



Metaverse in Education: An Overview of Systematic Reviews

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Abstract

Background: The experience of virtual education during the COVID-19 pandemic resulted in educational institutions accepting new educational environments. The present study aims to review the existing research on the use of metaverse in education and its pros and cons.

Materials and Methods: Online databases PubMed, Scopus, Web of Science, PyscINFO, ERIC, CIVILICA, and Google Scholar search engine were searched for related systematic reviews up to February 2023. Two reviewers evaluated the quality of eligible studies and carried out the selection procedure.

Results: Eight systematic reviews (involving 317 studies published from 2022 to 2023) were selected. Learning with the metaverse has many advantages. It helps visualize materials and makes learning more interactive, easier, and interesting for students, and aids educators in the learning process. Also, the metaverse assists competency-based and inclusive education and blended learning and facilitates the use of synchronous and asynchronous learning and methods such as flipped classrooms and cooperative learning. However, it is associated with several limitations, such as the high cost of XR equipment, lack of familiarity with XR and VR environments, inadequacy of the underlying infrastructure for the educational metaverse, and low accessibility. Metaverse also entails risks, including issues with privacy and data security, ethics, and morality, as well as the possibility of addiction and mental health complications. The metaverse is a pathway and not a goal, and physical schools and their activities cannot be completely replaced with the metaverse.

Conclusion: The metaverse is simply a tool to improve services without completely replacing the real world. Future development is needed to maximize the advantages of the metaverse as a learning platform and counter its limitations.

Key Words: Application, Education, Cons, Metaverse, Pros.

*Please cite this article as: Imannezhad Sh, Vahedian-Shahroodi M, Shariati kh, Mansourzadeh A, Saeedi M. Metaverse in Education; an Overview of Systematic Reviews. Med Edu Bull 2023; 4(2): 731-43. DOI: 10.22034/MEB.2023.405301.1079

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Received date: Feb. 10, 2023; Accepted date: Jun.22, 2023

1- INTRODUCTION

The experience of virtual education during the COVID-19 pandemic created conditions for educational institutions to accept new educational environments. In today's world, remote work, online meetings, distance learning, online shopping, and similar activities have become a part of people's lives (1-3). As a result, the human desire to expand the boundaries of the physical world and to live in and experience a more advanced virtual world has intensified (4). Virtual reality (VR), and augmented reality (AR) are highly promising technologies in education fields, which combine the real and virtual worlds. This virtual world is called the metaverse (4, 5). The term "metaverse" was introduced in the 1992 science fiction novel *Snow Crash* as a portmanteau of "meta" (meaning "beyond"), and "verse" (the root of "universe") (6-8). In this novel, humans could freely access a 3D space that reflected the real world through digital agents (avatars), and could interact with each other (9).

The metaverse development is often linked to advancing virtual reality technology following the increasing demand for immersion (10-12). It received renewed interest following the announcement that the social media giant Facebook is rebranded and positioned as Meta (13). Metaverse is a hypothesis of the next generation of the Internet, which consists of a decentralized and stable online 3D virtual environment (14, 15). It is a digital world that can be accessed through the virtual environment and is created through the integration of physical and digital reality (16). From an educational point of view, the metaverse offers advanced immersion experiences in the virtual space along with an interactive learning experience for students where they can share their experiences. Metaverse is an interactive and scalable network of 3D

virtual worlds presented in real time that can be accessed simultaneously by an unlimited number of people while maintaining a sense of personal presence. So that students really feel that, they are present in the real environment (17). This way, the metaverse allows students to interact face-to-face in a virtual classroom without being physically present. Using avatars in the metaverse creates the possibility to interact with the virtual environment (18). The use of the metaverse in educational and training processes to create new learning environments that allow learners to function in a parallel, safe, and personalized reality is gaining ground (19-22). Metaverse is a virtual world that humanity will face in the near future (18). The metaverse provides innovative perspectives for education, but the challenges associated with its use, as well as the benefits, should be considered.

