

Exploration of Digitalization in Educational Scenarios in the Context of the Metaverse

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Abstract: This article explores the digital transformation of educational environments in relation to the metaverse. As an emerging phase in the evolution of the internet, the metaverse amalgamates diverse information technologies to establish a digital realm that harmoniously integrates virtual and physical realities. The educational metaverse, which is predicated on these technologies, exerts a considerable impact on conventional educational environments. Its implementation in education is anticipated to redefine critical components such as instructional resources, learning communities, educational contexts, and technological support, thereby offering learners an immersive and authentic three-dimensional educational experience. The metaverse serves as a virtual milieu that enhances pedagogical practices, presenting innovative avenues for knowledge acquisition and skill enhancement. This article explores the creation of an open space that reconciles the virtual and the real within the educational metaverse, examining its spatial manifestations across material, spiritual, and practical dimensions. Additionally, it addresses the shift from traditional physical spaces to virtual digital environments enabled by technological advancements. The article further evaluates the value and significance of the educational metaverse concerning technological empowerment and spatial construction in the realm of education.

Keywords: metaverse, digitalization of education, virtual reality, immersive.

1. Introduction

In the context of the digital era, the metaverse represents the third technological revolution in the history of internet development, permeating both practical applications and academic research. Significant breakthroughs have been achieved in artificial intelligence, big data, virtual simulation, holographic sensing technologies, and generative AI algorithms[1].The metaverse amalgamates diverse information technologies to establish a novel digital network space, facilitating user participation in a digital society that harmoniously intertwines virtual and real components alongside a digital identity. The implementation of metaverse technology within the educational sector leads to the development of an educational metaverse, which functions as a pioneering learning environment grounded in emerging technologies. The metaverse serves not only as a framework for educational activities but also as a fundamental basis for their development. This concept encompasses both tangible characteristics and social implications, representing a vital aspect of educational progress and transformation. The evolution of metaverse technology provides interactive, immersive, and

meaningful educational experiences, which are increasingly indispensable in modern education, especially in terms of engaging students' attention[2].

2. The Definition of the Metaverse

The term *Metaverse* originates from the 1992 science fiction novel *Snow Crash* by American author Neal Stephenson. The novel depicts a virtual world that exists in parallel with the real world, where individuals can enter this alternate realm through their avatars[3]. Ryskeldiev et al. argue that the metaverse comprises a collection of hybrid reality spaces that are mapped across various geographical locations, are persistent, and are continuously updated[4]. Park et al. describe the metaverse as a three-dimensional virtual world where avatars engage in political, economic, social, and cultural activities while interacting with the real world[5]. Xu et al. define the metaverse as a virtual universe that parallels the real world, facilitating communication between individuals and objects through digital avatars[6].

3. The Spatial form of Educational Digitalization within the Metaverse Framework

Henry Lefebvre, in his seminal work *The Production of Space*, introduced the theory of social space and proposed the trialectics of spatial practice. that human space is constituted by three dimensions: spatial practice, representational space, and represented space. Spatial practice refers to the actual utilization and perception of space in everyday life, representing the material aspect of space. Representational space encompasses the symbols, languages, and scientific knowledge associated with space, reflecting the mental or conceptual dimension. In contrast, represented space denotes the symbolic meanings and imaginations within space, representing an abstract realm crafted by human design[7]. This theory emphasizes that space is not merely a physical entity but also a product of social production, highlighting the intricate interplay between space and social structures, cultural practices, and individual experiences. Educational space, as a unique dimension of social space, encompasses the material, mental, and practical aspects. Technological innovation, serving as a catalyst for educational revolution, initiates transformations in the components of education and their interrelationships. Metaverse technology profoundly influences all levels of educational space.

