Metaverse in Education: A Bibliometric Analysis and Mapping the Potential and Barriers

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Abstract - The relevance of technology advances in the classroom has been underscored by the post-pandemic world's emphasis on digital learning. It also shown that many of the readily accessible online learning materials are either useless or too error-prone to be utilized routinely with students. When it comes to online education, nothing beats the efficiency and effectiveness of the metaverse, a 3D virtual extension of the internet that promotes in-depth knowledge acquisition. Users have a great deal of leeway in terms of spontaneous communication. By facilitating interaction and providing a platform for immersive education, the metaverse is revolutionizing the classroom. E-learning is expected to benefit greatly from the metaverse because of the improvements it will bring to the realism and interactivity of virtual classrooms. The purpose of this study is to draw up a bibliographical roadmap of research on the possibilities and limitations of metaverses in the classroom. The author used a global perspective and utilized bibliometric mapping to evaluate recent developments in the field of metaverse research on education.

Keywords - metaverse, virtual reality, immersive, learning, education, bibliometric.

1 Introduction

The "Metaverse" is a notion that has become more relevant as technology has advanced in recent years [1]. To survive in today's rapidly evolving technology landscape, it's crucial

to be able to quickly learn and master new systems. With this in mind, it is crucial to keep up with technological developments, particularly in the realm of education. The shift from "passive receiver" to "active participant," which happens throughout the learning process, necessitates a radical rethinking of traditional teaching practices in light of the new communication technology [2]. Education and training may now be conducted by students regardless of where they happen to be located, all thanks to the innovative use of technology in classrooms.

One of the emerging fields in education is the usage of metaverse apps, which provide users with interactive, virtual learning environments [3]. In order to convince the user that they are in a computer-generated world and able to manipulate virtual things, it is essential to present accurate and detailed information. The degree to which the user is fooled by the simulation depends on how well the visual and aural data portray the setting.

1.1 Metaverse

The term "metaverse" is an amalgam of the concepts of "beyond" (meta) and "universe" (verse). The idea of the "Metaverse" makes it possible to build online societies for more than just shopping and games [4]. The "digital great bang" in cyberspace is referred to as the next generation of the Internet, which incorporates a three-dimensional virtual realm where users may communicate with one another through their avatars [5] et al. Teleporting to the workplace, business, or family home may be done in the form of a hologram, and new kinds of experiences can be had beyond what we often associate with phones.

1.2 Metaverse in Education

From a pedagogical point of view, the Metaverse may be assessed as a concept that introduces a novel environment rich in meaning and potential educational experiences. The metaverse might provide a platform for novel instructional methods. [6] et al. observes that a learning system suitable for Metaverse-based training has been proposed. But when it comes time to move classes into the Metaverse, both students and educators will benefit from having a firm grasp on what it takes to make the leap. While [7] acknowledge that professional development programs should be effective provided instructors grasp the pedagogical potential of augmented reality, they dispute whether or not the Metaverse has the capacity to offer for education. The ability to conduct research in virtual worlds and actively interact with content is what makes the metaverse so effective as a teaching tool, piquing students' interest and expanding their knowledge.

It has been shown that virtual environments, which give students access to a wealth of perceptual signals and flexible feedback, may easily be integrated with real-world settings, encourage student interaction with information, and improve concept retention as a consequence of making learning fun [8]. In addition, it aids students in knowledge construction by delivering highly interactive learning experiences that tap into students' feeling of being there and their own creative faculties. By allowing students to meet virtually regardless of their physical locations and by including sensory elements like

sound, vision, and touch, this technology facilitates interactions between students and virtual objects. When the proper infrastructure is in place, it is well recognized that virtual reality technology, which provides new instructional settings today, is highly valuable, particularly in distance education.

As a result of technological advancements, education may now be provided even in remote locations. Military training, particularly in the field of engineering where nuclear studies will be conducted, pilot and astronaut training through the creation of virtual cockpits, learning, language, and medical training on artificial cadavers are all areas where this technology has found practical applications [5] et al. Through the medium of the Internet, students from different parts of the world who would otherwise never get the opportunity to meet in person may connect and learn from one another. Since this technology makes it possible to bring students from various nations together, it may be put to good use in the teaching of foreign languages. In addition, students may get a deeper comprehension of historical events and geographical formations by using virtual reality applications in the study of history and geography.