Due to the growth of the metaverse technology in various fields and the importance of using it in education, the present study aimed to explore the existing systematic reviews of the metaverse in the educational field. It also discusses opportunities, advantages, challenges, and risks related to this novel technology.

2- MATERIALS AND METHODS

2-1. Data sources

In this overview, a systemic search of electronic databases Medline (via PubMed), Scopus, Web of Science, EMBASE, PyscINFO, ERIC, CIVILICA, SID, Magiran, and Google Scholar search engine was performed with no time limit up to February 2023. The following keywords were used alone or in combination: "Metaverse, Education, Students, Educators, Pros, and Cons". The studies were written in English or Persian.

2-2. Inclusion criteria

Inclusion criteria were the existing systematic reviews describing the metaverse in education written in English or Persian.

2-3. Study selection

A database search was done for suitable studies, abstracts of the studies were screened for identification of eligible studies, full-text articles were obtained and assessed, and a final list of eligible studies was made. This process was done independently and in duplication by two reviewers, and any disagreement was resolved by a third reviewer.

3-RESULTS

A total of eight systematic reviews (involving 317 studies published from 2022 to 2023) were selected. The combined results of included studies indicated several pros and cons of using the metaverse in education. The main characteristics of the selected studies are summarized in the following:

1. A systematic review (in 2023, n=17 articles) aimed to analyze the existing research on using the metaverse in education. The results showed that metaverse has the potential to enrich and transform education, increase learning outcomes, and enhance students' engagement and motivation. However, the use of metaverse in education is in its infancy, and further research and experiments should be carried out at all educational levels and populations to assess its impact and improve its effectiveness. In addition, designing valid instruments is necessary to evaluate the educational experiences generated within the metaverse (23).
2. A systematic review (in 2022, n=41 articles) aimed to evaluate the research on metaverse in education from the viewpoint of information system (IS) theories/models for a thorough pointer to help scholars carry out further research on metaverse

acceptance. The results showed that the Technology Acceptance Model (TAM) was the most widely used model for predicting people's intentions to uphold the metaverse system. Also, SmartPLS (PLS-SEM) was a typical tool for validating metaverse models. In most of the evaluated research, university students were the primary respondents concerning data acquisition (24).

3. A systematic review (in 2022, n=22 articles) aimed to examine the studies on the use of metaverse technology in education, to analyze the changing understanding of its use in education over the years, and to investigate the reflections of the concept of metaverse in education. The results showed that all studies reached conclusions about the beneficial aspects of using metaverse in educational settings. The findings indicated that with the metaverse, a participatory and sustainable learning environment could be created, and the efficiency of the learning process could be maximized. Metaverse can facilitate the use of synchronous and asynchronous learning and other methods such as the flipped classroom and cooperative learning. It can introduce fun into learning to provide motivation and cooperation and ensure students' attendance. The metaverse contributes to the development of trust, awareness, communication skills, interaction, product creation, and team management processes. In the studies included in the systematic review, metaverse technology appeared in two different contexts: three-dimensional computer software-based metaverse platforms and digital reality-based metaverse platforms. Metaverse is perceived today as virtual worlds where people exist and interact through their avatars, created by computers connected by blockchain technology and powered by digital reality technologies (25).

4. A systematic review (in 2022, n=30 articles) aimed to discover the possibilities,

effectiveness, advantages, and disadvantages of learning with the metaverse. The results showed that the metaverse could be an effective learning tool as learning in the metaverse has many advantages: it helps visualize materials, makes learning more interactive, easier, and interesting for students, and aids teachers in the learning process. However, there are also some limitations, such as the cost of the device needed to support the metaverse, even though there are more advantages to using the metaverse in education as a learning tool. Future development is needed to maximize the metaverse advantages and counter its limitations as a learning platform (26).

5. A systematic review (in 2023, n=84 articles) aimed to explore the potential of the metaverse in education and other fields. The results showed that the metaverse presented a promising opportunity for educational innovation, particularly in fields that require hands-on experience and practical training. The economy of the metaverse is predicted to reach over 824\$ billion by 2030. Organizations currently investing in this technology are posited to win the innovation race. However, the metaverse can only reach its full potential if organizations work together to create an open, safe, sustainable, and all-encompassing environment that encourages innovation and translates into value for all involved. This will require huge technological investments and adaptations, sophisticated content creation tools, and large servers to maintain system stability and create a truly immersive experience (27).

