



Under the Perspective of Technology Empowerment of Construction of Scenarios of Edu-Metaverse

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Abstract

The metaverse is the integration of multiple new technologies which generates next generation of Internet applications and the state of social, its application in the field of education has the potential to bring the third way for human beings to comprehend the complexity of educational system and the regularities of development of education. This study uses CiteSpace visualization software for literature analysis, investigates critical nodes of current researches related to Edu-metaverse, and bases on six core technologies of Edu-metaverse, Edu-metaverse application scenarios are constructed in five dimensions: teaching mode, teaching environment, teaching resources, teaching activities and teaching evaluation. On this basis, it is initially applied to the teaching of a professional course at University H. The results of the accompanying tests of the course are recorded, and the mechanism of action is verified through performance analysis.

Keywords: *Edu-metaverse; Core Technology; CiteSpace Analysis; Application Scenarios;*

1 INTRODUCTION

The metaverse is a next-generation Internet application and social form arising from the integration of multiple new technologies, which achieves spatio-temporal scalability based on extended reality technologies and digital twins, human-robot fusion based on AI and IoT for virtual humans, natural humans and robots, and economic value-added based on blockchain, Web 3.0, digital collections or NFT, etc. [4]. The metaverse has three major attributes that expand the space of human existence, perspective dimension, sensory experience, and thought practice. In the metaverse, through the construction of the media environment, the individual's visual and auditory senses of mobile Internet are expanded into visual, auditory, tactile, temperature and other sensory experiences, which can be infinitely enriched and extended.

Professor Cai-Chun Gong proposed the concepts of "twin media" and "fictional media" in the "White Paper on China's Metaverse". A twin medium is a new generation medium that uses physical space and its

virtual digital twin as a medium for information carrying [6], presentation, organization and dissemination, and provides users with real-time online and immersive interactive experiences based on the Internet [2]. By applying the metaverse containing the concept of "twin media" to the field of education, the pursuit is to integrate various natural interaction technologies such as voice, gesture, eye movement, kinesthetic or touch simulation, and AI assistant to build an immersive teaching and learning scenario and achieve a more intuitive, immersive, relaxed, and comfortable interaction experience.

2 CITESPACE VISUAL ANALYTICS

In this study, we used CiteSpace (5.6.R3), a literature information visualization software, to analyze 60 valid documents in CNKI database with the theme of "Edu-metaverse", and set the Node Types to "Keyword" in the main interface of CiteSpace. "Keyword" in the main interface of CiteSpace, other settings remain unchanged, and the default view, i.e. keyword co-occurrence mapping, is obtained as in Figure 1. The nodes in the

graph represent the analyzed objects, and the more frequently they appear, the larger the node circles are, and the stronger their centrality, the larger the font of the nodes. The line between the nodes indicates the co-occurrence relationship, and its thickness indicates the

intensity of co-occurrence. In the figure, the font of "metaverse" and the circle of nodes are both the largest, which means that this keyword is the largest node in the map, with the most frequent occurrence and the strongest centrality.

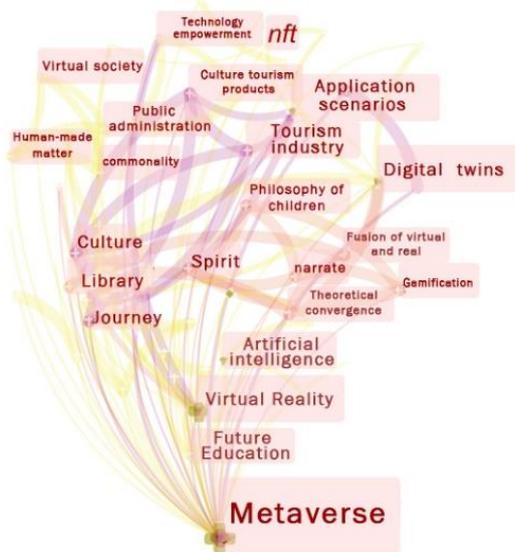


Figure 1 Keyword co-occurrence network mapping for Edu-metaverse research

The quantitative table of keyword frequency and centrality was automatically generated on the left side of the keyword co-occurrence map, and the keywords with frequency above 4 and their data were selected by me, as shown in Table 1. Among them, the centrality of "metaverse" exceeds 0.1, which indicates that it is closely connected with other keywords and can be used as a key node; the frequency of "virtual reality" is above 10, which is a hot topic in the education metaverse. The word frequency of "application scenario" is slightly lower than

that of "virtual reality", but its centrality is slightly higher than that of "virtual reality", which indicates that the discussion on application scenario is a hot topic in the education metaverse research. The frequency of "application scenarios" is slightly lower than that of "virtual reality", but its mindfulness is slightly higher than that of "virtual reality", indicating that the discussion of application scenarios is a hot topic in the education metaverse research.

