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Academic Paper

The Metaverse in Education: The Future of Immersive Teaching & Learning

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Abstract

The metaverse connects social media to virtual reality and augmented technologies. Their collaboration unleashes creativity and promises transformation ranging from industrial sector to distance/online education. New style of meta-education and metaverse-powered online distance education have emerged to provide formal and informal blended learning experiences in a virtual 3D online campus. Online learning in the metaverse is to break the last frontier of social connection and informal learning. Physical presence in the classroom will be a privileged educational experience. Telepresence of gestures and feelings, avatar body language and the precision of facial expressions will help make participation equally effective. In addition, social mixed reality in the metaverse enables blended active pedagogies that fosters profound and lasting knowledge. More importantly, it can become a democratizing factor in education, enabling world-wide participation around the world without geographic constraints. This academic paper presents six aspects of the metaverse applied to education: (1) the meaning and definition of the metaverse, (2) technologies empowering the metaverse, (3) concepts of the metaverse for education, (4) concepts of the metaverse for education, (5) potentials of the metaverse in education, and (6) its future in education. These aspects of the metaverse and its applications are essential for educators to deliver forefront teaching and learning.

Keywords: Metaverse, *digital technology, education, immersive teaching and learning*

1. Introduction

Innovations in computer science have a big impact on people's everyday lives because they change and improve how people interact, communicate, and do business with each other. From the point of view of end users, three major technological waves have been centered on the introduction of personal computers (PC), tablets, the Internet, and smart phone devices, in that order. At the moment, spatial and immersive technologies like

Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (MR), and applications are driving the fourth wave of computing innovation. (Kamenov, 2022). This wave is expected to create a further widespread computing paradigm that has the potential to transform, training, healthcare, sport, business, entertainment and everyday human use, especially its applications to improve education for humanity. This new paradigm is the metaverse. The word "metaverse" is a closed compound word with two components: Meta and universe. The metaverse is the next iteration of the internet, supporting ongoing online 3D virtual environments where the world's publicly accessible virtual experiences, real-time 3D contents and other related media are connected and accessible through VR/AR, as well as through classic devices, such as PC and smart phone devices. In other words, the metaverse is a post-reality universe, a perpetual and continuous multi-user environment that merges physical reality with digital virtual reality. As for online distance education, the metaverse has great potential to seamlessly resolve the fundamental limitations of past web 2D e-learning tools (Mystakidis, 2022).

Education is a critical field for learning and growing people in society as well as for economic development both nationally and globally, where the main method of operation remains unchanged; it is related to content development in classroom and textbook despite the vast innovations in educational technology (Phakamach et al., 2021a). Petchroj (2022) asserted that prompt actions are required for teaching via web/e-learning tools, accelerating teachers' need to create a new body of knowledge, and increasing online innovations. Universities in the digital age need modern technology networks, digital media center, and digital skills development for faculty members, students and support personnel. In this regard, educators often use technological resources to enhance the classroom learning experiences. Below are several examples of the metaverse being used in education. First, it has been found that meaningful learning through the virtual world has the potential to provide numerous educational opportunities. One study in particular explored the various advantages and disadvantages of the virtual world in an academic environment with the aim of strengthening the curriculum using this technology. Second, as a result of researching whether AR technology can contribute to informing and educating elementary school students regarding the COVID-19 outbreak, it was found that it improves students' cognitive abilities around knowledge retention, as well as their creativity. It has also been confirmed that learners can develop self-learning through the combination of rational learning styles using these technologies. Moreover, based on past research from various case studies of the word metaverse, it is important to be accurate. The results confirm that the metaverse can provide additional meaning to teachers, educators and educational policymakers. Third, there is also an education on the use of AR math games for elementary school students using MathBuilder, and the use of AR-enabled storybooks to reduce the anxiety of young people learning math (Jeon, 2021).

