ISSN (e): 2250 – 3005 || Volume, 13 || Issue, 2|| Mar.-Apr. – 2023 ||
International Journal of Computational Engineering Research (IJCER)

# Metaverse in Education-Culmination of Technologies

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***ABSTRACT***
*The metaverse, a 3D digital environment that combines the actual and virtual worlds, has been hailed as a significant trend in future education. The previous study, however, hardly ever discussed the metaverse from the standpoint of education because it is still a new topic. In this paper, discuss several metaverse visions and their origins, definitions, and commonalities.*
***Keywords:*** *Metaverse, actual world, virtual world.*

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Date of Submission: 08-04-2023 Date of acceptance: 22-04-2023

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## I. INTRODUCTION

Some physical world activities have made their way into the virtual world. Online meetings, distant learning, online purchasing, and other activities such as telecommuting have all become commonplace in modern life. As a result, the desire for a more developed virtual world has increased as humankind's quest to push the limits of the physical world has intensified (Suzuki et al., 2020)[1]. The metaverse, a 3D digital realm with collapsed virtual and actual boundaries, has drawn increased attention as a result of the advancement of VR (virtual reality), AR (augmented reality), AI (artificial intelligence), blockchain, etc. It has been acknowledged as the Internet's next generation, which is about to fundamentally alter how we connect with the outside world (Hwang and Chien, 2022)[2].
The majority of educational scholars may not be familiar with the metaverse's definition, elements, and implications because it is a new concept.

To provide a thorough understanding of the metaverse in education, including its definition, structure, typical features, potential applications, obstacles, and future research topics, this research study will evaluate a number of sample papers. The following are some of this paper's significant contributions:
• A detailed framework of the metaverse in education is proposed, along with the discussion of features of metaverse-based learning compared with in-person classroom learning and screen-based remote learning.
• The origin, definition, and typical features of the metaverse are discussed with the perspectives taken from state-of-the-art studies.
• The metaverse's potential uses, difficulties, and potential research areas in education are discussed.

## II. LITERATURE SURVEY

The term "metaverse" refers to a new virtual universe that combines the words "meta-" (beyond; transcending) and "verse" (the root of "universe," cosmos; the entire globe). Produced beyond the physical world. The word "metaverse" was invented by American author Neal Stephenson in his 1992 cyberpunk science fiction novel Snow Crash (Stephenson, 1992[3]; Joshua, 2017)[4]. In this story, humans could freely access and interact with each other in a 3D universe that mirrored the actual world via digital agents (avatars). Throughout the next three decades, science fiction films such as Ready Player One, Lucy, and The Matrix powerfully illustrated the metaverse notion (Zhao et al., 2022)[5]. At that time, the metaverse envisioned by filmmakers, could not come into being in reality.

The fast advancement of new technologies, such as wearable gadgets and three dimensional (3D) photography, has enabled people to gain access to the virtual world throughout this decade. The sandbox game Roblox was listed in New York in March 2021 under the halo of "the first stock of the metaverse"; in October, Facebook announced its rebranding strategy and changed its name to "Meta." Since then, governments all around the world have made significant efforts to make it a reality. This dormant "lion" had been roused.

As noted by researchers, education is one of the most major uses of the metaverse with huge promise in the coming future. We believe that the presence of the metaverse can be used to create a new educational environment (Suzuki et al., 2020; Prieto et al., 2022[6]; Rospigliosi, 2022[7]); thus, the metaverse in education can be viewed as an educational environment enhanced by metaverse-related technologies that fuse with elements of the virtual and real educational environments. It enables learners to access the educational context via wearable devices without regard to time or place, and it allows them to utilise digital identities to interact in real time with many types of things (e.g., avatars, intelligent NPCs, or virtual learning resources).

## III. METHODOLOGY OF METAVERSE

Kang (2021) offered a metaverse architecture with possible fundamental stacks such as hardware, computation, networking, virtual platforms, interchange tools and standards, payments service, content, service, and assets in prior literature, as well as briefly described its arguments. Nevertheless, there are no more explanations concerning the metaverse's implementation in detail. Park and Kim (2022) split the metaverse into three fundamental components (i.e., hardware, software, and contents) and three approaches (i.e., user interaction, implementation, and application) for the metaverse in a broad sense.