Table 1 High-frequency keywords for Edu-metaverse research

No.	Keywords	Frequency	Centrality	Year
1	Metaverse	56	0.88	2020
2	Virtual Reality	13	0.01	2020
3	Application Scenarios	9	0.02	2020
4	Technology Empowerment	4	0.00	2020
5	Digital Twins	4	0.02	2021
6	Information Technology	4	0.00	2020

3 OVERVIEWS of the EDU-METaverse

3.1 The connotation of Edu-metaverse

Education is one of the important fields of metaverse application. In the past, people usually studied the educational system in two ways: theoretical research and experimental, while the emergence of metaverse has the potential to bring a third way for human beings to understand the complexity of educational system and the law of occurrence and development of education. At present, Edu-metaverse is still a concept that is constantly developing and evolving, and scholars from different research directions keep enriching its meaning in their own ways. Based on the technological dimension, Zi-Xun Hua believes that the Edu-metaverse can be understood as the creation of digital identities by teachers, learners, administrators, and other participants of educational activities to open up formal and informal teaching and learning places in the virtual world and to interact in virtual teaching and learning places [3]. Based on the perspective of nurturing people, Dacheng wisdom science proposed by Xue-Sen Qian [5] provides theoretical guidance for the Edu-metaverse and constructs a linkage path between the metaverse and wisdom education.

Although traditional teaching is combined with computers, PPT and other teaching tools, it still cannot

meet the teaching needs in providing learners with an authentic learning environment [8], which leads to the situation that learners "emphasize theory over practice" and "knowledge is difficult to apply". "It is difficult to apply knowledge. The application of various natural interaction technologies such as integrated voice, gesture, eye movement, kinesthetic or haptic simulation, and AI assistant, which are pursued by the metaverse twin media, to education teaching can make up for the lack of real learning environment in traditional classrooms and build an all-round immersive learning scenario. Learners enter the education metaverse from the first perspective, and become the subject of knowledge acquisition through exploration and discovery. The immersive teaching environment built by the Edu-metaverse allows learners to build bridges with new knowledge through a "silent" approach, and in the process of exploring and practicing, they can achieve a mental flow experience and promote knowledge transformation. The natural interaction technology used by Edu-metaverse can record learners' performance, feedback and insights throughout the learning process, and these data are an important part of teaching evaluation, which is conducive to the optimization and iteration of Edu-metaverse itself. The education metaverse combines constructivism, contextual learning and participatory learning theories to enrich traditional teaching models (Table 2) and promote the transformation of traditional teaching classrooms.

Table 2 Edu-metaverse and pedagogical theories, approaches

Edu-metaverse	The learner becomes the subject of knowledge acquisition	Build an immersive teaching environment	Natural interaction technology
Teaching Theory	Constructivist learning theory	Contextual learning theory	Participation in learning theory
Learning Style	Explore	Immersion	Communication
	Discover	Practice	Feedback

3.2 Technology support for the Edu-metaverse

In recent years, the core technologies in the metaverse, such as blockchain technology, virtual reality technology, artificial intelligence technology, and Internet of Things technology, have been implemented in different fields of

education and have profoundly changed the existing organization and operation mode of education. Referring to the six core technologies of the metaverse: Blockchain, Interactivity, Game, AI, Network, and Internet of Things [10], the technical support and application scenarios of the education metaverse are deduced as shown in Figure 2.