6. A systematic review (in 2023, n=42 articles) aimed to determine the prevalence and current conditions of the metaverse technology in education. The results showed that research interest in metaverse technology has significantly increased in the last ten years, peaking in 2022.

Augmentation and simulation are the most prominent uses of metaverse technology in the learning process (28).

7. A systematic review (in 2023, n=31 articles) aimed to explore the results of using the metaverse as a virtual space in education and the response of educators and students to the process and to evaluate the advantages and disadvantages of virtual educational spaces in the metaverse. The results showed that the students mostly enjoyed using the metaverse as their learning method and could comprehend several lessons better when using the metaverse than traditional learning-textbook-based and face-to-face learning. In general, the authors concluded that the metaverse has excellent potential to be explored in education due to the development of skills in the use of technology and a significant increase in student practice scores. However, the guidance of teachers and parents is still needed so that students can avoid the disadvantages (29).

8. A systematic review (in 2023, n=50) aimed to review the existing literature to investigate how, why, where, and when the metaverse can be used for educational purposes and discusses the opportunities, challenges, and risks related to this novel technology. The results of a critical review of the literature suggested that there were both pros and cons of using the metaverse in education. Educators should consider the potential disadvantages of the metaverse, including privacy breaches and security risks, as well as possible addictions and the development of mental health issues, among others. Students and educators can use the metaverse to engage in a simulated digital universe that could reconfigure their sensory inputs and definitions of space, time, and points of access to information. In addition, the use of the metaverse in education can create infinite possibilities to enhance their knowledge, competencies, and abilities

through its immersive applications. However, it also raises awareness of possible challenges in the short term as well as other risks associated with the prolonged use of this promising technology (30).

4- DISCUSSION

This study aimed to explore the existing systematic reviews on the metaverse in the educational field. Based on the existing research, learning with the metaverse has many advantages: it helps visualize materials and make learning more interactive, easier, and interesting for students and aids educators in the learning process. In addition, the metaverse assists competency-based and inclusive education and blended and language learning. However, there are also some limitations, such as the high cost of XR equipment and a lack of familiarity with XR, inadequate infrastructure to support the educational metaverse, and inaccessibility to everyone with the current technology. Also, the risks of the metaverse, including privacy and data security breaches, ethics and morality issues, and possible addictions and the development of mental health problems, should not be ignored.

In the past few decades, the education sector has undergone significant changes. Educators have improved their teaching methods to match the pace with the rapidly evolving technological sphere, moving forward from word-of-mouth explanations and blackboard drawings/sketches to digital smart classes. Today's teaching practices aim solely at students' learning and focus on creating an engaging and immersive environment where they can learn concepts better (2, 3). With online learning becoming mainstream, especially after the pandemic, the education sector is now dominantly focused on integrating immersive technologies into academic curricula to make learning fun and engaging. The metaverse is one such focus

for educationalists across the globe (18, 19). It aims to involve students in an immersive experience where they can participate in fun activities, making learning more entertaining (31, 32).

The metaverse is a three-dimensional virtual world that integrates aspects of online gaming, social media, VR, and AR to create a space where users can interact virtually (20).

Based on the existing research, the metaverse is made of several key components, including:

- **Avatars:** Avatars are digital representations of users that can be customized and personalized to reflect their identities. They can be designed to resemble real people, animals, or imaginary creatures.
- **Environments:** Environments are virtual spaces that can be designed to mimic real-world environments or create new ones. They can range from a classroom or a lecture hall to a virtual museum or a laboratory.
- **Objects:** Objects are digital items that can be interacted with in the virtual space. They can include anything from books and documents to scientific equipment and laboratory tools (33).