Currently, there is fierce competition in building the infrastructure, protocols, and standards that will govern the metaverse. Large organizations are trying to build their own closed proprietary hardware and software ecosystems to attract more user groups and it could be the de facto end of the metaverse (Kesselman & Esquivel, 2022). However,

different systematic approaches and strategies contradict concepts, such as openness and privacy. The outcome of this competition determines the level of user privacy rights. Like whether the metaverse covers informal students and school students. Both issues have significant implications for the study. This will determine whether the metaverse can become mainstream in e-learning. Educators must continue to search for answers. Jeon (2021) has argued that inside the metaverse 'sub-verses' are being born as seen in the presence of a globally inclusive learning platform. Educators are developing a virtual world called the Eduverse, based on Web3, aiming to bring learners together as avatars. The magic of Web3 is heavily promoted by industry leaders in technology and modern innovation. Its outstanding benefit is Web3's equal goal of creating opportunities for development for all human beings. This is an important step in the path toward creating equality in education for learners.

For this purpose, this academic paper is structured in seven sections: (1) Meaning and definitions of the key concepts, (2) Technologies empowering the metaverse, (3) Concepts of the metaverse for education, (4) The metaverse changing the world of education, (5) potentials of the metaverse in education, (6) Metaverse future in education, and (7) conclusion and recommendations.

2. Meaning and Definition

The term "metaverse" was coined in Neal Stephenson's 1992 science fiction novel Snow Crash, in which humans interact with each other as avatars within a 3D virtual world. In this novel, just like in real life, the metaverse is a 3D virtual extension of the Internet. It gives users a lot of freedom when it comes to real-time interactions, while also allowing them to create any online environment imaginable. (Mystakidis, 2022).

Initially, the metaverse can be defined as the post-reality universe. It is a perpetual and continuous multi-user environment that combines physical reality with digital virtual reality. It is based on the convergence of technologies that enable multisensory interactions with virtual environments, digital objects and people, such as VR and AR. Hence, Thus, the metaverse is an interconnected web of networked social environments in a persistent multi-user platform. This allows seamless communication with figurative users in real-time and dynamic interactions with digital artifacts. People's use of the metaverse assumes that the first iteration is a web of virtual worlds where avatars can move between them. The contemporary iteration of Metaverse is delivered from a socially immersive VR platform that is compatible with online multiplayer video games. It is an open game world and is a virtual collaboration spaces with AR itself (Zhao et al., 2022).

Finally, the metaverse can be defined as a virtual world, a simulated world where users with the same interests come together to form a society. "Social" is the second world where humans spend their real-world time making share experiences with other users without borders in 4 dimensions: media, real world, interaction and social. In the name of practical use, the metaverse is an imaginary world filled with the responsiveness of the human mind that is not the real world. The metaverse world has no limits on who you can

meet. This is the world where we can rebuild ourselves to go out and learn what we don't know via a digital mode.

3. Technologies Empowering the Metaverse

The technologies empowering the metaverse are in four types: Virtual, Augmented, Extended and Mixed Reality.

3.1 Virtual Reality (VR)

The term "virtual reality" refers to a technique known as "virtual reality," in which a computer mimics a virtual environment. The majority of a virtual reality experience comprises visualization, which can be exhibited on a computer monitor or a 3D display device. Users are able to engage with the virtual environment through the use of conventional importing gadgets (Jeon, 2021). It is possible to build a simulated environment very similar to the real world, such as a simulation used for training pilots. On the other hand, a simulated environment can also be very different from the real world, such as in games that are being developed by game developers nowadays. Because of technical constraints, such as those regarding processing power and visual resolution, it is extremely challenging to produce a virtual reality experience that is as realistic as possible in practice. On the other hand, it is anticipated that such limits will be eliminated in the not-too-distant future as a result of developments in technologies relating to visual and data communication as well as processing power (Slater & Sanchez-Vives, 2016; Yadav, 2022). Two examples of VR are shown in Figure 1.

