, tourism, commerce and other fields, create a number of metaverse demonstration application projects, and support the construction of a number of metaverse application scenarios. At the same time, it will provide financial subsidies and talent introduction and other policy support. In the "14th Five-Year Plan for the Development of Shanghai's Electronic Information Industry", Shanghai pointed out that it is necessary to actively pay attention to and cultivate the development of metaverse-related technologies, and support public relations for immersive display, real-time interaction, massive connectivity, massive communication, edge computing, sensing technology, image engine, blockchain and other technologies that meet the requirements of the metaverse.

Wuhan pointed out in the "Government Work Report" that it is necessary to promote the integration of metaverse, big data, cloud computing, blockchain, geospatial information, quantum computing, etc. with the real economy. In November 2022, China's Ministry of Industry and Information Technology, Ministry of Education, Ministry of Culture and Tourism, State Administration of Radio and Television, and State General Administration of Sports issued the *Action Plan for the Integrated Development of Virtual Reality and Industry Applications (2022-2026)*, which proposed that by 2026, the overall scale of China's virtual reality industry will exceed 350 billion yuan, cultivate 100 backbone enterprises with strong innovation ability and industry influence, and create 10 agglomeration areas with regional influence and leading the development of virtual reality ecology.

On the one hand, the rapid growth of the metaverse is due to the bottleneck period of development of the global Internet industry. The long-term lack of breakthroughs in content carriers, communication methods, interaction methods, participation and interactivity of various companies, resulting in "growth without development". Technology is thirst for new products, capital is looking for new exports, users are looking for new experiences, and all parties urgently need to seek new growth opportunities<sup>[6]</sup>. At the same time, the continuous spread of the novel coronavirus pandemic (referred to as the pandemic) around the world has seriously affected the development of offline activities, and the demand for online office, life and entertainment has driven all walks of life to move their business online. During the pandemic prevention and control period, the time people spent on the Internet has increased significantly, and people's imagination of the metaverse virtual world has also accelerated the virtualization process of real society.

## 2. The Concept of The Metaverse

The development of the metaverse concept stems from people's fantasy and continuous exploration of highly immersive alien space and surreal abilities. There is currently no universally accepted definition of the concept, and experts in various fields have their own understandings from different perspectives. From a technical point of view, the metaverse is a three-dimensional Internet, and technology is the core element supporting the realization of the metaverse, whether from the production of environmental scenes, sensory and tactile experience, physical rule setting, ethical order maintenance, character object simulation, etc., all need to rely on the support of technology, including virtual simulation technology, blockchain technology, Web 3.0, digital twin technology, 5G/6G technology, cloud computing, digital collections/NFT, and etc., of which artificial intelligence technology supports most of these technologies. The various technologies on which the metaverse relies present a barrel effect, that is, the extent to which the metaverse can be achieved depends on what stage of development that "short board" technology has reached.

From a social perspective, the metaverse is a next-generation Internet application and social form driven by various concepts and technological developments, which realize the replication and expansion of time and space through various technologies and establish a virtual world parallel to the real world. It includes three levels, one is to simulate the virtual world of reality, that is, the complete mirror and simulation of the real world, with all the elements of the real world, even people's emotions and feelings can be reflected in the virtual world. The other is beyond the virtual world of reality, in this world, there are characters, objects and environments that do not exist in the virtual reality, people can have superpowers, the environment can be a natural environment and social environment does not exist in the real world, and people can do many things that they cannot do in the real world<sup>[1]</sup>. The third is the blending world of virtual reality. In the future world, the virtual and real world will form a close integration and interaction - from virtual to real, from real to virtual, virtual in reality, reality in virtual, all elements of the real world will produce mirroring and interaction in the virtual world, thereto create mutual influence and integration, and produce impact and value.

## 3. Analysis of The Current Situation of Metaverse-empowered Smart Education

In 2022, the application of the metaverse in the education industry also develops gradually. The industry generally believes that the arrival of the metaverse will reshape the education in the future, and even calls 2022 the first year of the education metaverse. Both domestic and foreign companies involved in metaverse research deploy educational projects. In April, VR education social platform Engage announced that it has partnered with VR education platform VictoryXR to launch 10 virtual universities, also known as "metaversities", in the United States. Facebook seeks to build a strong learning ecosystem in the metaverse, students in the metaverse can observe Saturn's rings in the solar system, and can travel

back more than 2,000 years to talk to ancient Roman philosophers<sup>[1]</sup>. As a key product of the "*iFLYTEK Super Brain 2030 Program*", iFLYTEK's superbrain virtual human plans to release a companion robot that understands knowledge and learns by 2030, and jointly build a joint robot laboratory with the University of Science and Technology of China, and jointly undertake "brain science and brain-like research" and "Chinese school-age children's brain development cohort research" with Beijing Normal University.

