Original Article

Evolution of Learning Spaces: Metaverse for Educational Platforms

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Abstract

Today, online educational platforms are recognized as a vital tool to transfer knowledge and skills in an effective and attractive way. Creating an educational platform in Metaverse is a strategic opportunity to provide educational services to a global and wide community. This educational platform in Metaverse is supposed to provide a multidimensional and interactive space that allows people to access various training courses using virtual reality technology and augmented reality plugins. This platform will be suitable for everyone, from children to adults and from beginners to advanced. Creating an educational platform in Metaverse enables knowledge and skills to be actively transferred to people using new technologies, and in this way, an important step towards the future of education is taken. In order to provide a coherent and comprehensive analysis of metaverse literature in the field of education, this article deals with a deep and organized review of the role of metaverse in this field. By focusing on current and future technologies, along with an analysis of challenges and opportunities, this paper attempts to provide a comprehensive and inclusive perspective. The purpose of this research is to provide a detailed and extensive study of the role and effects of Metaverse in the field of education, so that through the examination and analysis of future perspectives, it will be directed towards the progress and development of educational platforms.

Keywords

Introduction

The concept of metaverse was first proposed in 1992 in the science fiction novel "Snowfall" by Neil Stephenson, an American author [1]. The characters of the novel "Snowfall" become avatars - virtualized characters of real characters - and interact with each other in a 3D virtual reality, and this 3D virtual reality, which is somehow beyond the real reality, was called the metaverse. [2]. After the emergence of the concept of the metaverse, extensive efforts and researches were made to make the metaverse a reality. In 2006, a non-profit educational organization focused on research and development, especially in the face of accelerating change, unveiled the Metaverse Roadmap. In this road map, where the idea of metaverse was introduced, four stages of metaverse evolution were listed and it was stated that the metaverse should be considered as a point of intersection between the physical world and virtual reality [3]. In this 3D virtual reality, virtual characters, which are avatars, try to learn and imitate real human behavior [4]. In this definition and based on this modeling, the real-world merges with the virtual world. The noteworthy point is that the real person is identified with the avatar or the virtual person and this avatar participates in economic, social and cultural events, and what is more interesting is that the avatars interact with each other and in this process of interaction, learning is also formed. [5, 6]. This term refers to the digital world as a new world embodied through digital media such as smartphones and the Internet [7]. The metaverse is not simply a form of virtual reality, according to Mark Zuckerberg, it is an embodied, 3D iteration of the Internet [8]; A space without time and place limitations, where people can

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redesign their real life through avatars] 9.[

In the context of the future vision, there are predictions that jobs and businesses, educational systems and various activities will migrate to the metaverse. Thanks to the development of wearable technologies, people can participate virtually in the workplace through avatars and then be in the classroom at the same time without time lag. Before discussing the concept of metaverse and examining its effectiveness in the field of education, we will first have a definition of some basic concepts in the field of digital world, concepts such as virtual reality, augmented reality, mixed reality and extended reality. Virtual reality is not a new concept in the literature of virtual and digital world. The movie "Tron" introduced it to society in 1982 and it became a mainstream attraction in the 1990s. Virtual reality simulates a fully digital environment and essentially acts as a kind of metaverse with advanced 3D graphics, avatars, and real-time communication tools [2]. On the other hand, augmented reality involves the integration of 3D virtual objects in a real-time environment. It is a combination of physical and virtual elements, often achieved through the use of smart phones, tablets, smart glasses [2]; A popular app like Pokémon Go serves as an example of augmented reality implementation. Mixed reality combines elements of both virtual reality and augmented reality and enables interaction between physical and virtual elements in the same environment. While, augmented reality is expressed as a more general term and includes virtual, augmented and mixed reality technologies. Another support of Metaverse technology is Web3 technology. While Web1 technology was one-way and did not allow any change, Web2 technology, currently in use, allows user interaction but is dependent on the server, Web3 technology promotes a decentralized Internet, and This allows for more immersive experiences through connected headsets and glasses.

