Metaverse Framework: An Application for Pre-service Teacher Education

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Keywords: Metaverse, Pre-service teacher education, education space, Artificial intelligence

Abstract: The application of the metaverse to higher education has become an important trend in the future development of education, but in the field of pre-service teacher education, it is necessary to deeply analyze its internal operation mode and path construction. Through the current dilemma of pre-service teacher education and the technical advantages of "metaverse education", a composite field to promote the "Student-Centered Teaching, Learning-Based Classroom, Developing-Oriented Education" learning of pre-service teacher is constructed. In terms of implementation path, it is mainly divided into Infrastructure layer, human-computer interaction layer, software system layer and scenario application layer, so as to create a metaverse world where combine with virtualization and reality, thereby providing a new direction for the development of pre-service teacher education.

1. Introduction

In March 2021, Roblox launched the "first shot" of Metaverse stock by listing on NASDAQ, and since then, Microsoft, Google, and Facebook have made changes one after another[1], thus,the year 2021 has been called the "first year of Metaverse"[2]. The American author Neal Stephenson firstly introduced the concept of metaverse in his science fiction novel "Avalanche"[3]. Because of its complexity and epochal character, there is no uniform definition of metaverse by scholarly.

From the perspective of symbolic interaction theory, metaverse is a persistent and immersive virtual world in which users can interact with other users and the surrounding environment similar to those in the physical world[4][5]; from the perspective of spatial and information forms, metaverse can be divided into four types: augmented reality, vital records, mirror worlds, and virtual worlds[6]. From the perspective of lexical composition, it can be considered that Metaverse is a compound word beyond "meta"(meaning beyond) and "verse"(abbreviation of universe)[7], which refers to the three-dimensional virtual world in which avatars are engaged in political, economic, social and cultural activities beyond the physical world[8].

Technology-enhanced education plays a crucial role in teacher's lesson preparation and students' learning[9][10]. Particularly in the context of the COVID-19 pandemic, metaverse has provided a platform for the development of online education, and the global education landscape has undergone tremendous changes, with the flat "e-learning" of the internet era quietly transforming into the three-dimensional "metaverse + education" as people expect real social interaction and rich spiritual pursuits[11][12].

A number of universities have already explored the practical applications of the metaverse in different professions. Stanford University has used virtual reality technology to help medical students experiment with dangerous surgeries[13]; New Mexico State University is looking to offer degrees where students can take all their courses in VR, and victor XR expects to build and operate 100 digital twin campuses by 2023[14]; University of Almería in Spain has used a "holographic lens" device in a three-dimensional concept class to study the molecular structure of compounds and mathematical three-dimensional geometry[15], etc. However, there is little mention of how the metaverse is used in teacher education.

Mataverse is associated with teacher education because of its immersive, cross-field, and multi-contextual characteristics[16]. Therefore, the advantages of the integrated metaverse can contribute

110   **DOI: 10.25236/iemetc.2023.019**

greatly to the shaping of a colorful new educational form and the creation of a new composite and diversified educational concept in pre-service teacher education.

2. Pre-service teacher education dilemma

2.1 "Theory" is not effectively integrated with "practice"

There is a phenomenon of unbalanced development of educational theory and teaching practice in teacher education[17]. First, pre-service teacher are not exposed to the latest educational theories. With the development and change of society, some of the theoretical models cannot adapt to the development of the times, resulting in the lack of practical guidance for teacher trainees' cognition of theories. Secondly, teaching practice, because of its contextual, implicit and individual differences, is often overwhelming for beginning teacher educators, especially in the high-pressure teaching environment, and the effectiveness of educators' practice is greatly reduced. Finally, due to objective factors, such as the new crown epidemic, natural disasters and other force majeure, pre-service teachers' practice time is too soon, resulting in their lack of practical ability and their inability to truly stand firmly on the podium.

