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Use of Metaverse Technology in Education Domain

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Abstract— ***Metaverse is the digital mirror of the physical world where users are connected as individual avatars. The purpose of the virtual surface where it should gather and mirror actual-time global statistics and also inquire for immersion is to link the physical and digital worlds. Users' physical inputs may be used to train artificial intelligence (AI) systems to provide client users with highly customized offerings. This technology offers an appropriate answer in the sphere of education and training by using its process. By using Metaverse extended reality, education sector will be changed drastically. This study outlined the required principles and approaches for transforming the education sector utilizing the Metaverse. Qualitative method has been used for analyzing. In addition, ten key techniques based on Metaverse's quality education standards have been outlined. This research will impact the whole education sector by visualizing contents, virtual campus, 3D simulation, and remote quality education which is accessible for all including underdeveloped countries. Additionally, the anticipated developments in the education industry have been highlighted. Finally, a model of classroom has been proposed using Mozilla Hubs platform, which can be used for group discussion, seminar, thesis meeting, presentation and many more which will bring changes to education system eventually. The main purpose of our research is to improve education sector using Metaverse by engaging more students from developing and under-developing countries, as well as providing more facilities and quality education.***

Keywords— Metaverse, Education, Virtual Reality (VR), Augmented Reality (AR), Virtual campus, Mozilla Hub.

I. INTRODUCTION

The Metaverse, a term popularized by science [1], refers to a virtual world where individuals can interact with each other and a digital environment in real-time. In recent years, advancements in technology have made it possible to bring the Metaverse to life, and the education sector is one of the areas where it has enormous potential. The application of Metaverse technology in education can revolutionize the way students learn by providing them with immersive, interactive, and engaging virtual learning experiences [2]. The Metaverse in education can provide students with access to a wide range of resources, including multimedia presentations, videos, images, and audio recordings, as well as interactive objects that can be used to support the delivery of lessons [3]. It also provides a virtual platform for students to connect with each other and with teachers from around the world, regardless of their physical location.

Online virtual worlds are becoming more widely used as a practical replacement for a growing spectrum of everyday human experiences because of the recent COVID-19 epidemic [4]. For instance, the graduation ceremony at UC Berkeley was held using Minecraft [5], which was created as a gaming platform. The requirements for the creation of the metaverse have gradually reached with the development of 5G, 6G, and other supporting technologies like blockchain, artificial intelligence, and many more.

Three segments make up the metaverse's framework [6]. The physical layer contains the hardware required to make the metaverse's operational aspects, such as processing, communication, and storage. To provide adaptable, efficient, and global access to the metaverse, a vigorous physical surface is absolutely necessary. The development of a corresponding living environment in which user avatars may interact with one another and other items is the second purpose of the virtual surface where it should also gather and mirror actual-time global statistics and inquire for immersion using technologies like digital twins made available by edge intelligence [7]. Customers may use the interaction layer to link the physical and digital worlds. Users' physical inputs 2 may be transformed into precise actions in the virtual world. The abundance of user data might be used to train artificial intelligence (AI) systems to provide clients with highly customized offerings, improving service delivery.

The COVID-19 epidemic has resulted in real-world constraints like "social distance", and the metaverse has allowed" social connection" in response by offering a place where individuals with similar interests may come together and converse [8,11]. These social relationships in the metaverse [9], however, are weaker than they are in the actual world. In the metaverse, one creates the "I wish to present" by hiding the details they don't want to show. It is hard for the administration to predict every user behavior because of the degree of flexibility [10,12]. Because of the essential features of the metaverse, particularly virtual space and anonymity, people's feelings of guilt about committing crimes are minimized [12,15]. Potential issues include new, terrible, and highly technical crimes that surpass those that now exist. The" I" taking part in the virtual world may look similar to reality and feel similarly about themselves, but they may also do it as a separate person with a distinct identity and point of view[15,16,17]. The word "sub-character" and the idea of an avatar are interchangeable (additional character). As living in which the virtual world and reality coexist grow more typical in a virtual environment where one's identity is never disclosed, it is envisaged that people's identities would gradually become freer. Compared to reality, people can only be recognized to a certain degree. They should exercise caution since their increased anonymity makes them more susceptible to criminal activity in the metaverse. In a metaverse that values freedom, it is challenging to individually control the vast volumes of material created and distributed by individuals all over the globe [8].