Another Scarce suggested metaverse effort in teaching comes from Hwang and Chien (2022). They examined the responsibilities of intelligent tutors, intelligent tutees, and intelligent peers in delivering educational services, as well as prospective metaverse uses for educational settings from the standpoint of AI. Yet, the metaverse is not created by a single technology, such as AI, but rather by the integration of several technologies. In light of the limited studies that have examined the metaverse for educational purposes, we suggest a framework for the metaverse in education based on the perspectives gathered from the research publications.

In this part, we will outline the framework of the metaverse in education and delve into its essential components, as represented in Figure 1.

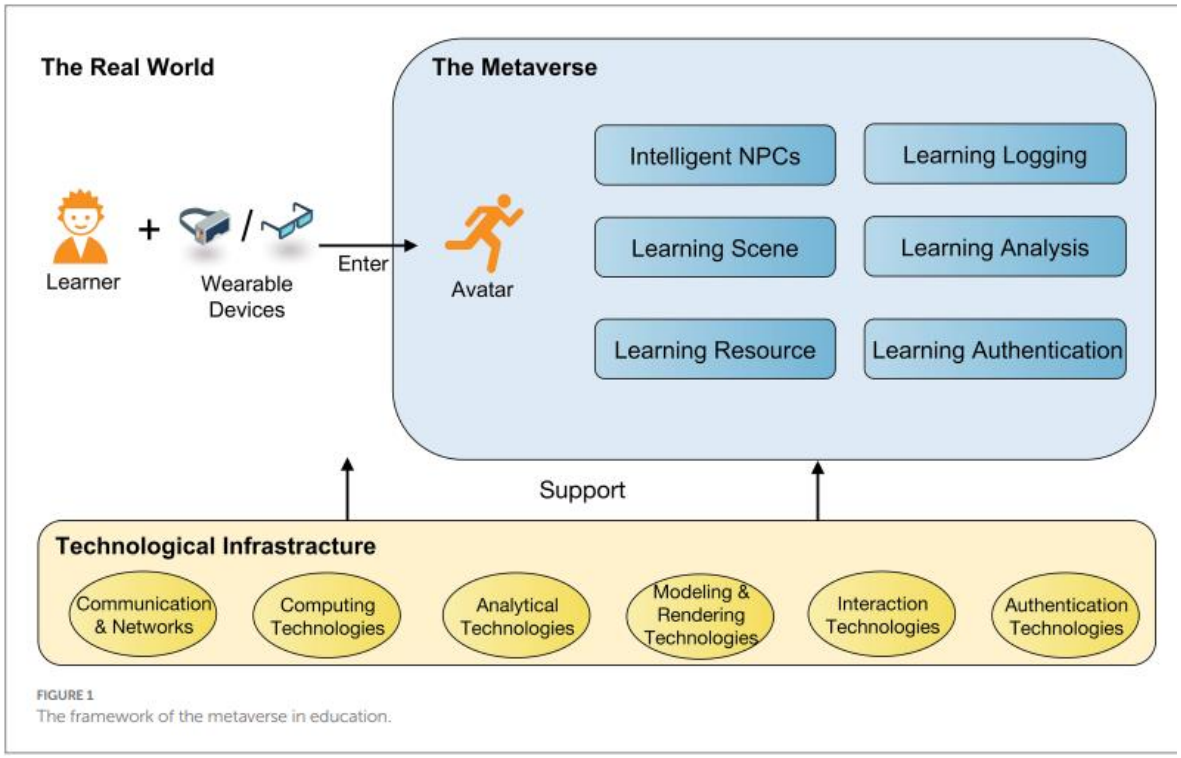


FIGURE 1
The framework of the metaverse in education.

At first glance, the metaverse appears precisely as a result of technological maturity, implying that the implementation of the metaverse in education is heavily reliant on cutting-edge technology. As a result, a variety of technologies might form the metaverse infrastructure in education, responsible for providing great support for the components both in the actual world and the metaverse world. Below is a breakdown of each component of the metaverse's technical infrastructure in schooling.