2.2 Weak information technology teaching ability of college teachers

Currently, teachers' ability to apply informatization teaching is generally not strong enough to adapt to the development of higher education in the new era[18][19]. Thus, with the gradual acceptance of higher education by Generation Z (i.e., the generation born after 2000), the flat teaching resources cannot satisfy these "information technology natives", resulting in the teaching effect falling into a rut. Some researchers argued that the proficiency and frequency of use of information technology teaching by college teachers are not high, and exist differences in the cognitive abilities of expert teachers, key teachers and young teachers [20]. Others also suggested that the information technology teaching level of university teachers is not only a matter of knowledge updating, but also the responsibility and mission of engaging in the teaching profession[21]. Specifically, many university teachers are unable to use effective resources to integrate organically with the curriculum and develop and design high-quality informatization courses.

2.3 Inadequate educational beliefs rooted in the grassroots

Educational beliefs are the spiritual core of teachers' professional ethics, and pre-service teachers are the reserve force of teachers[22], so enhancing the educational beliefs of teacher trainees is the source of living water for improving the quality of basic education and teachers' professional ethics. As pre-service teacher have the dual identities of students and prospective teachers, colleges and universities should create an educational atmosphere, give them opportunities to practice. Due to the influence of career education and utilitarian factors, some teacher-training students do not engage in grassroots education after graduation. Some scholars argued that educational beliefs are a stable psychological state internalized by teachers through study and practice, and are the unification of teachers' subjective cognition and objective practice. However, some teacher-training students did not develop sufficient identity and sense of belonging to education after experiencing higher education, which is fundamentally due to insufficient educational beliefs, resulting in slow growth of subject education specialization and sluggish development of rural education.

3. "S-L-D" intelligence framework

3.1 Theoretical framework

Based on the above situation, and in response to the traditional classroom is difficult to reflect the student-centered, teaching atmosphere is not active, it is rarely to cultivate the real innovative talents and the new generation. Our research team, on the basis of years of classroom reform and innovation practice, summarizes and proposes a new classroom concept based on multidimensional evaluation. On the basis of many years of classroom reform and innovation, our research team summarized and

condensed the new classroom concept based on multidimensional evaluation.

The concept requires a change in the traditional concept of education and teaching, and the classroom teaching process should reflect the new concept of the trinity of "Student-Centered Teaching"[23], "Learning-Based Classroom"[24] and "Developing-Oritented Education"[25][26] (Fig.1). At the same time, a student-centered classroom atmosphere should be constructed, and a learning-based teaching process should be built to constitute an education oriented to student development. Teaching should reflect learning as the center, stressing student presentation, and transform teaching into learning; classroom should highlight student learning, emphasize interaction of thinking, and transform classroom into learning; education should focus on student growth, accentua quality development, and transform education into growth.
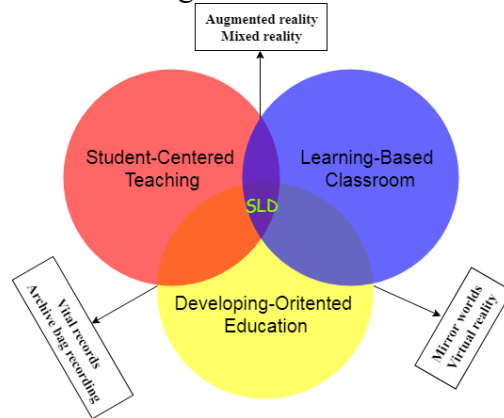