Originally exclusively used for the online virtual world, the word" metaverse" has come to refer to both the online and actual worlds in the post-pandemic era. concentrating on technologies related to virtual and augmented reality [8]. COVID-19 has a major role in this technology shift. Those of Generation Z make up the majority of metaverse users. People who were born after 1995 and exhibit traits that distinguish them from preceding generations are referred to as members of" Generation Z." Since this generation grew up with the development of PC and mobile technology, research has focused on their preference for gaming-centric experiences [9]. The phrase" gameful experience" is a technique for boosting user motivation and engagement in non-game settings including business, education, and healthcare by using game components like points, badges, levels, and leader boards [22]. Through these game 3 elements, gamification in education promotes student engagement, involvement in the learning process, and attitude development [23]. A gameful experience is one that resembles playing a video game but takes place outside of a gaming setting. It varies from a game-like experience in how it is experienced. It is possible to say that someone had a gameful experience if they unwittingly play a game [24, 25].

Some of the first application fields to leverage AR and VR-supported teaching to achieve outstanding training speed, performance, and retention include STEM education, operational skill enhancement (such as surgery), and laboratory simulations [26 - 28]. Immersive journalism is now possible since Metaverse has the capacity to take 360-degree panoramic images and volumetric spherical videos, which enables accurate and unbiased education of big audiences about new situations and happenings in distant places [29]. The metaverse may also enable novel types of online education that transcend the constraints of the present system. The education system by using metaverse may provide vivid institutional and casual functional sophisticated experiences of learning in their fixed substitute 3D autonomous campuses of the institute.

Metaverse is a revolutionary invention of the 21st century. It has become more popular because of its connectivity. It is changing the world faster than it can be imagined. As a result, the world is facing a huge technological shift. This technology can help us towards many emerging technologies. Such as blockchain, web 3.0, augmented reality, virtual reality, IoT, and many more [30,31]. Recently many giant technology companies have announced plans to enter Metaverse. It will help the world to reach the peak of technology where imagination will be the only limit. On the other hand, recent COVID-19 has hit the economy also [32]. Now the world needs more advanced technology to adopt the future as well as economic growth and sustainable development [33]. For this reason, this topic has been chosen.

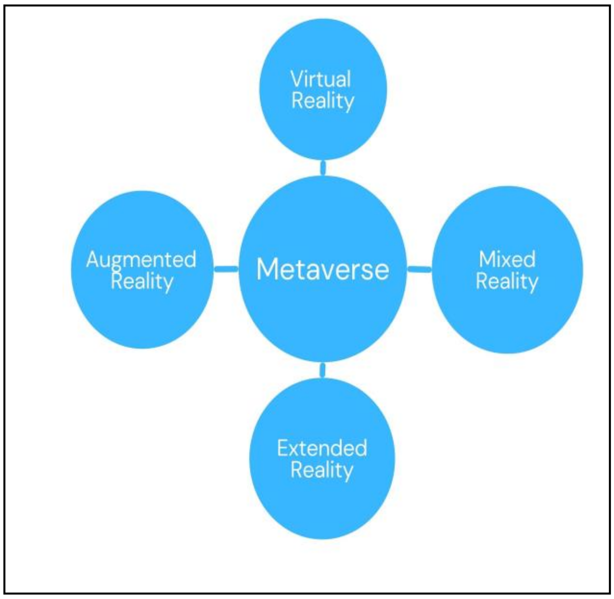


Figure 1: Metaverse combination [30]

The research of the metaverse is an emerging study. Although some research has been conducted on metaverse services in extended reality technologies [Figure 1], visual or audio rendering, etc. [34-37] which may be kept as a history on the blockchain. Compared to the blockchain-based reputation system, the reputation value falls more gradually. Due to the centralized platform's manipulation of unpleasant interactions into good ones, the unreliable employee's reputation gains value. In a reputation system without blockchain and suggested views, the unreliable worker's reputation value continues to climb, since MSPs that are favorably serviced by the unreliable worker rely only on local reputation opinions to assess their reputation value [38,43,44]. Blockchain is at the heart of all infrastructure, guaranteeing that the metaverse is decentralized. Blockchain will ensure that all decentralized data, databases, and computers are totally reliable and that only inhabitants of the metaverse are the legitimate owners of everything in the virtual world [39-42].