**3.1 High speed communication and network:**

According to researchers, wireless communication and high-speed networks, such as 5G or 6G, are essential for the deployment and operation of the metaverse world. The metaverse can maintain fluency, stability, and low latency for data transfer, scene display, instant feedback, and user connection with the use of high-speed networks. On the other hand, high-speed networks enable learners to smoothly transition from the physical world to metaverse instructional settings.

**3.2 Computing technologies:**

Because the metaverse is a multi-player space, computing technologies (e.g., edge computing, cloud computing, distributed computing) are required to process, compute, store, transmit, and interchange data and information between the virtual world and the real world, as well as among users . In this situation, these technologies can assist learners in more correctly, efficiently, and synchronously storing, utilising, and sharing learning data (e.g., learner information, learning records, learning materials).

**3.3 Analytical technologies:**

With the fast growth of analytical technologies, associated technologies such as artificial intelligence (AI), big data, and text mining have been identified as important tools in the educational area. AI in the metaverse can play an essential role in providing intelligent NPC tutors, intelligent NPC tutees, and intelligent NPC peers to assist arbitration, simulation, and decision-making educational services. As a result, including analytical tools in the metaverse can aid in measuring, tracing, collecting, and analysing learner learning data (e.g., learners' actions, emotions, preferences, and performances). Additionally, in light of this data, the metaverse may not only allow teachers to assess learners in a thorough fashion but also provide learners with personalized resources and services.

**3.4 Modelling and rendering technologies:**

The metaverse intends to build a 3D digital universe that is both virtual and real, with diverse replicated or reflected sceneries, avatars, NPCs, and so on. There are now various modelling and simulation tools for creating virtual things, such as Sketch Up, Unity, and Blender (Tlili et al., 2022). The worldwide trend of VR or AR research has also enabled the creation of lifelike 3D material (Wu et al., 2013; Parmaxi, 2020); nonetheless, Park and Kim (2022) feel that the metaverse is much more than VR or AR, but a notion more akin to XR. Some researchers (for example, Lv et al., 2022) have suggested that technologies like as digital twins, holography, and MR (mixed reality) can be employed to represent and portray the metaverse environment.

**3.5 Interaction technologies:**

Embodied and multimodal interaction distinguishes the metaverse frothe traditional Internet.Users' manipulations, navigations, collaborations, and sensory feedback (e.g., vision, audition, and kinesthesia) in the metaverse require interaction technologies such as VR, XR, sensors, real-time tracking, IoT, and BCI (brain-computer interface) (e.g., Davis et al., 2009; Genay et al., 2021; Prieto et al., 2022). Learners may move their bodies with the use of interactive technologies to participate in various exploratory learning activities, cooperation, and socialisation, in order to activate different sensory organs and receive real-time feedback. To some extent, the metaverse can deliver real and embodied learning experiences for learners.

**3.6 Authentication technologies:**

According to some researchers (e.g., Berg et al., 2019; Vergne, 2021; Thomason, 2022; Yang et al., 2022), blockchain is the most representative authentication technology in the metaverse because it can provide transparent, open, decentralised, and reliable services while also protecting users' privacy, allowing the metaverse world to have a sustainable ecosystem. In this respect, blockchain may be used to not only make learners' data and metaverse works unforgeable and traceable, but also to avoid some undesirable situations, such as fraud or plagiarism.

## IV. FEATURES OF THE METAVERSE IN EDUCATION

Based on the suggested metaverse in education framework, it is clear that learning in the metaverse environment will not feel the same as studying in a traditional classroom or screen-based video-conferencing platforms. Table 1 compares in-person learning to screen-based remote learning and metaverse-based learning. It is clear that metaverse-based learning is more than a hybrid of in-person and screen-based remote learning, and it is likely to compensate for both's shortcomings. As a result, each trait and its significance are explained as follows:

| Factor | In-person classroom learning | Screen-based remote learning | Metaverse-based learning |
|---|---|---|---|
| The time and location for learners to participate in class | At a fixed time in accordance with the class schedule and school timetable in the real classroom | Available only when a teacher opens a meeting on the video-conferencing platform | Without being limited by either time or location |
| Learner identity | Real identity | Real identity | Customized and dynamic digital identity (avatar) |
| The people learners interact with | Real teachers and peers | Real teachers and peers | Real teachers and peers in the form of avatar, or virtual teachers and peers in the form of intelligent NPC |
| Learning scene | Real learning scenes | Real learning scenes | simulated learning scenes |
| Learning resource | Mainly printed or multimedia learning resources that learners usually cannot interact with | Mainly multimedia or online learning resources that learners usually cannot interact with | Mainly visualized or decentralized learning resources that allow learners to interact |
| Learning activity | Primarily based on lectures from teachers | Primarily based on lectures from teachers | Primarily a series of contextualized learning activities in 3D learning scenes |
| | Allows learners to participate in a series of learning activities, except in the pandemic era | Cannot easily allow learners to participate in some complex learning activities | Allow learners to participate in a series of learning activities virtually, |
| | | | Can support remote collaboration |
| | Allow learners to collaborate with peers, except in the pandemic era | Cannot easily allow learners to collaborate with peers | Initiate activities more like inquiry-based or problem-solving tasks |
| | | | Facilitate creative learning activities |
| Learning experience | Mainly based on face-to-face communication | Mainly based on online communication with video and audio | Mainly based on multi-sensory and embodied participation |
| Learning objective | Mainly aims to develop low-order cognitions | Mainly aims to develop low-order cognitions | More easily to develop high-order cognitions |
| | | | Mainly aims to achieve more comprehensive learning objectives |
| Learning assessment | Focus on learning results | Focus on learning results | Combine with formative and summative data |
| | Based on summative data | Based on summative data | Pay more attention to learners' growth |

Table 1- Comparisons of in-person classroom learning, screen-based remote learning, and metaverse-based learning

### 4.1The time and place for students to engage in class

People can transcend time and space in the metaverse by employing high-speed networks or computational technology. From this perspective, the metaverse enables teachers to experiment with different modes of learning implementation, such as synchronous and asynchronous learning. Learners, for example, can utilise avatars to join the metaverse realm and study by engaging with intelligent NPCs teachers in a preset method. As a result, the flexible mode of interaction can provide ease and independence to both instructors and students.

### 4.2 Learner identity

Learners use their actual names to attend lessons in either the physical classroom or the video-conferencing platform. In the metaverse, students can portray themselves in a variety of ways. They attend lessons using personalised, realistic, and dynamic digital identities (i.e., avatars). In the metaverse, avatars are digital representations of real-world player characters. Learners can gain a sensation of being in the metaverse by manipulating and managing their avatars in a new pleasurable and entirely immersive way.

### 4.3 Learning objectives

Because of some of its peculiarities, the metaverse allows learners to engage in various types of learning activities regardless of whether they are in classes or not, which may assist learners in applying, analysing, evaluating, or creating knowledge more easily throughout the learning process. To some extent, it will have a influence on the development of learners' objectives from high-order to low-order. In other words, in the metaverse, learners can not only acquire fundamental knowledge but also build skills and capabilities for future life, resulting in more holistic growth throughout the learning process.

### 4.4 Learning assessment:

Due to the difficulties of capturing learners' performance and collecting their learning data in traditional learning settings, teachers frequently assess learners summatively through learning results. In this instance, scores will be the sole indicator of learners' learning, resulting in undesirable consequences such as educational inequity. Teachers may analyse learners' performance more completely in the metaverse with the help of learning logging and learning analysis based on both formative and summative data. Most importantly, it focuses on learners' progress rather than results, breaking free from some of the limits of traditional evaluation.

## V. FUTURE ENHANCEMENT

It is interesting that several prospective metaverse uses such as gaming, working, or learning were clearly exhibited when Mark Zuckerberg introduced the rebranding plan of Facebook in a live-streamed virtual fashion. Both students and professors can escape the constraints of time and space in the metaverse. More importantly, the metaverse's quirks will unleash a plethora of fantastic learning opportunities for learners, allowing them to observe, investigate, and create the world in new ways. As a result, it is possible that the metaverse world will provide a new avenue for future education.