2 Review of Literature

The metaverse is a virtual, three-dimensional extension of the internet that provides a productive online learning environment that promotes in-depth knowledge. There is a great deal of leeway for consumers in terms of instantaneous communication [9]. With its emphasis on communication and its infrastructure for immersive learning, the metaverse is revolutionizing the classroom. E-learning is expected to benefit greatly from the metaverse because of the improvements it will bring to the realism and interactivity of virtual classrooms.

The technology known as "Meatverse" has just appeared. The modern scientific and technological goal is to transform physical space into a metaverse of virtual space [10] et al. Most of their time will be spent there as they relocate their homes, workplaces, possessions, and data. They want to join the cutting-edge yet divisive online community. The concept of the "metaverse" refers to a new kind of virtual environment that would be more realistic and immersive than previous attempts. The riches of the globe would be made available to everyone, and education wouldn't need physically travelling anywhere. The dynamic between teachers and students will evolve as a result of this new technology, which will increase the breadth, depth, and velocity of instruction. With metaverse learning, the divide between instructor and student disappears.

According to [9], understanding of the metaverse has grown in recent years. Due to the lucrative potential of the metaverse, business magnates from all over the globe are investing in it, with China taking the lead. There are parallels between the classroom and the metaverse. The metaverse provides an ideal environment for online education. Many individuals get the impression that the whole process of creating and using the metaverse is a scam [11] et al. The broad adoption of the metaverse quickly faces obstacles such as a

lack of information, faith in existing technology, and comprehension of educational uses. Knowledge of the metaverse, its technological advancements, and the rate of progress might inspire confidence.

The metaverse is a persistent and eternal multiuser ecosystem where virtual and physical realities merge. Virtual and augmented realities (VR/AR) provide rich, multimodal engagements with digital content and avatars (AR). The term "Metaverse" refers to a socially networked virtual environment that is persistent across many user interfaces [5] et al. It makes it easier for people to engage with digital artifacts in real time and in a fluid way. In an earlier version of the technology, avatars could travel between connected virtual worlds. The most up-to-date incarnations of the metaverse include social, immersive VR platforms that may connect players to MMOs, open game realms, and augmented collaborative reality settings.

Both AR and VR have showed early promise in STEM education and laboratory simulations (for purposes like safety instruction and surgical practice) [10] et al. The capacity to capture 360-degree panoramic photos and volumetric spherical video in the metaverse paves the way for immersive journalism, which may inform the general public about events in far-flung places [12]. Distance learning enabled by the metaverse has the potential to go beyond the confines of traditional 2D media. Meta-education has the potential to provide students a wide variety of direct and indirect learning experiences on online 3D virtual campuses where they are co-owners of virtual locations and co-creators of liquid, customizable curriculum.

Social media connection, virtual reality (VR) affordances, and AR capabilities may all be brought together with mixed reality (MR). Several sectors, including online education, might be affected by their innovative collaboration [13]. Using the potential of the metaverse, online distance learning may give rise to novel forms of meta-education that combine different environments for learning. Education in the virtual world, or "metaverse," has the potential to improve communication and education in a more casual setting. Attending class will no longer be a special treat. Telepresence, realistic avatar body language, and expressive face animations will all contribute to successful virtual participation. Knowledge gained via social mixed reality in the metaverse may be both more in-depth and long-lasting. It has the potential to democratize education by removing geographical barriers to equitable participation from all around the world.

In 2021, [14] described his journey into the metaverse. He mentioned constructing an avatar as a prerequisite to join the metaverse. With the control panel, he was able to alter my appearance by replacing my hair, eyes, clothing, and jewelry. His avatar's previous clothing was hideous, so he swapped it out [14]. Once he had chosen the proper attire, he was free to go forth into whichever part of the virtual world he so liked. He hopped between parallel dimensions. Through his newfound social activities, he was able to meet and befriend other people. He gave the excuse that he missed the other planets. As a place where visitors can get the education they want in a virtual environment that mirrors the actual one,

and where they can follow in the footsteps of John Dewy and study by doing, this experience might also be merged with the teaching-learning world.