In this paragraph the authors would compare why the metaverse over traditional e-Learning [14]. Traditional e-Learning refers to the use of technology to support and enhance the delivery of education and training. This typically involves the use of online learning platforms, such as learning management systems (LMS) or online courses, to provide students with access to course content, assessments, and communication tools.

In comparison, the prospect of Metaverse in education refers to the use of virtual reality technology to create immersive, interactive, and engaging learning environments. In the Metaverse, students can interact with a digital environment, other students, and teachers in real-time, just as they would in the physical world. This provides students with a highly personalized and interactive learning experience that goes beyond what is possible with traditional e-Learning. Here are some of the key differences between traditional e-Learning and the prospect of Metaverse in education [45-47]:

Immersiveness: Traditional e-Learning relies on 2D screens and text-based interactions, while the Metaverse provides a fully immersive and interactive experience that allows students to explore and interact with their learning environment in a more natural way.

Personalization: Traditional e-Learning is often a one-size-fits-all approach to education, while the Metaverse can provide a highly personalized learning experience that adapts to the individual needs of each student.

Collaboration: Traditional e-Learning often relies on asynchronous communication, while the Metaverse provides a platform for real-time collaboration between students and teachers, allowing them to work together on projects and engage in interactive discussions.

Accessibility: Traditional e-Learning is often limited by geographical location and internet connectivity, while the Metaverse can provide students with access to quality education from anywhere in the world.

Multimedia: Traditional e-Learning is often limited to text-based content, while the Metaverse provides a platform for the use of multimedia, such as videos, images, and audio recordings, to enhance the delivery of lessons.

Overall, the prospect of Metaverse in education has the potential to provide students with a more immersive, personalized, and interactive learning experience that goes beyond what is not possible with traditional e-Learning [48-50]. For these reasons the authors have chosen this new emerging area [48, 51]. In the next section the objective and the theoretical framework will be discussed.

II. OBJECTIVE

The future technology trend and how the education sector can be improved in a positive and sustainable way using the metaverse. The proposed process will be a hypothesis for improving the education domain. The objective of our research is to determine metaverse applications and its activities in the education domain. It is also our purpose to determine a hypothesis framework and propose a model for better quality and everyone's accessible education in the metaverse; specifically creating an interactive classroom environment for group discussion, presentation, thesis meetings using the "Mozilla Hubs" open-source platform which is free, customizable, and accessible from all around the world. The theoretical framework of the proposed model has been given below.

The framework for the Metaverse in education should be designed to provide students with a high-quality, engaging, and immersive learning experience. Here are some of the key elements that should be considered in the development of this framework:

Learning Environment: The Metaverse should provide students with a virtual environment that is designed for learning, with interactive objects and multimedia resources to support the delivery of lessons.

Personalization: The Metaverse should be able to provide a highly personalized learning experience that adapts to the individual needs and preferences of each student. This can be achieved through the use of data and analytics to understand the learning needs and preferences of each student.

Collaboration: The Metaverse should provide a platform for real-time collaboration between students and teachers, allowing them to work together on projects, engage in interactive discussions, and participate in virtual events.

Accessibility: The Metaverse should be designed to be accessible to students regardless of their location or internet connectivity, providing them with access to quality education from anywhere in the world.

Security and Privacy: The Metaverse should ensure the privacy and security of personal data and intellectual property, with appropriate measures in place to prevent unauthorized access and data breaches.

Interoperability: The Metaverse should be designed to be interoperable with other learning platforms and tools, allowing students and teachers to easily access and integrate their existing resources into the Metaverse.

Integration with Physical Education: The Metaverse should be designed to integrate with traditional education, allowing students to attend virtual classes and receive support from teachers in real-time.

Sustainability: The Metaverse should be designed to be sustainable, with appropriate measures in place to ensure that it can be maintained and updated over time to meet the evolving needs of the education sector.

Overall, the framework for the Metaverse in education should be designed to provide students with a high-quality, engaging, and immersive learning experience that supports the delivery of effective and accessible education to students around the world.