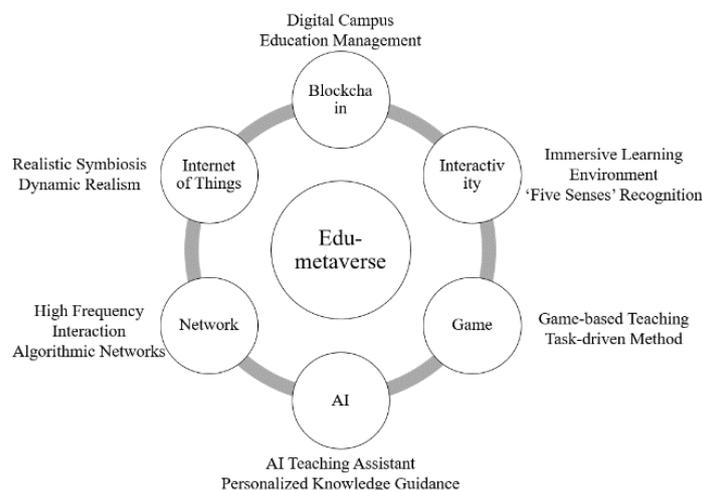


Figure 2 Technical support and application scenarios of Edu-metaverse

(1) Blockchain

The core value of blockchain technology lies in the multi-centered peer-to-peer transmission, which makes all participants have complete, public, and tamper-evident transaction information, solves the intermediary credit problem, ensures the integrity and security of data information generated in the process of educational management and teaching, and can provide a knowledge sharing and authentication guarantee based on rules and algorithm operation for the self-organized operation of digital campuses in the Edu-metaverse, which facilitates educational management.

(2) Interactivity

The immersive learning environment supported by human-computer interaction technologies such as computer graphics, computer vision, gesture recognition, gesture recognition and even brain-computer interface brings infinite imagination to the education metaverse. In the education metaverse, learners are no longer limited to the visual and auditory channels, but the multi-channel fusion interaction technology brings together the integrated sensory experiences of vision, hearing, touch, smell and taste.

(3) Game

The gamification features of video game technology make the learning in the educational metaverse more interesting for the learners. With the task-driven method and interactive technology to provide the context of experiencing practice and perceiving problems, the learners start learning around the task and make the active construction of a highly intelligent learning system of inquiry, practice, thinking, applying and solving in the process.

(4) AI

As a feasible exploration of idealized education, Edu-metaverse advocates open thinking and attaches importance to process rather than fill-in knowledge

indoctrination. Through artificial intelligence, we analyze learners' existing knowledge trees, sort out knowledge structure defects, and provide personalized knowledge guidance to learners. AI teaching assistants, intelligent tutors and other virtual humans will be more widely developed and applied in the education metaverse.

(5) Network

As an extension of the metaverse in the field of education, the education metaverse provides a solid hardware environment for future students and teachers to enjoy ubiquitous learning scenarios with high bandwidth, low latency and multiple connections.

(5) Internet of Things

Based on IoT data, Education Metaverse establishes a comprehensive and dynamic virtual mirror of real objects through artificial intelligence and big data analysis, providing a transmission channel for creating an immersive learning environment, and this connected learning environment for everything will surely inspire learners to create a new world with their hands.

These underlying supporting technologies and application scenarios provide a solid, powerful foundation for the development and implementation of the education metaverse, and paint a highly imaginative blueprint for the future of education.

4 CONSTRUCTION OF EDU-METVERSE APPLICATION SCENARIOS

The application of metaverse in the field of education has been shown when the concept of metaverse is hot. ACAI, one of the world's top AI academic conferences, held its 2020 symposium on the Nintendo game Animal Crossing; Stanford University offered a Virtual People course, which brought together more than two hundred students in a "metaverse classroom" through VR devices. The first course in Stanford's history to be taught through VR technology.

These initial explorations of the Edu-metaverse are all about participants creating digital identities and exploring formal and informal places to interact in the virtual world. Based on the Edu-metaverse technology, this study constructs Edu-metaverse application

scenarios in five dimensions: teaching mode, teaching environment, teaching resources, teaching activities, and teaching evaluation (Figure 3), and compares the Edu-metaverse with traditional teaching scenarios to clarify the value of the Edu-metaverse.