Figure 1: Virtual Reality (Yadav, 2022)

a) b)

3.2 Augmented Reality (AR)

Augmented Reality (AR) is a new technology that combines the real world with the virtual world through the use of various devices, such as webcams, mobile cameras, computers, combined with the use of various software. This makes it possible to see images that look like objects, such as people, animals, things, and spaceships, displayed on the screen as 3D objects floating above the actual surface. Augmented Reality (AR) was created by combining the real world with the virtual world (Pellas et al., 2020). Additionally, augmented reality can be incorporated in virtual reality headsets with the

capacity of pass-through mode by showing input from integrated camera sensors. This will give viewers the impression that they are participating in a "real" event. Two examples of AR are shown in Figure 2.

Figure 2: Augmented Reality (Yadav, 2022)

a) b)

3.3 Extended Reality or Cross Reality (XR)

Extended Reality or Cross Reality (XR) is a generic term that combines a set of realistic technologies: electronics, communications, digital environments in which information is displayed and projected. XR technology will be a collaboration of VR, AR and MR (Mystakidis, 2022). In every aspect of the XR mentioned above, humans observe and interact in all or part of the synthetic digital environment created by these technologies. Two examples of XR are shown in Figure 3.

Figure 3: Extended Reality (Kamenov, 2022)

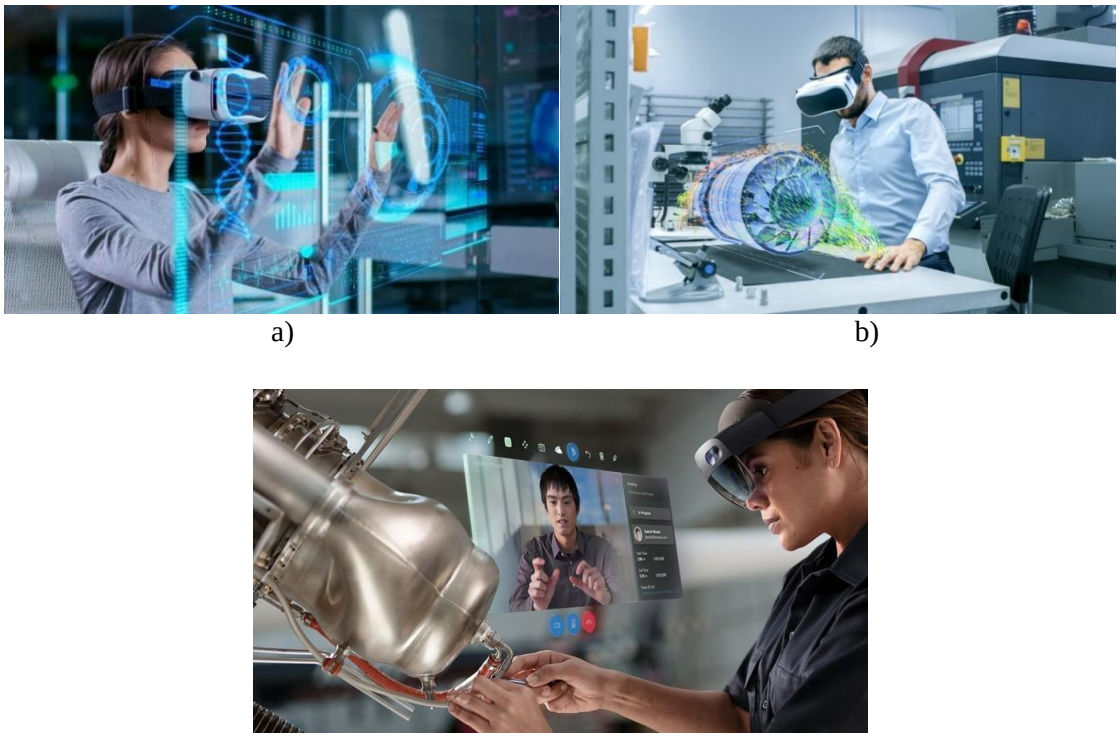
a) b)

3.4 Mixed Reality (MR)

Mixed Reality (MR) combines the strengths of VR and AR technologies and takes it to the next level by creating visualizations that users can interact with in an environment that combines real with virtual worlds. Using next-generation touch and imaging technology, MR allows us to see and experience the world around us even when interacting with virtual environment with the user's own hands without having to remove the glasses. This technology allows users to place one foot or hand in the real world and put the other side in the virtual world. It breaks down the fundamental concept between reality and

imagination in providing experiences that can change the way people play games and work in modern times (Kamenov, 2022). The rationale behind this decision is the long-term technological evolution and maturation of AR to include interactive affordances. Therefore, AR and VR remain the two fundamental technologies and MR their combination (See Figure 4).