III. PROPOSED MODEL OF BETTER EDUCATION SYSTEM USING METAVERSE TECHNOLOGY

1. *Metaverse Activities in Education Sector:*

- Remote education, telepresence, augmented reality education
- 3D models for education, visualization diagnosis, and planning
- Architectural design for better education
- Visualization of massive databases
- Education planning
- Virtual campus

- Consulting through Virtual Reality
- Educational psychology
- Virtual students
- Simulation of textbook pictures and experiment

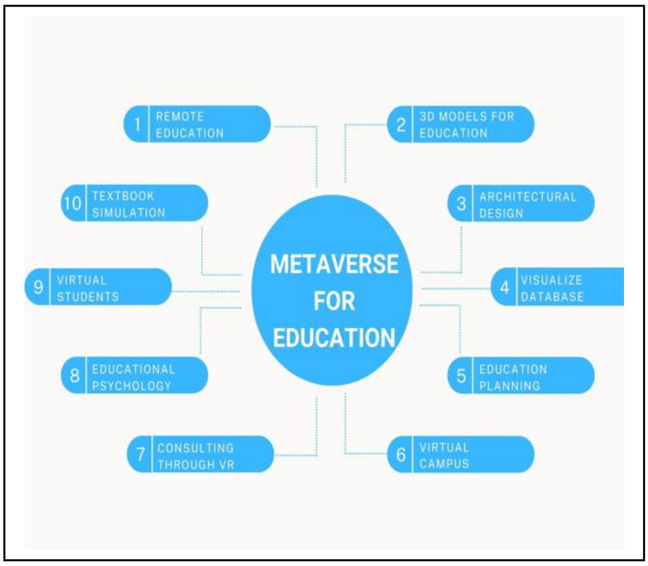


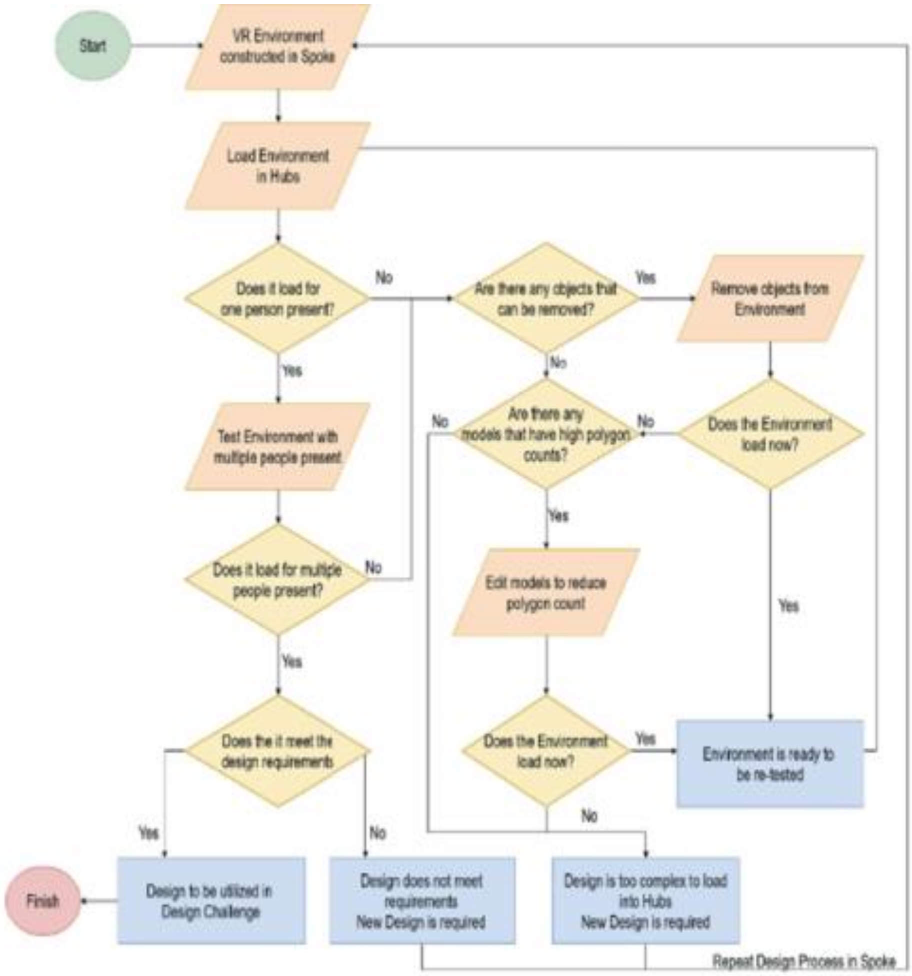
Figure 2: Proposed Metaverse for Education sector