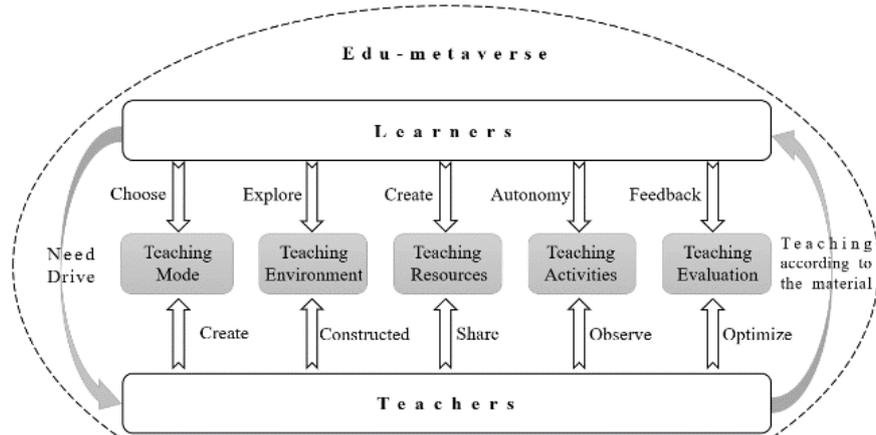


Figure 3 Construction of Edu-metaverse application scenarios

4.1 Create multiple teaching models based on IoT and video game technology

Education is not just the transfer of knowledge, nor is it limited to learning each subject and accomplishing learning objectives. The traditional teaching model is more oriented to mastering knowledge itself, and teachers present knowledge in the form of "storytelling", and learners do so by "listening to stories" or even "memorizing stories". Learners learn by "listening to" or even "memorizing" stories. Whether the learners are able to think independently in this process and whether they have the ability to transfer knowledge is not known.

The multiple teaching modes created based on IoT and video game technologies support learning activities in a variety of ways such as inquiry-based, experiential, thinking skills development, and complex problem solving. In the Edu-metaverse scene full of freedom and creativity, learners can choose their favorite or the teaching mode they want to experience, and teachers can categorize learners' characteristics through learners' feedback and match the same type of learners to the same space for teaching activities. This variety of alternative teaching modes will connect different disciplines, as well as self and world, time and space, inner and outer, to achieve the cultivation of learners' thinking skills and promote their overall development.

4.2 Build real teaching environment based on interactive technology

Due to space and geographical constraints, traditional teaching activities are divided into different classes and groups according to certain ratios, and are fixed in a closed campus environment by setting a uniform overall subject knowledge and curriculum time. This closed

classroom setting and spatial planning prevents learners from actively exploring and acquiring knowledge, and they even feel that learning is not related to the "outside" world.

Based on interactive technology, Edu-metaverse can provide an experience environment with deep integration of virtual and reality, and can build a real teaching environment based on subject knowledge. In the knowledge scenario constructed by the Edu-metaverse, learners can immerse themselves in the "snow of Jinan", manipulate various equipment to complete experiments, and feel the hustle and bustle of the ancient battlefield as if they were "traveling through time". This kind of perceptual experience beyond reality will open up learners' vision and lead them to explore the ocean of knowledge actively.

4.3 Blockchain-based technology to share real-time teaching resources

With the development of information technology, knowledge acquisition channels have increased and transmission speed has accelerated, but the update of teaching resources is relatively slow. The Edu-metaverse built based on blockchain technology ensures the integrity and security of data information generated in the teaching process, brings together various effective resources, and acts as a real-time update of teaching resources.

Teaching resources provide various conditions for effective teaching and learning, and the secondary creation of teaching resources by learners in the learning process is recorded and kept by the Edu-metaverse, and teachers communicate with learners at the end of teaching activities to update the teaching resources with new information beneficial to the development of

teaching resources. Learners are not only the users of teaching resources, but also the creators and updaters. This process not only exercises the learners' ability to think independently, but also creates a free environment for two-way communication between learners and teachers, and teachers can sort out and summarize existing teaching resources to improve their level of literacy.

4.4 *Special teaching activities based on artificial intelligence technology*

Traditional personalized learning methods mostly focus on personalized learning materials or assignments pushed by algorithms, which are still in essence passive knowledge instillation for learners to accomplish the required learning goals, and cannot realize the teaching of thousands of people according to learners' individual characteristics. By analyzing learners' existing knowledge trees and sorting out knowledge structure defects, artificial intelligence technology can realize personalized knowledge guidance for learners.

The AI teaching assistant tracks the learning data of learners from the time they choose the teaching mode, and the behavioral performance generated by learners in the learning process will continuously improve the learning data as the basis for the development of special teaching activities. Teachers use AI teaching assistants to understand learners' learning data before conducting teaching activities, and carry out special teaching activities suitable for learners by combining with the teaching mode chosen by learners. The Edu-metaverse makes the learners become the leaders of teaching activities, shifting from passive to active in a series of independent learning exploration, liberating the learners from the constraints of thinking, and cultivating creative thinking and innovative ability. The teacher can make adjustments at any time during the learning process according to the learners' performance and feedback, and both sides can collaborate to complete the teaching activities.