Figure 4: Mixed Reality (Kamenov, 2022)



a) b)

c)

In order to appreciate and illustrate how these immersive technologies interact with their surroundings, we point to Milgram and Kishino's one-dimensional reality–virtuality continuum. The best way to depict this continuum is as a line that is straight and has two points at either end. The natural and physical environment are located on the leftmost end of the line. The right end denotes the transition into a completely fabricated and virtual environment, which the user will encounter instead of the real one. As a result, augmented reality (AR) is located toward the left end of the spectrum, whereas virtual reality (VR) is located on the right extremum. Both SR and MR are contained within MR. The metaverse is founded on technologies that make it possible to interact in a variety of sensorial ways with digital items, digital settings, and other people. A three-dimensional depiction that is capable of conveying a sense of depth is what makes the XR system's visual fidelity possible. This is made feasible by simulating one's vision in a real-world setting using two displays, one for each eye, which are distinct from one another and somewhat different from one another. The high-resolution XR display may be viewed by the user from a wide angle, which can range from 90 degrees to 180 degrees. When compared to 2D, 3D, spatial, or binaural audio systems, the XR system provides a greater auditory experience. This

allows users to create sound landscapes that are more realistic than what is possible with VR and AR. In addition, users are able to orient themselves and pinpoint the location of the audio stream thanks to the usage of spatial broadcasting. It is an effective tool for navigating the metaverse as well as attracting the attention of those who utilize it (Pellas et al., 2020).

In addition to the previously mentioned passive sensory inputs, the XR system also enables interactive interaction with virtual elements through the utilization of motion controllers. Handheld input devices include those with grips, buttons, triggers, and thumb sticks. Users have the ability to touch, hold, manipulate, and operate virtual items while employing the controls that were discussed earlier. Because of this skill, they become enthusiastic agents in each and every user experience. The user experience will also be improved by the introduction of a totally manual tracking system, which will make the experience feel more natural. Researchers are currently concentrating their efforts on movable electronic devices that may be worn, such as touch-sensitive suits and gloves. The digitization and simulation of smells has been investigated further within the realm of sensory research.

Pellas et al. (2020) detail interactions that take place in XR environments in which the user is immobile throughout the experience. The user has control over the entirety of the body. Tracking of position and rotation is enabling the transmission of a user's actual movements into an augmented reality setting. Either a permanently mounted external camera (outside-in) or headset sensors and an internal camera that detects position changes in respect to the physical world can be used to track motion. One of these two methods is referred to as "inside-out" tracking. The supported degree of freedom (DoF) of the XR headset is a needed specification that reflects its motion tracking capabilities. This specification was required after the XR headset was utilized in a standalone wireless headset. The cutting-edge and high-fidelity headgear provides support for a total of 6 degrees of freedom (DoFs), which includes lateral body movement along the x, y, and z axes. The translation of motion over time, which is essentially a highly strong treadmill moving in just one direction, is one of the limitations associated with closed virtual reality spaces.

4. Concepts of the Metaverse for Education

The technological capabilities connected with each facet of the metaverse for education can create a clear picture of how the metaverse can revolutionize education. This is the impression of how the metaverse can promote education and learning for humanity (Weilage & Stumpfegger, 2022; Suh & Ahn, 2022).