### 5.1 Blended learning is aided by the metaverse.

Screen-based remote learning using videoconferencing systems such as Zoom, Google Meet, or Teams has become the standard during the COVID-19 pandemic. 263 students using VR headsets congregated in the metaverse through the Zoom and ENGAGE platforms. During the metaverse learning sessions, learners were required to participate in a range of virtual and remote activities, such as big group field excursions, small group panels, quizzes, and designing virtual places both alone and collectively. Figure 2 is a screenshot of the metaverse platform's class discussion area In this way, the metaverse provides both teachers and learners located in diverse physical locations with numerous chances to participate in educational settings via wearable devices. Learners can connect constructively with either real or virtual professors and peers in various learning scenarios by using avatars to participate in various learning activities. Learners' engagement and learning interest may be considerably increased through such modes of learning. More importantly, the challenges that now exist in video-conference learning may have a practical solution.

### 5.2 The metaverse facilitates learning through virtual experiments

Virtual experiment learning is critical in natural science courses. According to some scholars, virtual experiment learning faces numerous challenges, including limited funding for materials and infrastructures, a lack of solutions to the closure of physical laboratories due to COVID-19, and so on, which has resulted in practical experiment training being prioritised over theoretical learning. With the support of modelling and rendering technologies, a virtual laboratory may be formed virtually in the metaverse, as can the experiment instruments projected in 3D to the virtual world to execute a range of virtual experiments. In this sense, using the metaverse for virtual experiment learning may overcome physical world constraints space, budgets, locations, equipment, or potential risk, as well as allow learners to witness, measure, record, and alter experiments in a stand-alone or collaborative manner remotely. Based on these advantages, using the metaverse in virtual experiment learning might be beneficial.

### 5.3 Language acquisition is aided by the metaverse.

Language learning has been essential for obtaining bilingual or multilingual competency for K-12, higher education, or professional fields since the twenty-first century. Traditional language acquisition, on the other hand, has been absorbed passively, either in or out of the classroom, for a variety of reasons, including a lack of contextual practise or engagement. One speaking session, for example, aims to improve spoken abilities by simulating a discussion about inquiring for flight information in an airport setting. In the actual world, instructors cannot, for example, transport an entire class of students to the airport or ask airport personnel to visit the school.

It is difficult for him or her to contact acquaintances and assemble to practise English. Once in the metaverse, this learner might ask his or her spouse to enter the virtual world through avatar and then remotely rehearse conversations in a previously constructed or rebuilt situation.

### 5.4 The metaverse contributes to inclusive education.

Inclusive education is implemented to allow every kid, regardless of special needs, to obtain education and required assistance in mainstream educational settings. Based on the metaverse's features, it is understandable that the metaverse might be used as an ideal zone that allows children with special needs to study alongside general learners. Initially, identity differences are a significant barrier to the integration of learners with special needs in general schools with general learners . Following that, metaverse technologies might expand those learners' affordances of organs and senses to converse and engage regularly with general learners while obtaining sensory inputs and cognitive growth during the learning process. Furthermore, because learners with special needs learn differently than regular learners, the metaverse may support learners with individualised learning and specific services based on physical and emotional data via computers, big data, learning tracks, and so on.

## VI. CONCLUSION

The technological advances in high-speed communication, computers, AI, and virtual technologies have created several opportunities for the development of the metaverse (Park and Kim, 2022; Thomason, 2022). By 2027, approximately 30% of people would spend 2 hours per day in the metaverse for work, leisure, education, and sociability, according to Gartner (2022). The existence of the metaverse in education is a totally new notion when contrasted to existing educational tools. As previously said, the metaverse can provide tremendous potential and advances in education. A multitude of hurdles and constraints in contemporary schooling might be overcome to some extent in the metaverse environment.

Furthermore, incorporating the metaverse into the educational area may raise various contentious concerns (e.g., security, ethics, or addiction) that require additional debate; otherwise, the "metaverse" will be a "metaworse." It is more important for educational scholars to consider how to use the metaverse to overcome the limits of existing education and maximise its good impacts on future education. As a result, the emergence of the metaverse in education is both thought-provoking and eagerly anticipated.

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