Fig.1. "S-L-D" intelligence theoretical framework

3.2 Metaverse educational space

Educational space is a complex of social systems and life-related systems, which is a new type of educational space that integrates physical and virtual education spaces[27]. "Metaverse + pre-service teachers education" builds a new teaching model based on the theory of "SLD" and features such as super-domain learning and large-scale collaborative learning, as shown in Fig.2. In the metaverse vision, the physical learning space and the virtual learning space together form a composite learning space.
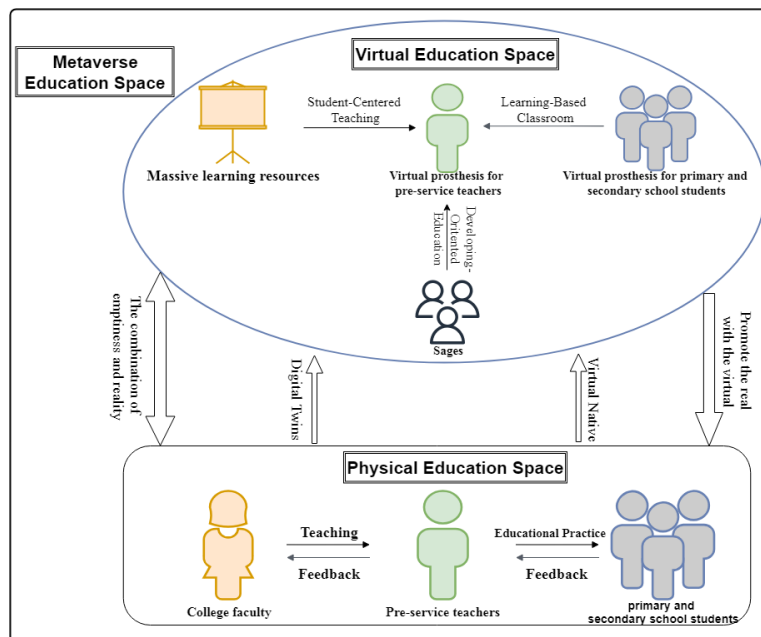

Fig.2. Metaverse + pre-service teachers education Model

3.2.1 Physical education space

The essence of physical education space is the space of educational scenes containing nature,

school and society in the physical world. By combining the characteristics of pre-service teacher education, a physical learning field belonging to teacher education is constructed, in which teacher-training students can put themselves into physical education space to experience the teaching process. Before the class, teachers can upload learning resources in the physical world for teacher-training students to master the relevant course contents in advance; during the class, teachers can choose different teaching methods to transfer knowledge according to different course contents; after the class, teacher-training students can give feedback to the teacher, and teacher will solve the teacher-training students' knowledge and skills, emotional motivation and other problems in a targeted way.

3.2.2 Virtual education space

Virtual education space is an imitative and transcendent educational scene space based on the Internet. Virtual education space is never a simple replica of physical education space, but a new space that expands space-time and dynamic interaction. First, the virtual world has a huge amount of learning resources, and pre-service teachers can fill the gaps of learning in the physical world as well as deeply explore their interests and build their self-confidence and pride. Second, educational practice in the virtual world is not limited by time and space, which reduces the time and resource costs for teacher educators to compare the effectiveness of different instructional designs. Finally, in addition to the cultivation of professional knowledge and teaching literacy, the cultivation of teacher education beliefs and teacher ethics for teacher trainees is also of paramount importance. In the virtual world, students can watch videos, explore in the field, sense interaction, and interact intelligently to develop the "virtue" of human beings.

3.2.3 Metaverse education space

The metaverse connects the physical learning field with the virtual learning field and is an important foundation for building a composite learning field, and the metaverse education space is the concrete embodiment of the composite learning field. First, in the metaverse education space, pre-service teachers' personality development and overall development are mutually reinforced, thus producing future teachers with individuality. Secondly, professional ethics can be effectively integrated with professional ethics. Finally, pre-service teachers can develop in the physical world and the virtual world synergistically, solving different problems through different fields in the metaverse education space, thus improving the learning efficiency and moral development of teacher trainees. The value of pre-service teachers is truly student-centered, nurturing-oriented, and firm in their beliefs.

4. Technical pathways for metaverse pre-service teacher education

The metaverse is the inevitable result of the development of various technologies in the information era, and a systematic theoretical and practical path has not yet been formed in the field of preservice teacher education. Therefore, this study refers to the operation mechanism of some online learning platforms and divides "metaverse + pre-service teacher education" into four layers in terms of technology path: infrastructure layer, human-computer interaction layer, software system layer and scenario application layer, as shown in Figure 3.
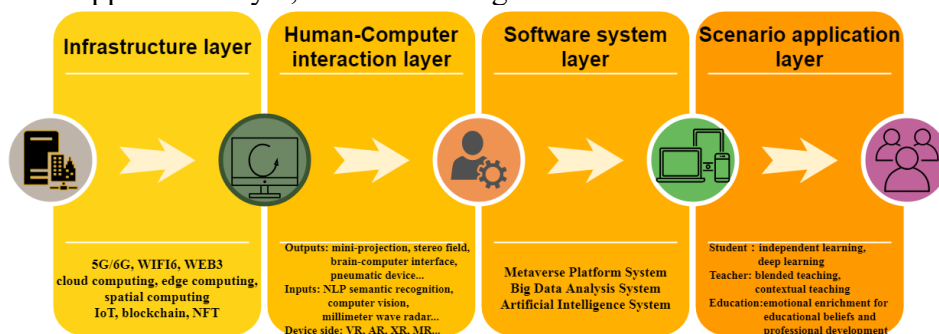