4.1 AR Uses in Education

The use of AR technology enables the creation of digital overlays on top of real-world objects, which can then be rendered as three-dimensional. Users are able to investigate a variety of applications of the metaverse for educational purposes or for learning in augmented reality by utilizing educational impact. For instance, AR can assist in locating otherwise unseen components and finding solutions to problems in a more

expedient manner. Augmented reality can be used to power in-depth material overviews. Because of this, observing and comprehending text is much easier. In addition, interactive activities like reading and writing can help generate interesting experiences and promote learning that is participatory.

4.2 Lifelogging Uses in Education

Lifelogging focuses on documenting everyday life and thoughts with a focus on effective results. It can help drive the use of the metaverse for education with a focus on self-learning experiences. Users will be able to review and reflect on the daily events of each person's life very well. Thus, the metaverse can offer an essential tool for expressing and implementing feedback and learning from one's life. It also opens a way to explore different types of data from a critical perspective including helping to reflect on learning experiences, stories and real experiences along with improving the creation of new information creatively.

4.3 Mirror World and Education

The world reflected in the mirror is yet another significant aspect to take into consideration. The question "How will the metaverse alter education?" comes up because it has the potential to provide an immersive online learning environment. When it comes to learning and education, the mirror world can help overcome space constraints as well as other physical limitations. For example, online video conferencing tools can be used as a virtual world for real-time online classes to enter quality virtual learning.

4.4 VR in Education

When searching for knowledge regarding the appropriate educational uses of the metaverse, educators should also take into account the educational implications of virtual reality. A computer-generated simulation of a hands-on demonstration taking place in a digital setting. Training sessions on risk management, for instance, that focus on the management of fires and flight training for airplanes. In the actual world, it often comes at a high cost. Having a virtual reality (VR) fire training simulator as well as a flight simulator, on the other hand, can easily be a more cost-effective solution.

If teachers are planning on introducing the metaverse into their classroom soon, it is important to have a firm grasp on what XR is. XR is an umbrella term that encompasses a few different digital experiences (VR, AR, and MR). In VR, students enter a simulated, 3D reality through a head-mounted display. Their real-world audio and visual stimuli are replaced by digitally-generated counterparts. As they move around, they can interact directly with nearby digital objects. In AR, students view digitally-generated content through a see-through and head-mounted display. They remain grounded in the physical world, but can interact with digital elements (i.e., hiding behind a virtual rock). In MR, students can use mobile devices or see-through, head-mounted displays to view digital elements superimposed on their physical surroundings. After all, MR has little interaction between the digital and physical elements but can be incredibly realistic.

In addition, metaverse field trips use 360º technology to turn mobile devices, such as tablets and smartphones into virtual experiences. This allows young students to enjoy the learning benefits that augmented reality can offer in a safe and harmonious way. Using virtual field trips can help students learn and grow quickly. (Phakamach et al., 2021b). They can learn the following:

Critical thinking: Students are analyzing the environment around them and making timely and holistic decisions to move to the next stage of a game or a virtual field trip.

Creativity: Students are imagining new uses of space to create new ideas and experiences. When they come in contact with artists, monuments, historical sites that they shouldn't have been exposed to at a young age.

Cross-collaboration and teamwork: The metaverse is designed to connect people, places, and ideas. Students can learn, collaborate and meet new heroes, people, and work together to solve problems of interest.

Social-emotional learning: While students are dealing with real situations or important moments in the past. They have to take on the role of someone else and understand their own emotions. They also can develop compassion for one another at an early age which is key to developing relationships later in life, career paths and peaceful coexistence in society.

5. The Metaverse Changing the World of Education

For a few years now, some video games allow users to interact with each other and attend events such as parties and concerts through avatars. However, gaming is not the only industry that can benefit from the metaverse with the growing popularity of online learning. Educators, teachers, and institutions are constantly looking for ways to make distance learning more engaging and interactive (Pellas et al., 2021). Let's look at a few ways the metaverse can help with that.

5.1 Creating an Engaging and Life-like Online Classroom

The main benefit that eLearning can reap from using the metaverse is its ability to liven up the online learning environment. Educators can create rooms to suit their educational needs where their only limitation was imagination. At the same time, fully customizable avatars allow learners to interact with realistic objects and put theory into practice. It adds a special sense of realism to the virtual classroom in order to make learners more involved in the learning process, build more life skills, and more satisfied.