3.1. The material space of virtual reality

The metaverse, a vast digital virtual environment that reflects the physical world, is constructed from data algorithms and enables the synthesis of reality and virtuality. It provides users with the opportunity to interact with both real and virtual identities, thereby altering the concept of physical presence. This integration surpasses the limitations inherent in traditional internet frameworks, advancing cyberspace towards a multidimensional, open transition that harmoniously merges the virtual and the real. The educational metaverse, characterized as a dualistic realm where virtual and real elements coexist, challenges the two-dimensional constraints of conventional online education, removes the barriers of physical educational settings, and promotes an open educational landscape.

The educational metaverse demonstrates its openness through two primary dimensions: educational resources and activities. In terms of resources, it combines both real and virtual educational content, facilitating the digitalization and widespread availability of educational materials. This integration allows users to access and modify resources freely, promoting collaborative creation and sharing. Regarding activities, the metaverse enables all users to participate in a variety of educational endeavors, including concerts, games, and lecture[8]. The educational metaverse provides educators and students with digital identities, facilitating their seamless participation in various educational activities. Educators are able to teach across multiple institutions, while students can engage in learning opportunities that span different institutions. This open and diverse educational

landscape offers an abundance of resources and complimentary educational activities for both educators and students, thereby nurturing a dynamic and enriching educational ecosystem.

3.2. Equitable and shared intellectual space

The understanding and creation of space necessitate a foundation grounded in life and existential meaning. The fundamental nature of space is influenced by the practical endeavors of individuals operating within it, as well as the relationships that emerge from these endeavors. The educational metaverse, leveraging innovations in virtual reality and digital twin technology, has transformed the conventional spatial relational framework. This evolution has led to the emergence of new roles for educators and learners, a redefinition of spatial relationships, an enhancement of pedagogical engagement, and an enrichment of emotional experiences.

The metaverse, through the utilization of advanced technologies, effectively captures the learner's state, encompassing foundational knowledge, behavioral performance, and learning characteristics. This capability facilitates the delivery of personalized learning content, methodologies, and assessments that are specifically tailored to meet individual needs. Such an approach is particularly beneficial for students experiencing learning difficulties and those who may lack motivation, thereby ensuring equitable access to educational opportunities. In this context, the role of the educator transitions to that of a more democratic and egalitarian facilitator.

Within the educational framework of the metaverse, the abundance of knowledge resources, collaborative storage platforms, and accessible methods of engagement cultivate an environment characterized by unlimited openness and fluidity of knowledge, thereby challenging the traditional notions of fixity and authority associated with knowledge. Consequently, the educator is no longer the exclusive authority on knowledge. In the virtual domain, digital media communication transcends the spatial and identity constraints of conventional education, transforming the educational landscape into an equitable and shared platform where students can actively participate and engage in meaningful dialogue. This transformation enhances students' participatory rights, discursive power, and recognition of their identities, thereby fostering the democratization of teacher-student relationships. This aspect represents a significant advancement over traditional educational settings.

3.3. Immersive Dynamic Interactive Practice Space

The educational metaverse establishes an innovative pedagogical framework that surpasses the conventional two-dimensional interface interactions characteristic of traditional online education. Through the utilization of technologies such as Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR), it facilitates the incorporation of embodied natural interactions and multisensory experiences[9].

The exceptional fidelity of this virtual teaching environment provides an immersive experience for both educators and learners, effectively merging the psychological and physical dimensions, as well as the real and virtual realms. This advancement elevates the level of interaction from a two-dimensional format to a three-dimensional, multimodal, and real-time interactive setting, fostering an open, collaborative, and dynamic space for engagement[10]. In this context, pedagogical components exhibit increased flexibility, allowing for a liberation of the physical presence of both educators and learners, while simultaneously enhancing the accessibility of resources. Various elements—including educators, learners, physical bodies, virtual avatars, educational materials, and learning environments—are able to interact and communicate with one another in a more unrestricted manner. The virtual representations of teachers and students serve to transmit the perceptions and experiences associated with their physical forms into the virtual educational domain. Conversely, the cognitions, perceptions, and emotions generated within this virtual context exert a direct influence on the physical

bodies of educators and learners in the tangible educational setting. This body-technology system effectively integrates the physical body into the virtual environment, fostering a profound sense of immersion characterized by presence and embodiment. For example, the virtual reality system utilized by the National Library enhances conventional static learning environments through non-contact virtual reality technology, thereby providing learners with more authentic visual and auditory experiences. The educational metaverse transforms the learning environment by enriching the meanings associated with its various components, revitalizing the structure of the educational setting, optimizing spatial relationships, and instigating significant disruptions within educational contexts.