Song Maoen, deputy secretary-general of the Internet Society of China, believes that the integration of "metaverse" and education will empower education from three aspects. It can overcome the limitations of time and space in education scenarios. With the support of developers, instructors and learners can have more in-depth and convenient interaction to achieve active "teaching and learning". Through the advantages of digital technology, the cost of education and teaching can be effectively reduced, the imbalance of educational resources can be improved, and the equality of education can be promoted.

In the metaverse scenario, education enables each learner to directly experience, build, and learn knowledge, and learners can complete their learning through guidance, feeling, and practice. In the new metaverse teaching environment, students wear VR devices and log in to the virtual teaching space, and can immersively use the three-dimensional teaching models that are not often observed in the real world, such as space travel, travel through history, and the internal structure of the human body. At the same time, a series of teaching models, teacher-student relationships, role positioning, etc. will also change. We look forward to the possibilities it brings to higher education.

#### 4. Key Technologies for Education Metaverse

Technology is a core element to the realization of the metaverse. In the virtual world of the metauniverse, whether it is the sense of experience, game rules, or scene construction, all needs to be supported by technology. There are many types of technologies that support the education metaverse, each has many subdivisions, and each technology may support multiple metaverse functions. Some scholars have proposed that the real immersion of the virtual world of the metaverse has four technical characteristics, namely audio-visual, interactivity, persistence and immersive (Gil-bert et al., 2011). Specifically, users can mobilize their perception through sight and hearing in the virtual world and interact with other users, and finally have a strong sense of presence through the integration of multi-perception devices. The main application technologies include artificial intelligence technology, interaction technology, blockchain technology, Internet of Things technology and learning analysis technology. Analysis and prediction based on big data and algorithms based on machine learning makes the simulation of the world and abstract summary become more and more intelligent. Based on the improvement of computing power, AI intelligent technology will also be deeply applied in the metaverse. Decentralized closed-loop financial system. Virtual currency based on blockchain technology provides social attributes to the metaverse. Cloud computing, fog computing, edge computing technology and etc. also provide a foundation for solving problems in the Internet 3.0 era, like large data transmission, low-latency information communication, and high-demand data security and ect. The above constitutes the key technologies of the education metaverse.

The technical framework of the education metaverse is roughly divided into several categories from the bottom to the top, namely, the basic support layer, the basic data layer, the unified certification platform layer, the content generation and application layer, and the interactive access layer. Each level is further divided into a number of subdivisions. The whole model covers the Internet of Things, big data, cloud computing technology, AR, VR, 5G, 6G, and etc. The model uses virtual technology and service packaging technology of the cloud platform, integrates big data and the Internet of Things, takes artificial intelligence as the line, eliminates the isolation of various problems and related objects in the field of smart education, and thus realizes the overall framework of the education metaverse, as shown in the figure1.

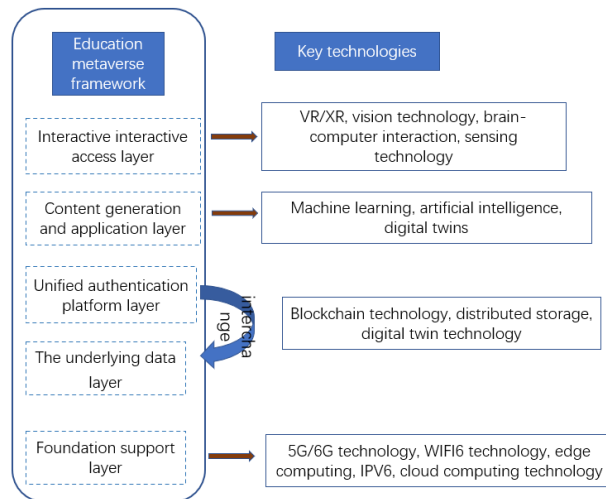


Figure 1: Education metaverse technology framework.