In education, augmented reality can serve a variety of purposes. It facilitates the pupils' acquisition, processing, and retention of knowledge. Moreover, AR makes learning itself more interesting and enjoyable. In addition, it is not limited to a single age group or level of education; it can be used effectively in all levels of schooling, from preschool to college to the workplace. The potential for augmented reality to replace paper textbooks, physical models, posters, and printed manuals exists. It provides portable and inexpensive educational resources. Consequently, education becomes more mobile and accessible mentioned in the Figure 2. AR learning that is interactive and gamified may have a big beneficial influence on pupils. It maintains their interest throughout the course and makes learning enjoyable and simple. There are numerous opportunities to enliven classes with augmented reality applications. Lessons in which all students participate in the learning process at the same time enhance teamwork skills. Through visualization and total absorption in the subject matter, AR in education helps students obtain better achievements. A picture speaks louder than words. Therefore, rather than reading about something in theory, students can observe it in action. AR is a component of Extended Reality (XR), which also encompasses VR and MR technologies. Using text, sound effects, visuals, and multimedia, augmented reality augments the real-world experience. In other words, augmented reality provides us with an enhanced version of our immediate surroundings by superimposing digital content over the graphical depiction of the physical world. However, AR content is generated by AR software, which is still primarily designed for a certain AR-hardware vendor and frequently offered as part of an AR hardware kit. Augmented reality in education and training offers a variety of applications and enables learners to receive real-time lessons while on the move. Using AR apps directly in the classroom is the most prevalent application of augmented reality in education. In this instance, they can assist the teacher in explaining a topic, provide a visual representation of the material, and aid students in putting their knowledge to the test. Common AR engineering uses include manufacturing, training, and support. Through the use of augmented reality, students can learn outside of the classroom. Moreover, AR-enhanced instructional resources make online and distance learning simpler and more effective.

1. Proposed model workflow

The use of metaverse is used to accelerate the learning process without any boundaries and in 3D environment. It is used in the realm of education to better comprehend the pupils. Students and academics may better their performance in the education and research fields with the help of future Metaverse technologies. Metaverse is a valuable and successful technique for increasing trainer and student happiness. This technology offers an appropriate answer in the sphere of education and training by using its process. Metaverse is a vital technology for the development process that employs specialized and sophisticated software and hardware. We can determine the particular purpose of the student's issue and gather the student's history. Utilizing a variety of devices and software, 3D virtual data is generated to generate a 3D virtual world. Using the optimal approach, the metaverse virtual reality and augmented reality of the needed data is constructed and identified. This process is suitable for planning the most effective method of instruction and ultimately contributes to providing everyone with a superior education. This research is done by start list method which is a qualitative research approach. It is done conducting a systematic literature review to find research gap and solve the problem. We have identified that previous research was done for developed countries and urban areas where education is accessible. So, our goal is to provide experiential education in the undeveloped areas using a easily accessible platform Mozilla Hubs which can be accessed from all kinds device and browsers. This will change the concept from current traditional education system to interactive education system.

In this research, a proposed process framework model and its model has been shown by using "Mozilla Hubs" which is an open-source platform for all. Hubs is for everyone who want to connect remotely with others. It is a fantastic approach to bring communities together in a virtual area shared by everyone. It is possible to have talks with the whole group or separate into smaller groups, exactly as in person, also hosting a conference, teaching a lesson, exhibiting artwork, or socializing with friends. Hubs facilitates the connection and sharing of photos, films, 3D models, and other media. With Hubs' spatialized audio. Hubs is cross-platform compatible with a VR headset, everyone can access Hubs. So, the proposed model and implementation is to create a virtual class has been design by Mozilla Hubs for thesis meetings and group discussions. In the following flowchart, we have shown a workflow of Mozilla Hubs from Brown et al. [51] to show how Mozilla Hubs works.



(a) Iterative design flowchart

Figure 3: Metaverse workflow [51].