4. The Value and Significance of the Metaverse in Empowering the Digitalization of Education

The educational metaverse transforms the manner in which individuals engage with spatial environments, incorporating novel attributes into educational settings. Concurrently, these emergent spatial configurations have a reciprocal impact on pedagogical and learning methodologies.

4.1. Technological Empowerment: Constructing New Virtual Teaching Scenarios

The revolution in digital technology, marked by developments in artificial intelligence, big data, the Internet of Things (IoT), digital twin technology, and virtual reality, has significantly altered the educational environment. Digital twin technology facilitates the creation of novel instructional scenarios, whereas virtual reality contributes to the cohesive integration of diverse curricula. Furthermore, mixed reality interaction technology enhances pedagogical approaches[11]. The emergence of metaverse technologies poses a challenge to the necessity of physical presence by facilitating the creation of blended environments that effectively merge virtual and real elements. This integration significantly modifies the operational dynamics of educational settings, leading to a shift from conventional classrooms to immersive virtual environments. Digital spaces are increasingly acknowledged as a vital form of educational context, thereby transforming the conceptualization of the future of education into a concrete reality. Research conducted by Jie Yuan and colleagues has involved virtual experiments that integrate both virtual and real components, resulting in the development of multimodal smart classrooms that enhance the efficiency of interactions between individuals and digital entities. These advancements serve to alleviate cognitive load for users and reinforce their sense of reality and engagement in operational tasks, ultimately fostering greater interest in the learning process[12].

4.2. Spatial Construction: Maximizing Educational Value

The deep immersive learning environment significantly enhances student engagement. The metaverse, utilizing digital twin technology, has established a blended virtual and physical higher education landscape, offering learners an immersive educational experience devoid of external distractions. In this setting, students can overcome physical limitations and engage deeply with rich socio-cultural contexts, such as virtual libraries, study rooms, and activity spaces. These virtual environments can be tailored to meet individual needs and provide sensory experiences that closely resemble real-world settings, effectively promoting situational learning and igniting students' enthusiasm for learning.

Multidimensional interactive teaching has significantly enhanced the engagement of educational participants. The interactive technologies within the metaverse have transformed teaching and learning models, enabling seamless communication among multiple participants in higher education, regardless of their virtual identities or physical appearances. This advancement has notably reduced the divide between real and virtual societies. With the support of these interactive technologies, classroom models can expand into multiple dimensions, offering diverse teaching methods that

address the limitations of online courses in terms of realism and engagement. Students can leverage metaverse technology to interact with global education experts in simulated real-world scenarios, free from the constraints of time and space. This approach provides a more effective learning and social experience for various participants, including teachers and students, amplifies students' voices in the learning process, and fosters barrier-free communication between educators and learners.

5. Conclusion

The metaverse, as a new field of educational innovation, continuously pushes the boundaries and functions of educational spaces into broader areas through its integration of virtual and real elements. This study explores the spatial forms and value significance of educational digitization within the context of the metaverse. By applying artificial intelligence technology, it aims to achieve the construction of spatial scenarios to build an open, shared, and inclusive educational ecosystem. The digitalization of education leverages technologies such as virtual reality to transfer some functions of physical spaces online. This not only promotes remote collaborative learning and interaction but also enhances students' initiative and interest in learning, encouraging them to independently exercise their creativity and imagination within the space and participate in the co-construction of that space. Education is not just the transmission and reproduction of knowledge; it also encompasses a rich dimension of meaning.

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