1) The basic support layer constitutes the technical foundation of the education metaverse, mainly including 5G/6G technology, wifi6 technology, cloud computing, edge computing, quantum computing, network security and other technologies, which are used to solve problems such as continuous large-scale user online, real-time signal transmission, and large-scale information computing. 2. Basic data layer technology mainly includes big data technology, blockchain, digital twin and other technologies to achieve uniqueness and decentralized rules and identification, mainly through the blockchain technology system as a guarantee, which mainly includes distributed storage, distributed ledger, consensus mechanism, data transmission and verification mechanism, timestamp and other subdivision technologies. Computing technology and distributed storage technology together provide strong support for smart education in the form of the metaverse. 3. The unified certification platform layer is an important part of the metaverse of college education. If personnel information is not properly managed, it may cause confusion in campus information management and even bring information security risks. A unified, convenient and secure identity authentication platform is needed to standardize the personnel management for colleges and universities and integrate various application systems in the universities. The platform is the data base and unified entrance of the education metaverse which provides unified identity authentication services. 4. The content generation and application layer includes game engine, machine learning, 3D modeling and other technologies, 5. The interactive access layer is the direct interface between the education metaverse and offline education Convenient access method and realistic immersive experience is one of the core characteristics of the metaverse Technologies supporting this feature mainly include sensing technology, VR/VR technology, vision technology, brain-computer interaction, virtual simulation technology, as well as the computer vision, speech recognition, NLP and other algorithms behind it.

Although it is still far from the expected experience of mature metaverse technology, the above-mentioned metaverse technologies have been applied to varying degrees in actual business. Various technologies will eventually converge and empower various application scenarios of the education metaverse.

## 5. Application Scenarios of Metaverse in Smart Education in Applied Undergraduate Universities

### 5.1. Holographic Connected Smart Classroom (Virtual -Class)

The holographic interconnected smart classroom is based on the metaverse system supported by perception technology, which builds a virtual and real fusion speech and teaching space through holographic projection, which can carry out online and offline teaching activities at the same time, and projects the projection screen to the entire teaching space through multi-channel projection fusion technology, and learners can immerse themselves in a virtual teaching environment surrounded by 3D stereoscopic projection in a 360-degree all-round way. The teaching content is presented in a three-dimensional holographic manner on the holographic projection screen, and the teacher interacts with the virtual content through touch and somatosensory behind the projection screen, and superimposes and merges with its body to form a mixed reality effect. With a holographic lectern system set up at the front

of the classroom, teachers can project notebook content onto the holographic projection screen through the front projector, which can support teachers and students to co-create XR (fusion VR, AR, MR, HR) courseware, and improve the sense of presence and immersion of teachers and students by integrating and connecting the physical space of both teaching parties in a virtual environment<sup>[3]</sup>. The teachers feel as if they are in the classroom, and students feel that the teacher is in front of them. It provides good support for the research and development of MOOC and "golden course" resources in higher education.

### **5.2. Immersive, Interactive Experimental Teaching Environment**

The equipment equipped in the immersive interactive learning laboratory can support a variety of functions such as free walking in large spaces, 360-degree panoramic virtual scenes, human-computer interaction, and multi-person real-time interaction, which aims to create a more interactive and immersive experimental teaching environment through cutting-edge technologies such as virtual technology. It can build scenarios such as high-risk or extreme environments, irreversible experimental operations, large-scale and complex social or natural environments, irreducible historical environments in reality, and other environments limited by financial, material and human resources, to provide students with an authentic, immersive, experimental learning experience.

### **5.3. Adaptive Learning System - metaverse + Virtual Companion**

Adaptive learning is to appropriately adjust teaching materials and feedback guidance suggestions according to the individual situation of learners to provide an intelligent interactive environment that meets the needs of learners. According to the actual situation of learners, intelligent tutors and virtual learning companions are individually configured to provide an intelligent system for adaptive learning. Smart tutors and virtual companions can be combined with physical teachers and students to create a hybrid online and offline teaching model of "multi-teacher + multi-buddy"<sup>[4]</sup>. Students can switch to the reality-virtual environment for learning at any time. While students receive the guidance or accompaniment of "intelligent tutors" and "virtual learning companions", teachers carry out personalized teaching through multiple "virtual teaching assistants", according to the needs of teaching activities, to provide one-to-many, many-to-many multiple interactive communication modes between virtual and real objects, therefor improves students' interest in learning and the efficiency of collaborative learning activities through knowledge quizzes, game interactions, learning exercises, intelligent tutoring, and etc.<sup>[5]</sup>