A. Steps of Enactment using the Mozilla Hubs

The normal classroom includes sufficient space for students to meet and exchange ideas. It often consists of tables, seats, blackboards, and other objects. Similarly, the virtual classroom should be organized. The implementation of our proposed classroom model has been carried out using" Mozilla Hubs" platform where we designed a 3D virtual classroom for seminar, group discussion, thesis meeting, presentation and project showcasing. Here are the steps to implement the above methods in Mozilla Hubs [51]:

Setting up a Hubs Room: Start by creating a Hubs room for the virtual classroom. This can be done the Mozilla Hubs website by clicking the "Create a Room" button and selecting the desired room size and features.

Designing the VR environment: Use the room creation tools in Mozilla Hubs to design the virtual classroom environment, including the placement of desks, chairs, a blackboard, etc. You can also add interactive objects, such as books, writing utensils, and other educational materials.

Customizing avatars: Use the avatar creation tools in Mozilla Hubs to design custom avatars for students and teachers. This can be done by uploading images, adjusting facial features, and selecting clothing and accessories.

Incorporating educational content: Use the room creation tools to add multimedia presentations, videos, images, and audio recordings to the virtual classroom. These can be used to support the delivery of lessons and provide students with additional resources for learning.

Connecting with students: Use the network communication capabilities of Mozilla Hubs to connect students from around the world in the virtual classroom. This can be done by sharing the room link with students, or by using a video conferencing platform to share the VR experience with remote students.

Assessing student learning: Implement assessments, such as quizzes and exams, within the virtual classroom. This can be done by creating interactive objects within the room that students can use to answer questions and receive feedback.

Continuously improving: Continuously collect and analyze student feedback, and use this information to iterate and improve the virtual classroom. This can involve updating the VR environment, incorporating new educational content, and adjusting the delivery of lessons.

Here are the steps to design a VR environment in Mozilla Hubs:

- Enter Room Creation: To start designing your VR environment, enter the Room Creation mode in Mozilla Hubs. This can be done by clicking the "Create a Room" button on the Hubs website and selecting the desired room size and features.
- Choose a Theme: Select a pre-made theme for your room or choose a blank room to start from scratch. The themes provide a base for your VR environment and can be customized to fit your specific needs.
- Add Interactive Objects: Use the object placement tools in Mozilla Hubs to add interactive objects to your VR environment. This can include chairs, desks, blackboards, and other objects that you want students to be able to interact with.
- Upload Assets: Upload custom assets, such as images and 3D models, to use in your VR environment. These can be used to further customize your environment and create a unique and engaging learning experience.
- Customize Lighting: Adjust the lighting in your VR environment to create a specific mood or atmosphere. This can be done by using the lighting tools in Mozilla Hubs to adjust the brightness, color, and intensity of the lights in the room.
- Save and Share: Save your VR environment and share it with others. You can share the room link with students or use a video conferencing platform to share the VR experience with remote students.

By following these steps, we can design a VR environment in Mozilla Hubs that meets your specific needs for teaching and learning. This will allow you to create a high-quality, immersive, and interactive virtual classroom that supports student learning.

Figure 4: virtually connected students

Figure 5: virtual class environment


Figure 6: virtual class board

Figure 7: virtual class environment


Figure 8: virtual class environment from another angle

By following above steps, we can use Mozilla Hubs to implement the proposed method for creating a virtual classroom for students in the education domain has been presented from figure 6-8. This will allow us to provide students with a high-quality, immersive, and interactive learning experience, regardless of their location.

IV. Conclusion

In conclusion, this study provides a comprehensive overview of the technical road map and educational applications of the Metaverse, specifically in the context of the Mozilla Hubs classroom. The proposed hypothesis framework and prototype model for Metaverse-based education were thoroughly analyzed and the activities in the education domain were demonstrated. The authors of this study contribute to the understanding of the potential for Metaverse technology in education and highlight the grandiose intentions of using the Metaverse to provide quality and sustainable education. However, the study also acknowledges the limitations and societal impacts of the technology and highlights the need for further research to fully understand its potential and limitations.

Despite the fact that the development of Metaverse technology is still in its early stages, there are obstacles that need to be overcome before it can be fully integrated into people's social activities. Nonetheless, the authors are optimistic about the future of the Metaverse and its integration into our daily lives, especially in the education sector. The potential use of the Metaverse for sustainable education facilities is also highlighted as a future proposal. Overall, this study underscores the importance of continued development and refinement of the Metaverse ecosystem to fully realize its impact in the education sector.

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