The future of the metaverse in education seems bright. Using VR in the classroom may improve visual learning by giving students the opportunity to "live" a particular event, which can lead to deeper and more meaningful understanding than is possible in a typical classroom setting. The metaverse has the potential to revolutionize education [10] et al. Let your mind wander to an astronomy class taught on a spaceship. Language barriers may be reduced or even eliminated in virtual classrooms. People from all around the world might attend classes together online without having to worry about communication barriers. A high-quality education, delivered in an environment conducive to learning, will be made available to individuals in far-flung locations thanks to the metaverse school and virtual learning space. Users may engage in conversations with 3D avatars on Microsoft's Mesh platform. Using Microsoft HoloLens, students and remote participants may experience immersive learning environments and interact with digital characters.

3 Methods

The purpose of this research is to analyze the current state of metaverse studies in the field of education, in order to spot emerging tendencies in terms of potential and obstructions. The author used a global perspective and utilized the bibliometric mapping method to reveal recurring themes in the studied literature, allowing for an evaluation of current trends in the field of metaverse research on education [15] et al. The interrelationships between fields of study, subject areas, individual publications, and authors may be graphically represented via bibliometric mapping. By measuring and evaluating certain characteristics of study in a certain topic, bibliometric studies make it possible to spot patterns [16]. Through bibliometric analysis, one may track down and learn more about the papers, institutions, researchers, and scientific flow that are all related to the chosen scientific problem.

4 Results

The term "Metaverse" is used to describe a post-reality world where digital virtuality is seamlessly integrated with physical reality. Virtual reality (VR) and augmented reality (AR) are at the foundation of the metaverse because they enable rich, multimodal interactions between users and their digital environments, digital objects, and other users (AR) [17]. Therefore, the Metaverse is a system of always-on, multiuser platforms that provide access to a variety of social, networked, immersive activities. It paves the way for real-time bodily communication and interaction with digital objects. It first appeared as a network of interconnected virtual environments where avatars might travel. Included in the present Metaverse are interactive, immersive VR systems that work with MMOs, open game worlds, and augmented reality collaborative environments.
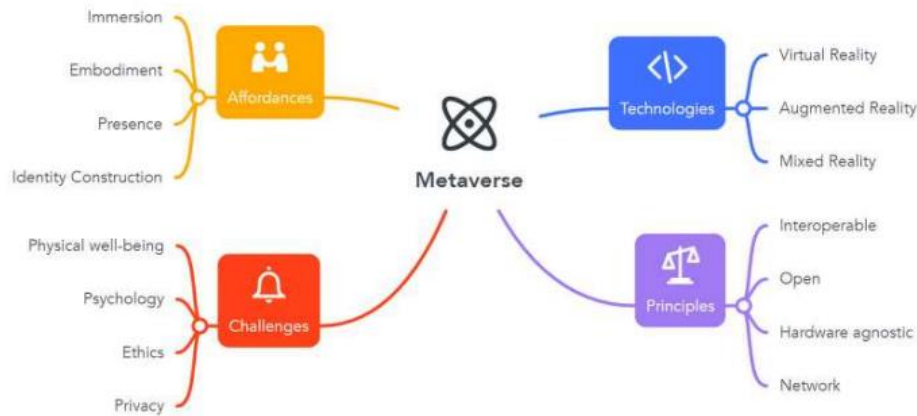
Fig. 1. Metaverse Concept (Mystakidis, 2022).

Figure 1 depicts the primary dimensions. But in the context of MR, it may combine the social media connectedness with the unique features of VR and AR immersive technology. If their collaboration is allowed to flourish, it might revolutionize several fields, including instruction. Using ideas from the realm of 3D virtual campuses, a new paradigm of Meta-education driven by online distant learning is possible [18] et al. Distance education in the Metaverse will test the limitations of communication and education in a more casual setting. Being present in the classroom won't have the same value it once had. An avatar body language, telepresence, and facial expression conformance will make virtual meetings equally as productive as in-person ones. In addition, MR in the Metaverse may pave the way for active mixed education, which can lead to the development of richer, longer-lasting knowledge [19]. In addition, it has the potential to contribute to the democratization of education by eliminating barriers to entry based on location [20].

The breakthrough known as the "Metaverse" is a digital realm that may be explored in three dimensions. Because of Metaverse and other enabling technologies, users may experience a convincing simulation of physical presence in a digital world [21]. The concept of the Metaverse has many potentials uses outside the realm of digital entertainment, including but not limited to the realm of education. So, how may online learning develop in the near future? Is this a chance or a risk for the school system?