### **5.4. Other Scenarios**

There are many scenarios where the metaverse is applied to college education and teaching, such as metaverse libraries, metaverse virtual teaching and research rooms, metaverse conference rooms, metaverse culture construction, and so on. Teachers and students can use wearable devices to enter the virtual metaverse library to replicate and simulate application scenarios such as resource retrieval, learning environment, virtual consultation, educational services, and personalized recommendation services. Virtual teaching and research departments can be built to explore new grassroots teaching organization models and provide new ideas, new methods and new paradigms for the construction of grassroots teaching organizations in colleges and universities. You can have a virtual campus tour, you can build a metaverse conference, hold a metaverse graduation ceremony, and etc., to make up for being not able to attend the graduation ceremony due to the pandemic and other reasons. Students can create a simulation experimental environment using more realistic VR/AR/MR technology, directly introduce virtual scenes into the real classroom using holographic projection technology, and realize mind control learning using brain computer interface technology.<sup>[5]</sup>

From the above discussion, it can be seen that the metaverse features immersive, high-fidelity, adaptive, personalized, and other characteristics, and has multiple application scenarios in higher education, Virtual –Class, Virtual –Room, Virtual Companion etc. We have proposed the educational metaverse ecosystem as shown in Figure 2.

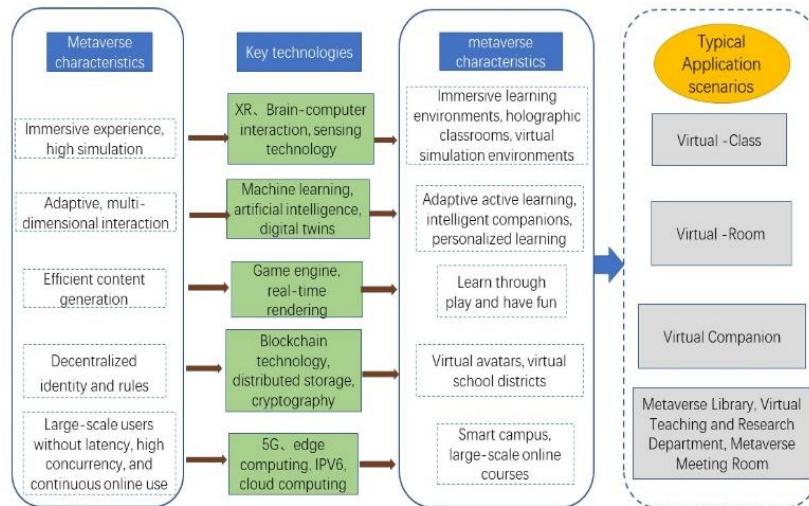


Figure 2: Education Metaverse.

## 6. Opportunities and Challenges for The Development of The Metaverse in Higher Education

Education is the foundation of a country. At present, various countries have tried to reform and innovate in order to use advanced technology to develop into a modern education power. In 2021, the EU published *the Action Plan for Digital Education (2021-2027)*, which aims to build an efficient digital education ecosystem and make the European education and training system more relevant to the digital age. In December 2021, China also issued the *"14th Five-Year Plan" for National Informatization Plan*, which pointed out that by 2025, the construction of digital China will make decisive progress, the level of informatization development will leap sharply, lifelong digital education will be carried out, the level of education informatization infrastructure construction will be improved, a high-quality education support system will be built, and the impact of artificial intelligence on education models and education objects will be studied.<sup>[2]</sup> At present, under the background of the "Double First-class" construction, the need for various countries to accelerate the development of intelligent education has become more urgent. The development of intelligent education is not only the demand of the information era, but also the only way to develop high-quality first-class universities.

Although the metaverse is only in the initial stage of development, its concepts, models, management, evaluation, and etc. to empower higher education will undergo great changes compared with traditional education. It will play a key role in promoting the new development of smart education, reshaping the new system of smart education, building a new education ecology, and leading the future development of education.

The development of education metaverse will also encounter many challenges. For instance, the price of virtualization products and equipment will remain high in a short period of time; teachers and students' role in education needs to be changed, educational ethics and social issues, as well as data encryption and information security issues will arise in the context of massive data generation. Although we face many problems currently, we are positive about the potential huge advantages and broad prospects of the metaverse in the field of higher education. Colleges and universities should timely analyze the new trends in the development of smart education both at home and abroad, seize the initiative and embrace opportunities, actively explore new paradigms of smart education, and cultivate advanced professional talents for the future world.

## 7. Conclusions

Education Metaverse is a new form of future education under the development of Metaverse technology. This study explores the origins, current state, and development of the Metaverse, discussing key technologies, potential applications, and future directions of the Metaverse in higher education. It analyzes the application scenarios of Education Metaverse, explores the opportunities and challenges for the development of intelligent education in higher education institutions in the Metaverse era. The fusion

of Metaverse and AI technology brings significant changes to the principles, models, management, teaching, and evaluation in higher education, which are of great significance in promoting new developments in intelligent education, reshaping a new system of intelligent education, and building a new educational ecosystem.

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