Infrastructure layer	Human-Computer interaction layer	Software system layer	Scenario application layer
5G/6G, WIFI6, WEB3 cloud computing, edge computing, spatial computing IoT, blockchain, NFT	Outputs: mini-projection, stereo field, brain-computer interface, pneumatic device... Inputs: NLP semantic recognition, computer vision, millimeter wave radar... Device side: VR, AR, XR, MR...	Metaverse Platform System Big Data Analysis System Artificial Intelligence System	Student : independent learning, deep learning Teacher: blended teaching, contextual teaching Education:emotional enrichment for educational beliefs and professional development

Fig.3. Pre-service teacher educational metaverse technical pathways

4.1 Infrastructure layer

The infrastructure layer provides the underlying architecture for the development of metaverse education and is the hardware foundation for the operation of the whole system[28]. The infrastructure layer is the beginning of the technology path, and this part mainly includes network infrastructure equipment such as 5G/6G and WIFI6 to provide a good network environment for students to interact with avatars and robots in real time; technologies such as cloud computing and edge computing provide arithmetic and algorithm guarantee for how to achieve greater computing effect and stronger robustness with limited facilities; IoT and blockchain technologies make students in the metaverse Democratization and decentralized socialization become possible.

4.2 Human-computer interaction layer

The human-computer interaction layer is a structure that collects information and acts on individuals through direct student contact with the device, and is mainly divided into the output side, the input side and the device side[29]. The output side is the device that transmits information from the student to the input side. The information transmitted can be either visual, auditory, tactile, taste, smell and other intuitive feelings or ideas judged by students' expressions, movements, intuition and other factors; the input side refers to the effective transmission of the information from the output side to the virtual human, the robot needs equipment, how to accurately translate into computer language is the key to this part; the device side is the bridge and link between the output side and the input side. The device side is the bridge and link between the output side and the input side, which currently refers to VR (Virtual Reality), AR (Augmented Reality), MR (Mixed Reality), and XR (Expanded Reality) technologies, and is a key facility for students' immersive learning.

4.3 Software system layer

The software system layer uploads the information collected at the human-computer interaction layer to the meta-universe platform system and big data analysis system through the equipment at the infrastructure layer, and makes feedback through artificial intelligence technology. The metaverse platform system, which mainly includes the metaverse operating system, language processing programs, database management system and other auxiliary software, is a crucial part of the student education experience. It should be noted that remote computing is required if the maximum value of arithmetic power at the infrastructure end is reached, so the infrastructure layer constrains the development potential of the software system layer.

4.4 Scenario application layer

The contextual application layer is based on SLD theory and provides learning contexts for college teachers and pre-service teachers to maximize individual development[30]. For teachers, inserting contextual teaching into the blended teaching is definitely a new green color for an efficient classroom; for pre-service teachers, they can learn subject expertise, pedagogical and psychological expertise and explore other knowledge of interest in the metaverse, as well as practice education in the metaverse to improve teaching skills and methods, and enrich students' professional attitude and professionalism. It also enriches students' professional attitudes and sentiments through human-computer collaboration.

5. Conclusion

This paper has explored the learning scenario based on the education metaverse and presented the technical architecture of the education metaverse. Admittedly, the application of metaverse in the field of teacher education is at the preliminary exploration stage, and various technologies are still immature, such as network technology cannot guarantee stable transmission of images, immersion devices do not conform to human physiological structure and are too costly, and the three real people, virtual people and robots generate inevitable ethical problems. With the rapid development of technology, we believe that in the near future the Metaverse platform system can significantly improve the level of pre-service teacher education in the world and inject new vitality into the

development of basic education in various countries.

Acknowledgement

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