

Metaverse in Education Sector: Current Theories, Research, and Future Directions

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Abstract

Education methodologies has taken a complete revamp since the declaration of the Covid-19 pandemic across the globe. The teaching and learning methods became dependent on virtual framework during the Covid-19 Pandemic. Metaverse refers to 3D digital space which bridges the gap between real and virtual world with the help of advanced technologies. The current study highlights its origin, features and possible application in the education sector. Metaverse could be an essential tool in the education sector especially in this era. The current work also provides in-depth discussions of metaverse's features.

Keywords: Metaverse, extended reality (XR), AI, IoT, AR.

1.0 Introduction

The COVID-19 Pandemic has forced people around the world to live at their home, with social gathering completely ruled out, people were mostly dependent on virtual medium to replace the daily activities, such as office work, gathering, social events etc. Education sector¹ was not pardoned from this sudden change as well, as the teaching learning method also adapted the virtual mode. The need of human interaction under these circumstances^{2,3} were quite clear. With the help of breakthrough technologies such as Artificial Intelligence, Augmented Reality, Virtual Reality etc., a new domain to bridge the gap between real and virtual world was introduced, namely the metaverse. Through many researches, it is predicted that Metaverse⁴ will be heavily involved to solve the problem of lack of social interaction among people.

The word meta refers to beyond or transcending and verse refers to the root of the Universe; which combines to provide the meaning of "Metaverse" referring to a virtual world with

advanced technologies which is beyond the real world. The concept of Metaverse⁵ has existed since 1992 through various forms of arts such as literature, movies, novels etc. The recent advancement of emerging technologies such as Artificial Intelligence, Internet of Things, Virtual Reality, Augmented Reality, Extended Reality, Data Analytics, Cloud computing, Edge computing etc. has opened the opportunity to materialize the concept of Metaverse into reality. Currently, there are various modelling and simulation solutions for creating virtual elements such as Sketch Up, Unity and Blender¹. The overall trend in VR and AR research has also resulted in photorealistic 3D content. By convention, teachers and students meet in the classroom which is only available for the learners, as per schedule or through e-learning when the teacher²¹ starts the video-conferencing system and the learners join in. In addition, there are metaverses focused on selling services and accessories, like shopping centres, where the avatar can make purchases equivalent to reality. metaverses can be found for specific educational purposes, such as visits to libraries, museums and university classrooms, text games and archaeology among others.

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Zhang et al in 2021 introduced⁶ the concept of Metaverse. In this paper they introduced the current existing technologies and also discussed about future directions of the Metaverse. There has been significant research about the applications of metaverse⁷, technologies and advancement of the metaverse. But barely any of the work has focused on the impact of metaverse in education sector. The current paper aims to provide insight into the metaverse in education sector.

The rest of the paper is organized as mentioned below: Section 2 discusses the existing technologies in metaverse. Section 3 talks about metaverse in education sector, sector 4 discusses about applications of Metaverse in education sector; paper concludes in section 5.

2.0 Existing Technologies in Metaverse

It is not possible for the Metaverse⁸ to offer some services that require touch or percussion, surgical procedures and percussive examinations. But the Metaverse offers various types of services ,e.g. learning, interaction, e-healthcare etc. The existing technologies of Metaverse are shown in Fig.1 and discussed in the current section.

A. Blockchain

Blockchains are distributed and encrypted databases that offers how to store and transfer data securely. Blockchains [9] are not the technology behind cryptocurrencies such as Bitcoin. Sharing data by many organizations are not secure enough from owner's side. On the dark web a single health records worth between \$70 and \$100 as it is stores on the centralised servers. Accessing such records legitimately takes longer time and it is laborious too.

B. Extended Reality

Metaverse will use Extended Reality (XR) to engage users with 3D content¹⁰ which will allow information-based content to move from a knowledge base to an experience base. Simultaneously, there will be a revolution in health communication system. The users will be manipulated in treat and coping appraisals. As a result, XR affordance can be used to improve healthy behaviour across three major application domains such as presence, agency and embodiment. XR, in reality, can create realistic experiences that creates genuine emotional, social, cognitive and behavioural responses based on abundant evidence.