5.2 Promoting Communication

It should come as no surprise that learning how to interact with others and communicate effectively online can be challenging at times. Both learners and instructors might experience feelings of isolation and loneliness when they are separated by physical distance. In order to combat these feelings and encourage participants to communicate with one another, the metaverse enables classroom teachers to construct rooms in which they can have meetings. These meetings can then take place within the classroom. At the same

time, students have the ability to build study rooms in which they can socialize with one another, work together, and learn. Everyone has the ability to communicate with one another face-to-face, share files, interact with the same object, or play the game easily using their avatar. Learners are encouraged to connect with their teachers and classmates through the use of these elements. The overall quality of the educational experience will consequently improve as a direct result of this.

5.3 Supporting Immersive Learning

AR and VR in particular are the primary technologies that are helping to enable the metaverse. Users enter the virtual world by donning headsets and/or glasses that grant them access to the environment. Online students have a lot to gain from participating in virtual learning since it enables them to study the appropriate theory until they are able to put it into practice, improves their ability to retain information, and boosts their engagement through participation in virtual interactions. Learners can have the experience of participating in simulations and games as if they were physically present thanks to virtual reality and augmented reality technology. For instance, 3D graphics can assist people comprehend how a particular piece of machinery operates or what a certain mathematical concept looks like when it is applied in the real world.

5.4 Enriching Gamification

The benefits of gamified learning have been known for years. It makes learning fun and effortless, improve problem solving skills, analytical thinking real-time feedback, and improve the overall learning experience. With the metaverse, gamification is more alive than ever because users are not just playing games but they are in the game. Combining VR/AR devices with the endless possibilities of the metaverse, teachers can also create game-based activities that students can perform in a thoroughly realistic environment with active learning that resembles real-life situations.

The advantages of learning through game-like activities have been recognized for many years. It makes learning entertaining and easy, improves problem-solving skills, analytical thinking, and the overall learning experience, and it provides feedback in real time. Gamification is more alive than it has ever been because to the metaverse, which allows users to not only play games but also participate as characters in those games. Teachers are also able to create game-based activities for students to perform in a thoroughly realistic environment with active learning that resembles real-life situations by combining VR/AR devices with the endless possibilities of the metaverse. Students will be able to perform these activities in the classroom.

The metaverse is the next step of the Internet and it's already here. The game industry is exploring its capabilities more quickly, but soon the gaming industry will enter other aspects of our lives. eLearning is also expected to gain substantial benefits from the metaverse, using its immersive capabilities to make the virtual learning environment more realistic, and learning by itself is more engaging and experiential. Although at this point we

can only imagine what the future holds, it is exciting to see that change happen (Weilage & Stumpfegger, 2022).

6. Potentials of the Metaverse in Education

Hirsh-Pasek et al. (2022) suggests that the final aspect in understanding how the metaverse will influence future studies. It focuses on possible ways in which the metaverse affects learning. Here are some featured metaverse applications in education that will change the way we perceive the value of the metaverse.

Engaging Guides: Teachers no longer have to display images or videos or read books in the metaverse. As a matter of fact, teachers can show students how to create specific machines or processes that occur at the molecular level. The immersive experience in the lesson ensures that more students remember the lesson.

Freedom to Create and Share: Students do not have to think of the metaverse in education as merely an educational form of online gaming. They can fulfill the mission objectives of the game. On the contrary, students can create and share their own experiences and designing learning experiences that extend the freedom and flexibility of learning.

Integrated Learning: The educational use of the metaverse also relies heavily on metaverse opportunities to be able to move between virtual spaces. For example, you don't need to worry about undoing how electrons flow in our bodies when understanding conductivity. The metaverse provides opportunities for improvement for the combination of multiple subjects in a single learning environment for holistic learning experience (Phakamach et al., 2021c).