The key metaverse components that are beneficial for education are discussed below:

- **Augmented reality**

Augmented reality helps create digital versions of real-life objects with various specifications. The mixed reality (of both physical and digital worlds) enhances the learning for students. AR can be accessed through smartphones as well. For example, it can help students with medical imaging for surgeries or get a 3D visualization of an architectural plan. In the metaverse, AR is used to layer real-life elements. Various

real-life landscapes are built into the metaverse using augmented reality.

▪ **Mirror worlds for metaverse in education**

It is possible to mirror the real world as a virtual reality through the metaverse. Real-world geography can be mirrored and spread out in the metaverse so that anyone can go anywhere. Google Earth is an example of a mirror world with realistic visualization. Mirror worlds in the metaverse can act as reflections of the real world that are informationally enhanced.

▪ **Realistic lifelogging**

Lifelogging promotes self-learning by allowing students to create their learning resources through documentation. Technologies such as VR let people document daily life in more than one way. Capturing, storing, and sharing everyday experiences, events, and interactions at an advanced level of reality helps the learning process be more dynamic than rote static textbook information. Students can feed their status into the system accompanying art and self-expression, which becomes a “backup memory” that will remain available forever. A real-life example of lifelogging is smartwatches with health and mood trackers.

▪ **Interactive virtual reality**

In the metaverse application, digital avatars of students and teachers can interact with each other just like in real life through VR digital spaces. Virtual experiences in the metaverse are unlimited, and virtual spaces can have their own economy (34, 35).

As Gartner (2022) predicted, nearly 30% of people will spend two hours a day in the metaverse for work, entertainment, education, and socialization by 2027 (36). In the age of communication and emerging technologies, the metaverse can provide great possibilities and innovations for education (4), as it offers a unique

opportunity to revolutionize the way that students learn and interact with information (37).

The metaverse is based on three main features: presence, interactivity, and standardization. Presence means that all metaverse users feel that they are present in a shared virtual world and can interact with other people. This feeling will increase the quality of online interactions. Interactivity means users in the metaverse world should be able to have multiple interactions between other users and objects. Standardization refers to the synchronization of the metaverse infrastructure with other platforms. Standardization helps the possibility of interoperability in the metaverse become operational. Another feature of the metaverse is the simultaneity of interactions and communications, high speed or instant, stability or the possibility of constant access, and eliminating the costs of the physical world. The metaverse allows learners to have more opportunities to experience, explore, teach, and learn in the new world as well as work and interact (38). A review of the use of metaverse systems in education showed that according to the principles of the metaverse, the virtual learning environment could simulate the law of dynamic evolution in natural phenomena and its processing process. In this structure, a space is provided where online and offline education are integrated, emphasizing the integration of different learning styles. Establishing powerful interactions is the most important indicator that separates online learning through the metaverse from other traditional online education models (39).

Some potential uses of the metaverse in higher education include:

▪ **Remote learning:** The metaverse can provide a way for students to attend virtual classes and interact with their peers and instructors from anywhere in the

world, regardless of physical distance. This can help address the challenges of remote learning and provide more flexibility for students.

▪ **Immersive learning:** The metaverse can create immersive and interactive learning environments that can help students understand complex concepts and theories better. For example, a virtual laboratory could allow students to conduct experiments that are too dangerous or expensive to perform in the real world.

▪ **Collaborative learning:** The metaverse can facilitate collaboration and teamwork among students, allowing them to work together on projects and assignments in a virtual space. This can help develop important skills such as communication, problem solving, and leadership.

▪ **Personalized learning:** The metaverse provides personalized learning experiences that can adapt to the needs and learning styles of individual students. For example, a virtual tutor could provide personalized feedback and guidance to students based on their performance and progress.

▪ **Accessible learning:** The metaverse can provide a way for students with disabilities or special needs to access education in a more inclusive and accessible way. For example, a virtual classroom could provide closed captions, sign language interpretation, or other accommodations to support students with hearing or visual impairments (37- 41).