Researcher used references, global citation rankings, and author keywords to do the cluster analysis, and we established the minimum clustering results at 5. It seems like every group is accepting virtual reality. In the same way, there were three groups formed for

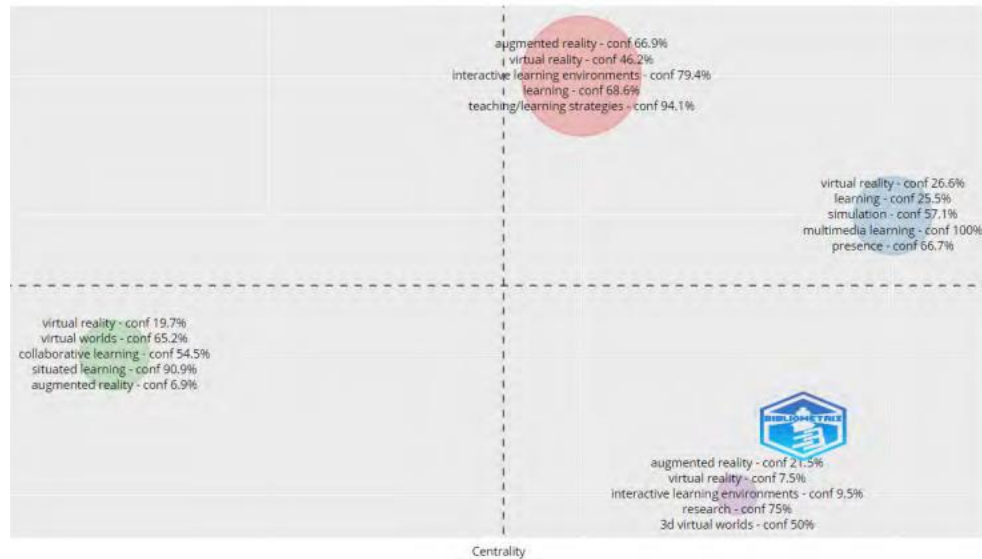augmented reality. Figure 2 in shows a network diagram of the authors affiliated with these subgroups.

augmented reality - conf 66.9%
virtual reality - conf 46.2%
interactive learning environments - conf 79.4%
learning - conf 68.6%
teaching/learning strategies - conf 94.1%

virtual reality - conf 26.6%
learning - conf 25.5%
simulation - conf 57.1%
multimedia learning - conf 100%
presence - conf 66.7%

virtual reality - conf 19.7%
virtual worlds - conf 65.2%
collaborative learning - conf 54.5%
situated learning - conf 90.9%
augmented reality - conf 6.9%

augmented reality - conf 21.5%
virtual reality - conf 7.5%
interactive learning environments - conf 9.5%
research - conf 75%
3d virtual worlds - conf 50%

Centrality

Fig. 2. Clustering Map

4.1 The potential of metaverse in education

Educators everywhere have adjusted to the ongoing CoVD-19 epidemic. According to [22] et al., the pandemic has had a dramatic impact on the world of academia. In hundreds of countries, pupils encounter the same disruptions in the classroom. Teaching and learning that used to take place in person between instructors and students must now take place on the internet utilizing a variety of digital tools [22] et al. Metaverse is promoting the idea of virtual worlds as a means to enhance the interactivity of online education. If you want to supplement your offline education with online resources, Metaverse can help you do so. Metaverse is a virtual world idea that promotes more participatory online learning. Metaverse aids online education without diminishing traditional classroom experiences [23] et al. Many people find it appealing since you may study whenever and wherever you wish. Technology allows for more efficient use of time, space, and money.

Innovations in technology are inevitable, and the educational sector will have to adapt. Instead, we should use these innovations in technology as a means to do good. As major computer corporations work to create the Metaverse, the education sector will need to adapt

to include it [4]. The global spread of the Covid-19 virus has had a dramatic effect on teaching practices everywhere. The virtual age may play a prominent part in enabling swift information pertaining to educational material, which in turn may make learners develop a broader comprehension of the subject matter. This is because today's teaching materials are not constrained to those given by teachers, but can also be made accessible anywhere anytime.

It is possible to construct wilder, more beautiful, and more fully-equipped school buildings in the virtual environment; this, of course, will make the ambience more comfortable, but it may weaken the connection between students and educators in the real world, as they may only interact with one another in the Metaverse through their respective avatar forms. Benefits of the Metaverse include, a new digital medium for communication that is easier to use. The use of applications in education has the potential to vastly enhance the quality of teaching and learning [24] et al. One of two current Metaverse difficulties in the education sector is 1) creating novel educational experiences. Therefore, it is important for students to be prepared for the use of Metaverse technology in the classroom. 2) Education continues to take place in spite of barriers like distance and time [25] et al. As a result of the technology of the Metaverse's impact on the field of education, all learning activities are conducted in a more open and dynamic setting. The learning experience is enhanced in the Metaverse universe.