Developing Values of Responsible Usage: There is no doubt that the metaverse offers many formidable values, especially bringing different ideas to life. However, there are other important concerns related to unauthorized use with the use of blockchain identity, students can discover new opportunities to use the metaverse responsibly over the long term.

7. Metaverse Future in Education

As experts continue to create new types of connected devices, the metaverse will become increasingly accessible to the world. At the moment, mobile IoT and 5G network infrastructure have received substantial investments and are expected to grow rapidly over the next decade. As the metaverse concept starts to integrate Web3 technologies enabled through blockchain technology, the future metaverse will be something similar to our real world in many ways and even replace some real world activities (Suh & Ahn, 2022; Kraus et al., 2022).

Li and Xiong (2021) described the metaverse not as a technology, but an idea and concept that needs to be integrated into new technologies, social communication style, and digital living spaces that combine the virtual space and the visual world. The emergence of the metaverse represents how humans will change the way of future development through science and technology. It has a great impact on the teaching shown by digital media arts disciplines, and may change the teacher's original teaching content design. For instructional

design, the impact of changes in the technological environment must also be considered in order to achieve the goal of training applied design talent. Therefore, interest in the metaverse is of great importance to the professional development of digital media.

With all of the above, it can be said that the future ahead of the metaverse also encompasses the concept of open work creation, with almost no disruption from a single person, community or company. This is because creator contributions come from all over the world. Because various business brands want to bring customers to the wider metaverse world just like today's internet usage (Hirsh-Pasek et al., 2022).

8. Conclusion and Recommendations

From the foregoing, it can be concluded that the metaverse is a digital landscape that participants can use to create their own virtual environment. The metaverse offers a great way to learn interactively with others around the world. Anyone from anywhere can wear a VR headset or use a web browser to log in to the virtual space and communicate with others face-to-face. It is best to think of the metaverse as a virtual game in the real world which users and developers can customize to suit their content. Educators can develop metaverse schools or virtual stadiums on the property they own. Combined in the world that is being geographically divided by pandemics and other disasters, it is a way for families and friends to interact in digital ways.

The metaverse is currently a well-known entity that serves as a source of inspiration throughout the web or within applications for novel aspects of education. The impact of the COVID-19 epidemic has resulted in significant reforms being implemented in both the working environment and educational institutions. People are getting used to the idea that team meetings should replace socializing in the classroom and the office. The metaverse makes available endpoint hosting tools that are able to function in both a virtual and a social setting. Students are able to use VR when on school field trips, particularly during museum visits, therefore the metaverse also has a lot of educational potential. The finest part is that even their buddies who live in other places can participate in the education. By providing students with an experience that is both immersive and engaging, these metaverse tours can help students improve their learning journey by significant leaps and bounds. Students get the opportunity to discuss their experiences based on their cultural backgrounds and opinions. By exchanging ideas with their classmates from various nations and trying to see the world from their points of view, they can gain an understanding of how cultural differences are connected. The ability to mimic an endless amount of learning is the most beneficial aspect of education in the metaverse. In other words, pupils are able to learn without even being aware of it thanks to the collaborative efforts of their virtual characters while they focus on the job of the metaverse. When education is combined with enjoyment, it is most likely to be retained. Because of this, the metaverse can easily be incorporated into a school setting. After all, educational institutions that utilize the most recent digital advances stand out from the rest of the competition. It is anticipated that the introduction of the metaverse would lead to a more engaging learning experience for students, which

will in turn assist drive their learning in online courses and lead to an increase in enrolment in institutions.

This article is meant for readers to understand the metaverse in terms of meanings, definitions, related technologies, advantages of metaverse in education, educational world change via the metaverse, potentials of the metaverse in enhancing learning capacity in the 21st century, and the future of the metaverse in educational applications. The authors concluded the metaverse's strengths for education with in-depth empirical research into its developments in support of learning. In this regard, educators, school administrators, teachers, technologists, educational innovators, evaluators and learners are all involved in the modern education systems for learners' knowledge and competencies as the ultimate goals.

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