Based on the existing research, the metaverse has great potential in the educational field to be explored further. **Figure 1** shows the framework of the metaverse in education. Using metaverse as a platform for learning-teaching activities has plenty of advantages, including:

▪ Assisting in experiments that could be risky, irreversible, or toxic in the real world (e.g., an experiment with a potential risk of explosion);

▪ Assisting in experimental conditions and scientific phenomena that could not be possible in the real world (e.g., an experiment that needs to be carried out in a vacuum);

▪ Assisting in experiments associated with high costs and funding in the real world (e.g., an experiment that needs expensive equipment and materials);

▪ Assisting in experiments that react slowly or need long-term observations and records in the real world (e.g., an experiment needs learners to observe and record the whole growth stage of an insect); and

▪ Enabling competency-based education. Competency-based education (CBE) is a leading paradigm for educational reform in the vocational education and training (VET) sector, where the competencies (e.g., knowledge and skills) needed in later vocational practice form the foundation for curriculum development rather than the general academic subjects (29, 32, 40-44).

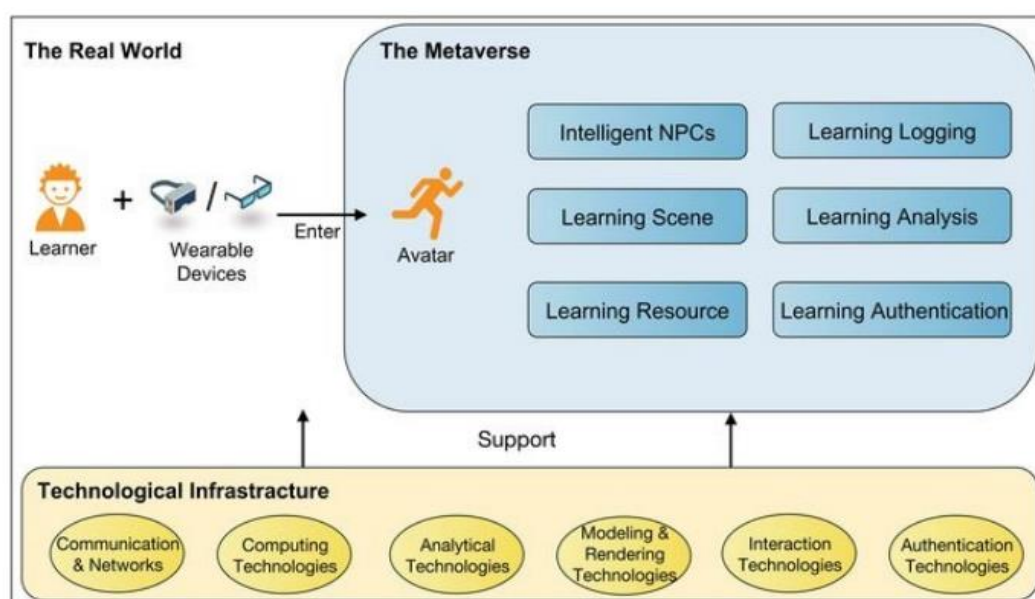


Figure 1: The framework of the metaverse in education (32).

Based on existing research, there are also challenges associated with the use of the metaverse in education, including:

- **High equipment costs**

VR hardware is costly, and not everyone can afford it, meaning that some students cannot enroll in virtual classes. Also, given the rapid pace of technological development, it is likely that any equipment purchased will become outdated and obsolete in a short time.

- **Data privacy and security concerns**

In the metaverse, teachers and students are required to submit substantial personal information, such as image, physical condition, and metrics regarding student performance and personal characteristics. In addition, educators and learners run the risk of having their materials and content plagiarized in the metaverse space.

- **Addiction**

Learners who experience difficulties with self-control may get too involved in a virtual world and become unwilling to switch back to real life. The reason is that immersive virtual environments may seem

too perfect and entertaining, causing learners to ignore or give up on real-life communication.

- **Technical limitations**

The metaverse requires advanced technologies like VR and AR, which can be expensive and require significant computing power. Additionally, technical issues like latency and network connectivity can influence the user experience.

- **Digital literacy skills**

The metaverse requires digital literacy skills, including the ability to navigate virtual environments and use digital tools effectively. This can be a barrier for some users, particularly those who are less familiar with the technology.