Unlike in the real world, when traveling to historically significant locations both at home and abroad, or even to outer space, might be challenging, history instructors have it much easier in the classroom. The natural splendor of Indonesia may be seen by students at the Borobudur Temple, the Prambanan Temple, and other popular tourist spots. Students may be introduced to historical concepts via direct visuals by visiting museums and, subsequently, to the virtual world by touring a virtual, three-dimensional museum. When we examine the internal anatomy of various animals (rabbits, frogs, cats, fish, and so on) in biology class [26]. Instead of dissecting actual animals, we may utilize computer simulations. In astronomy classes, students will be able to see the movement of the planets, which will appear completely genuine, and the eruption of mountains. Volcanic eruptions may be included into Geography classes, and field trips to museums aren't necessary when teaching about the past. We may attend a concert with the singer during our Art classes by downloading a future app. The planets' orbits will seem lifelike, and we'll be able to watch volcanoes erupt on the spot while we learn about astronomy.

4.2 Barriers of metaverse in education

Consequences of using the Metaverse include the following, as stated by [25] et al.: 1) Consumes a lot of technology due to the high quality and complexity of the visuals it generates. There is a high financial barrier to entry for the Metaverse's enabling technologies. Because the Metaverse has no boundaries, there is a chance for significant

social and cultural shifts. Fourthly, the metaverse and its relevance to the question of whether or not people really need to interact in a virtual space remain unresolved. Given the current state of affairs, this is a distinct possibility. In the future, metaverse tools will be used in the academic sphere. Obviously, we'll be looking at how each factor affects students' ability to succeed in the classroom [27] et al. At the very least, talk Metaverse has ushered in a new era of technological innovation in the classroom. Teachers in the present day need to improve their technological literacy by weighing the benefits and drawbacks of various tools in order to maximize benefits and reduce risks associated with using them in the classroom.

In the field of education, the Metaverse still has several holes that need fixing and problems that need solving. If the Metaverse is to be utilized in the field of education, it must be prepared to confront larger international interaction due to the nature of the Metaverse, which gives boundless space or is frequently termed borderless, and therefore may generate participation that tends to be bigger [28] et al. Another difficulty with the Metaverse is that not everyone has a secure enough income to afford the necessary hardware and software to participate. As a result, if habituation is implemented to this new technology, the introduction of this technology will provide a new environment and may maximize the standard of education in the future.

The Metaverse can be used for more than just instruction and assessment; it can also be used for things like teacher management, financial management, promotion files, supervision, and the like. Whether or not these things will ever be implemented in our country, however, is unclear; for the time being, they remain firmly in the realm of wishful thinking [29] et al. The lack of personal connection that comes from not interacting with other people face-to-face is one drawback that may be experienced if all educational activities were to be conducted online. If education is only a formality, then teachers need not get to know their pupils personally.

5 Conclusions and Discussion

In a positive light, the Metaverse's potential use in the classroom might provide a fresh and challenging setting for teaching. Technology and instructional media utilized now may be optimized by the presence of this Metaverse, making them more effective once again. Students will also benefit from a more positive self-perception and the stimulation of the development of soft skills thanks to the knowledge they acquire [30]. Still, there is skepticism about Metaverse's efficacy when applied to online education because of the absence of teacher-student connection.

Through the use of the Metaverse, students are able to have a more engaging and immersive student setting. Since the Metaverse will have an effect on the education sector, its arrival can only be celebrated. First, students will have a better time while they're studying. In the future, we will be able to experience a more realistic metaverse. There is an element of learning similar to a real class even if the student is at home, so the student

no longer feels like they are studying on their own [20]. Second, it's possible to more realistically conduct practical classes. Since it is challenging for students to acquire equipment and practical apparatus in the laboratory, procedure becomes a challenge in and of itself if we conduct out the web - based learning process [4]. Therefore, students have constraints while attempting to conduct out practice; however, with the availability of this technology, these constraints will be addressed, as students will be able to practice without having to physically go to the laboratory, only by donning a pair of Oculus glasses.