C. Network and Communications

A network in an interconnection^{11,12} among two or more linked computer, physically and logically. A physical network

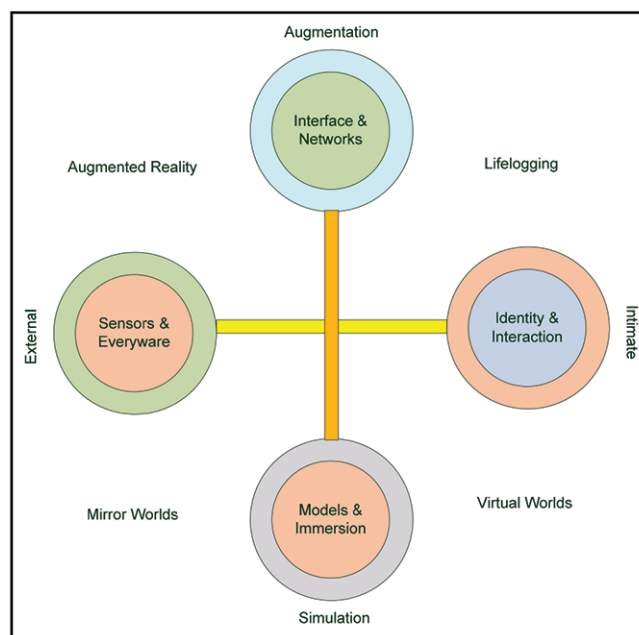


Figure 1: Block diagram of the Metaverse's methodology

consists of network's hardware such as telephone lines, cables and adapters. The logical network is the software and conceptual model. There are different networks and conceptual models¹³ that serve various purposes depending on the complexity of modern computer. OSI (Open System Interconnection) model satisfies ISO (International Standard Organization) is a seven layer architecture model and is used most frequently.

D. Layers of Computing

Measured data is processed on sensors or devices close to sensors in fog computing. It does not control the devices on the cloud or remote healthcare centres. Due to increasing amount of patients fog computing and cloud computing are on the increasing demand. Sodhro and Zahid using deep learning algorithms proposed the pathology location framework for smart healthcare system. Based on electroencephalogram signals it is possible to recognize pathology.

Three layers of computing in the metaverse is proposed to handle huge computation needs as a single layer infrastructure cannot handle huge computation needs in the metaverse. Rendering of images and videos is a core component of metaverse. The layers are discussed below:

(a) Cloud Computing Layer

Metaverse needs huge amount of computational power, storage space and fast and advanced communication technology. Increment of user-based cloud computing is must

and essential for any metaverse application. One use of cloud computing for metaverse is cloud gaming.

(b) Fog Computing Layer

Fog computing is the 2nd layer of computing in the metaverse. It is a layer between the cloud computing layer and edge computing layer of metaverse. The fog computing for metaverse minimizes the burden of cloud computing.

(c) Edge Computing Layer

Edge computing is the most essential layer among the 3 layers of computing in the metaverse. Edge computing is done at or near or edge of the source of the data being generated. Edge computing basically connects edge devices such input devices, sensors, IoT devices, etc.

When data is transferred from edge devices to the cloud computing layer fog computing layers play important role to lessen the burden of cloud layer if unnecessary data is transferred anytime, it will burden the cloud computing layer.

Cloud computing¹⁴ servers process the data and transmit it to the fog node. This confirms the analysis confirm that the proposed system is suitable. Sensors and IoT devices generate large volumes of data and the priority of usage and the required bandwidth for transmission¹⁵ must be handled. Network overhead and energy consumption are reduced by offloading data processing and storage to edge servers. The proposed framework provides lower latency and reduces overall energy consumption based on simulation results.

3.0 Metaverse in Education Sector

Metaverse is an amalgamation of the prefix “meta” which insinuate transcending with the word “universe” which describes a parallel or virtual environment linked to the physical world.

A. AI-Based

With the technology of Artificial Intelligence (AI), the metaverse technology will show as the personalized approaches in education. The main advantages of AI-based metaverse learning¹⁶ are, it has the spaces to respond with each student’s individual needs. The technology will give you the personalized based learning which mainly concern with the following application, i.e.: Multilingual learning application (Rem Darbinyan, 2022) for speech-to-text translator, text-to-speech converter and machine translation technologies enrich the learning process, Information Visualization is like a VR (virtual reality) in artificial intelligence which entitled new innovative techniques of perceiving information in the metaverse learning by enabling students or learners to learn the material through experience

and visuals, which helps process visual information faster and take in more information.

B. IoT Based

As the world is connected with the internets all time, so we need to develop application and software in metaverse learning in education. For this reason, Internet of Things is the one of the areas because using this concept we can manage the class attendance of the students and the availability of the necessary educational equipment through IoT¹⁷ sensors. With the help of IoT based concept in metaverse learning we can create a smart wearable device in metaverse framework^{18,19} proposed which can help students to enter into the virtual universe like classroom. As the smart wearable device can help learners to create connection between real world to the virtual world without any disturbances.

C. XR-Based

The collection of augmented, mixed and virtual reality is called the extended reality (XR). It represents a variety of technology where each of these sub-technologies are embedded between a completely computer-generated virtual environment which is totally virtual one and the physical reality on the other. Using the literature, they proposed an environment in real-time using audio-visual devices like smartphone or headphones, they can enter into XR metaverse based on the degree of virtually or the ratio of virtual versus physical content. One of the XR-based metaverse that are important in education that is – living laboratories for every subjects. Also, use of metaverse is online classroom it is very useful since the period of covid-19, 2020. Also, there are males ninny more applications which will give the proper output for the given context.