- **Ethical and legal considerations**

The metaverse raises several ethical and legal considerations, such as issues around intellectual property, content moderation, and data privacy. These issues need to be addressed to ensure that the metaverse is used responsibly and in a way, that protects users' rights and interests.

▪ **Social and cultural implications**

The metaverse can affect social and cultural norms, as well as the sense of identity and community. These implications need to be carefully considered to ensure that the metaverse promotes diversity, equity, and inclusion (32, 45-50).

The metaverse has the potential to revolutionize higher education by offering a more engaging and dynamic learning environment.

Some benefits of using metaverse in teaching and learning, include:

- The metaverse offers opportunities for immersive and interactive learning experiences that can be difficult to recreate in traditional classrooms.
- Metaverse-based simulations and role-playing activities can enhance critical thinking, problem-solving, and collaboration skills.
- The metaverse can facilitate student-centered and personalized learning through customizable avatars and adaptive learning technologies.

However, the implementation of the metaverse in teaching and learning requires consideration of accessibility and technical infrastructure (26, 45, 46, 51, 52), as well as a new education platform. It needs extensive research before the implementation into the education system. For now, the metaverse is only used for some subjects in education, requiring good bandwidth, a good computer, and an adequate server. Rapid technological improvement, however, predicts that the metaverse could be the future of education (26). Technological developments are inevitable, and people must learn to use them wisely to exploit the highest benefit, particularly in education. Nevertheless, technology, including the metaverse, is a pathway and cannot be an end in itself. Therefore, the physical school and its

activities cannot be completely replaced by the metaverse (28). However, the metaverse proposes a promising future for the advancement of teaching and learning. The integration of novel technologies such as virtual reality, augmented reality, mixed reality, artificial intelligence, and cloud computing in teaching activities significantly enhances and deepens the effectiveness of bilateral interactions. Consequently, this increases teaching performance considerably (52). Nevertheless, the use of metaverse in education is in its infancy, and more research and experiments should be carried out at all educational levels and populations to assess its impacts and improve its effectiveness. In addition, the need for designing valid instruments to evaluate the educational experiences generated within the metaverse is evident (23, 24, 37).

5- CONCLUSION

Metaverse connects the physical world with virtual (digital) life. It is the world of avatars and the next generation of 3D Internet. Based on the existing results, the metaverse presents the opportunity for educational innovation, particularly in fields that require hands-on experience and practical training. Learning using the metaverse has many advantages: it helps visualize materials and makes learning more interactive, easier, and interesting for students, and aids teachers in the learning process. In addition, the metaverse can facilitate the use of synchronous and asynchronous learning, as well as methods such as the flipped classroom and cooperative learning. The metaverse assists competency-based education, inclusive education, blended learning, and language learning. If implemented carefully and correctly, the technology could enhance or transform the overall learning experience. It could also accelerate the learning speed, establish an

inclusive environment for everyone, and make it possible to acquire practical skills in non-hazardous conditions. However, the metaverse is also associated with limitations such as the high cost of XR equipment, lack of familiarity with XR and VR environments, inadequacy of the underlying infrastructure to support the educational metaverse, and inaccessibility to everyone. The use of metaverse in education is in its infancy, and more research and experiments should be carried out at all educational levels and populations to assess its impact and improve its effectiveness. In addition, the need for designing valid instruments to evaluate the educational experiences generated within the metaverse is evident. The risks of the metaverse, including privacy and data security breaches, ethics and morality issues, addiction, and the possibility of mental health problems, should not be ignored. The metaverse is a pathway and not a goal, and the physical schools and their activities cannot be completely replaced by the metaverse.

5- AUTHORS' CONTRIBUTIONS

Study conception or design: SI and MS; Data analyzing and draft manuscript preparation: MH, KS, and AM; Critical revision of the paper: SI; Supervision of the research: SI and MS; Final approval of the version to be published: SI, MH, KS, AM, and MS.

6- CONFLICT OF INTEREST: None.

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