Third, it's never too early to start educating yourself and contributing to the body of human knowledge. Having a course load as vast as the universe and more time to delve deeply into areas of interest should give students a taste of the liberating potential of education [19]. Four, there will be a larger and steadily expanding pool of educational materials. Inevitably, the existence of technology will lead to the expansion of both human understanding and technological capability. The more we use the Metaverse as a tool in the learning experience, the more diverse the learning materials that will emerge, providing us with anything from new areas of study to new ways to expand our existing skill sets. Fifth, modern classrooms are more than simply structures. Many more virtual schools that don't need a lot of space for land or buildings will crop up as a result of the Metaverse's existence, altering the physical structure of educational institutions throughout the globe. Places of higher learning, the vast majority of which are inaccessible owing to prohibitive travel times and tuition fees.

Humanity risks losing both value and cultural legacy as a result of technology's fast advancement. Practical and self-centered thinking dominates human existence. With this comes a significant challenge for the field of education as we enter the age of the Metaverse. These kids need some means of overcoming these dynamics for the goal of bringing their real-world and technological lives into harmony and alignment [8]. It's "science" with the kind of knowledge-seeking that can be done without relying on anybody else, whether that someone is formally educated or not. These kids need to learn to value information for themselves, so that when the Metaverse period arrives, they may enter it with confidence and enthusiasm without abandoning the fundamentals of their education. In an age of fast technological advancement, there is an urgent need for humanist and fair education to help pupils escape the moral and material colonialism into which they have been born.

Soon, the Metaverse will seem so natural that its users will forget they're really in cyberspace, further blurring the lines between the two. Keep in mind that the Metaverse is just fantastical, and avoid destroying it [31] et al. The allure of the Metaverse is undeniable; after all, with the aid of a pair of oculus goggles, we may instantly teleport to any part of the world, no matter how far away or close by [25] et al. Again, however, the Metaverse is not the actual world, and upon reentering the real world, you will be confronted with the messiness that is the real world.

Fast and reliable internet technology is essential for the Metaverse, but the high price tag might be an issue. The lessons of yesterday's pandemic are that not all parents can afford

to buy cell devices for their children, and that online learning may be slowed by slow networks or even by people who can't get a signal [6] et al. Especially for gen-z, who tend to favor a computerized environment, the Metaverse has the potential to transform education into a digital experience as technology advances. Education has to adapt to the ever-changing technological landscape. The potential for Metaverse, a technology that delivers a virtual and imaginative environment, to be employed in the classroom is vast. Education has started to advance, but not wholly via the use of conventional means, as the digital world has become more integrated into the everyday lives of young people. Metaverses may exist to make learning environments more engaging for today's youth.

We are unable to stop the march of technological progress. To maximize technology's positive impact on society, particularly in the realm of learning, we need only use common sense in its application. Even as recently as the early 2000s, schools were so afraid of the internet's negative effects on pupils that they forbade students from having smartphones and confiscated the devices of those who were caught with them. After ten years, formerly terrifying innovations have found useful applications in classrooms throughout the globe. The field of education can't stop the march of development; all it can do is provide guidelines for putting new technologies to good use. As a means to an end, the Metaverse cannot be mistaken for the very stuff of existence. Likewise, the author believes that the Metaverse will not replace traditional classroom instruction and extracurricular activities. The educational community will use the Metaverse only as a tool to improve existing services without completely replacing the physical world. Education, after all, is meant to humanize its students, not virtualize them.

The Metaverse, now under development by several large technology firms, will force changes in classroom practices throughout the world. The educational system stands to benefit greatly from metaverse technology. This method is advantageous since it makes better use of the time available for educational purposes. Soon enough, it's possible that the whole educational process might be conducted in a digital environment thanks to the advent of metaverse. Everything from the construction of schools to the delivery of instruction to the management of educational institutions will take place in virtual environments. We can do anything in the metaverse without ever having to physically meet. Something like this would undoubtedly shake up the current state of schooling. The human connection that should arise through face-to-face interactions will be lost in the impersonality of the Metaverse. Because, after all, we all know that the internet is not the real deal. We do not truly reside in the Metaverse, but rather in the Real World. It's possible that a teacher who has spent months with his pupils may never meet any of them again. Learning may not transform people into fully realized people. However, many low-income children' academic performance suffers as a result of fewer opportunities to attend school. If pupils are to experience true education, this problem must have the optimal answer.

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