D. Some Common Mistakes

The immersive technologies are other types of XR- based educational learning that is very difficult to achieve. In the context of the above, XR hardware¹⁸ can access stereoscopic image and spatial people etc which helps students. Users can place 3D objects in their environment from educator through the online perspective, and feel as though they are sharing the space with the content itself. The technology also offered to personalization and visualization etc.

4.0 Application of Metaverse in Education

The current section discusses the application of metaverse in education sector. Teaching learning methods that are using

advanced technologies are commonly known as smart learning. Metaverse can be applied in different categories of smart learning.

A. E-Learning

As reported by researchers, wireless communications and advanced network systems such as 5G or 6G, are the foundation conditions in the metaverse applicable technologies. These network systems help the metaverse to maintain fluidity, stability and low latency for data transmission, connection among users, real-time feedback and scene presentation.

When eLearning¹⁹ is well designed, it provides highly interactive experiences for learners. With the online learning delivered in the meta worm, instead, learners may move to a virtual space to participate in the learning content, which is a lot more interactive than pressing the next button. Scenarios are very effective tools in online learning courses because they place learners in concrete simulations where they can apply what they have learned. The metaverse increases the potential of the scenarios because the simulation can go from an essentially textual description to a visual virtual space. Metaverse understands situations and places that would be very hazardous in the real world. The creation of these situations or locations in the metaverse's virtual space allows students to be placed in difficult situations. with no risk to their personal security.

B. Hybrid Learning

Interactivity, embodiment and persistence are three important aspects of metaverse²². Metaverse can range from micro-situations to wide-spread areas such as gaming; fantasy which involves existence of virtual world. Additionally, metaverses is also applicable to simulate situations based on real world problems. The examples of such can be military training, vehicle and transport operation in general, city design, landscaping, etc. Hybrid learning uses such concepts. Hybrid learning refers to the educational framework in which students can join the class physically or virtually. Additionally educators can also teach virtually or physically.

The fast growing analytic technologies such as Big data, Machine Learning, text exploration have been found to be quite useful in e-learning domain as well, providing deep analysis into student's need and outcome based learning. Metaverse uses multiple technologies such as distributed system, cloud computing, artificial intelligence, big data, data analytics etc. in order to provide multiple layers in the framework. This also helps to store, exchange and transmit data and information between real and the virtual world. Metaverse aims to provide a bridge between real and virtual

world merging them both to obtain maximum benefit from the technologies used such as using different simulated or mirrored scenes, avatars, NPCs, and so on. A consideration concerning the management of virtual worlds for education., is to facilitate the student a new study tool in which mobile technology and mixed learning, platforms are integrated, allowing the teacher new means and methods of teaching.

C. Microlearning

Microlearning²³ can be done via video, app, gamification, infographic and social media. Researchers have proved that microlearning helps to teach any important topic faster than usual learning methodologies. It can be consulted at any time or anywhere. Micro-learning is flexible to adapt to different learning styles and can be adapted to the needs of students. With short equipment, students can select the equipment that is needed, wanted and relevant. Microlearning helps to raise student retention rates and understanding levels. Microlearning concept is totally based on breaking the lecture content into micro-segments to make it easier for students to understand and remember the lecture contents. Additionally it also makes teacher's job easier as the contents are broken into small sections, hence updation, maintaining lecture and lesson plans becomes easier. The major problem of microlearning is it being inappropriate for complex and complicated material, and needs a detailed explanation. How you learn depends on your learning goals. If the material is in small parts, it may interfere with students' ability to fully understand it. Teachers have an obligation to produce their learning content. Microlearning strategies relate to individual learner qualities, teachers' propensity to use digital technology, and external circumstances such as the availability of learning materials.

5.0 Conclusion

With the advancement in the communication, computing, Artificial Intelligence, Internet of Things, virtual technologies etc; it has opened fantastic possibilities in the domain of metaverse. Gartner et al. in 2022 provided a statistic according to which 30% of the existing people will use metaverse²⁴ for at least 2h/day for entertainment, education, socialization, treatment, work etc. Although in the education sector the term Metaverse^{25,26} is quiet knew. The current paper discusses about various types of learning methodologies which can be adapted easily through metaverse. The opportunity for innovation in the education sector is quiet huge with the involvement of metaverse in it. Despite all the solutions it will provide; this will also come with certain limitations and drawbacks, such as continuity, security issues; privacy etc. In near future all possibilities will be studied through various

research works to establish a firm framework of metaverse in education sector.

6.0 References

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