4.5 *Web-based and computing technology feedback teaching evaluation*

The traditional sources of teaching evaluation are mostly based on teachers' experience and single data, which inevitably lead to one-sided and isolated evaluation. In the education metaverse, all learning behaviors can be collected in digital form, which itself has huge educational data resources, and the "arithmetic network" of the metaverse itself can meet the needs of ultra-high frequency interaction, calculation and connection.

According to the rich data sources, diversified evaluation methods and intelligent evaluation feedback of Edu-metaverse, it goes to realize accurate teaching

evaluation supported by various data. Through the evaluation, teachers can understand the weak points of learners' learning process and strengthen them in a targeted way. In this process, teachers can summarize their teaching experience, discover teaching problems, study teaching methods, improve teaching quality, promote their own professional development, and push the iterative optimization of the education metaverse scene to form a virtuous cycle.

5 INITIAL APPLICATION OF EDU-METAVVERSE SCENARIOS

The development of education cannot be separated from advanced technology, and the exploration of the application of Edu-metaverse cannot be separated from the current development status of technology. With the help of current teaching aids to design learner-centered teaching, build immersive teaching scenarios, and empower learners' learning in the existing traditional classroom, to realize the initial exploration of the application of the current Edu-metaverse scenarios. Based on this, this study constructs Edu-metaverse immersive scenario teaching for 30 learners of the undergraduate electronic information course "Network Integration Technology" at University of H. The results of the accompanying tests of the course in the second semester from 2021 to 2022 are tracked and recorded (Figure 4), and the mechanism of its effect is explored through performance analysis.

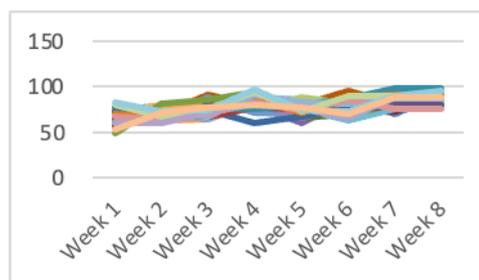


Figure 4 Edu-metaverse immersion scenario teaching accompanying test results

The average scores of the 30 learners in the in-class test from the first week to the eighth week of the second semester from 2021 to 2022 are shown in Table 3. From the second week to the fourth week, the average scores of the 30 learners showed an increasing trend, indicating that their acceptance of new knowledge and Edu-metaverse immersion scenarios was on the rise and understanding trend as the course progressed. The average score of the 30 learners in the eighth week was 91, an increase of 33.8% compared to 68 in the first week. This data proves that the Edu-metaverse immersion scenario is conducive to the development and improvement of learners' cognition of the subject.

Table 3 Edu-metaverse immersive scenario teaching accompanying test score average

Weekly	Average Score
Week 1	68
Week 2	71
Week 3	76
Week 4	83
Week 5	75
Week 6	78
Week 7	85
Week 8	91

6 CONCLUSIONS

In view of the current social and technological development, the metaverse is a major trend [7], and the Edu-metaverse shows great educational potential due to its characteristics of full interweaving of virtual and reality, full interaction between human and machine, and full connection between school and society. However, is the Edu-metaverse really an ideal space for learning and education? Educators are certainly justified in putting a big question mark. The challenges faced in the metaverse of gamified learning and philosophical existence are also a juxtaposition of many techno-ethical issues [9]. Education is a social activity that nurtures people, and educators must always adhere to the concept of human-centeredness and establish a warm education, so that education becomes a concern for survival, so that learners can learn to care for themselves in the process of learning, so that people can learn to care for each other in the process of learning, and so that the metaverse can truly become a place of equal and intimate interaction between people.

At the current stage, the education metaverse is still in its infancy, and its development is constrained by today's underlying technology, and it is still quite a distance from the imagined education metaverse. On the other hand, it is true that the Edu-metaverse can solve many problems in traditional education, but we cannot hope that the Edu-metaverse can solve all the problems. When exploring the application of metaverse in the field of education, we should not detach from the essence of education, but apply it reasonably and appropriately according to the actual teaching needs, teaching objectives, teaching contents and learners' characteristics.

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