In summary, these emerging technologies, including virtual, augmented, mixed, and augmented reality, each offer unique features and applications to the wider digital landscape. Virtual reality offers fully immersive 3D spaces that simulate the indoor world. Augmented reality adds virtual elements to the real world, usually through the use of portable devices and wearable technology. Mixed reality combines the two, allowing interaction between physical and cyber-digital elements, while augmented reality serves as an umbrella term for all of these realities. These technologies are crucial to the development of the metaverse, which is further supported by Web 3 technology advances, enabling decentralized and user-centric experiences] 10.[

Many believe that the spread of Corona became an opportunity and catalyst for the emergence of creativity and innovation and the use of technology for the effectiveness of the field of education. Metaverse was increasingly introduced in the field of education before becoming widespread in many applications [11, 12]. So far, various e-learning services and platforms (platforms) have been introduced to the market, the most famous of which are EdApp, LearnWorlds, V360E, WizIQ, Edvance360, Coursera, Skillshare, Edx, Moodle, Teachable, Udemy and Udacity [13]. With the advancement of technology, electronic education has become an essential tool for the educational systems of the world, and due to a set of advantages, including flexibility of learning and cost-effectiveness, and in line with the realization of the slogan "Education at any time and in any place", each of them has been able to attract the popularity of the education market] 14.[

But the distinguishing point of educational systems and platforms based on metaverse is providing safe and constructive learning environments using virtual reality technology and continuous learning and trying to expand learning experiences [15]. Therefore, in Metaverse, Virtual Learning Environment (VLE) will be essential for all Virtual Learning Systems (VLS) currently known. In addition, Metaverse combines online and Internet technologies with augmented reality (XR) as well as a virtual reality (VR) environment] 16 ,17.[

The expression that we often encounter in education is that pedagogy precedes technology,

and sometimes it is said that pedagogy should be designed and implemented first, and then technology should be followed [18, 19]. "Pedagogy first" has become a slogan for some lecturers and teachers, supported by the metaphor of the "educational horse" driving the "technology cart". Some researchers even believe that many technologies are transitory and therefore too much emphasis on technology is doomed to fail in the future. Of course, it is clear and evident that the integration and injection of technology into education under the guidance of experts has always been of interest since the formation of distance education, especially during the Corona epidemic. It seems that these rapid technological developments, along with the corona conditions, forced teachers to familiarize themselves with technology-based tools more than ever. Either way, this push has highlighted the advantages of technology in education and added to the myriad of digital tools and resources that educators can use to create a rich and dynamic learning environment for learners.

In another research that has been done, the researcher stated that placing technology first or last separates it from education, and concluded that this view makes the educational system susceptible to technological or educational determinism. Therefore, he presents a model of interwoven education that includes the mutual formation of technology, educational methods, goals, values and content, and argues that we should go beyond separate ideas of technology or educational methods, to interwoven combinations of diverse elements involved in educational activity] 20[

In a recent research, it has been shown that with the implementation of digital technology in the educational system, the use of digital technology in the teaching process has created higher requirements for digital literacy, educational competencies and technology of teachers. Accordingly, teachers' knowledge and skills should be developed and teachers should improve their ability to use technology effectively in their teaching. In fact, it should not be ignored that digital literacy, technical and educational competencies of the participants may be affected by individual and environmental factors] 21.[

The use of technology-based applications in education can create a practical and interactive experience for learners of all disciplines and of all ages. The main point in the crisis of pedagogy and educational technology is that it insists that pedagogy comes before technology, which may reduce creativity] 22 ,23.[

What is clear is that the Covid-19 epidemic fundamentally changed the way of life, including the way of learning and education. The Covid-19 crisis showed us to use new pedagogies such as the use of metaverse technologies, and proved that educational technology and pedagogy are not mutually exclusive.

With technologies such as 6G Internet and VR, humans may create a holographic digital environment that parallels the real world in the metaverse [24]. This article aims to introduce different educational frameworks based on metaverse and get familiar with metaverse educational platforms, and to deal with the efficiency, effectiveness, opportunities and challenges related to it. In the next section we bring the Research literature review and in section 3 we describe bout Metaverse in education and finally in section 4 we discuss and conclude the subject.

Research literature review

Access, learning, and future readiness with educational technology have improved post-pandemic; The Covid-19 pandemic left an indelible mark on the education system and has caused a fundamental change in learning methods. This unprecedented situation has led to the rapid adoption of educational technology as a tool to ensure an integrated continuum of learning and by facilitating multimodal learning styles, integrating educational technology with traditional educational methods, offering flexibility and increasing interaction and providing global standard learning solutions. In addition, it enables learners to access the

resources of their choice, fosters interactive and creative learning experiences, and promotes human-centered education that emphasizes critical thinking, creativity, and entrepreneurship. In this style, training, management, and engagement are all enhanced by being data-driven. In the face of innovation in technology and its extension to education, the use of Metaverse provides opportunities and challenges for the field of education.

From an educational point of view, the Metaverse virtual environment is infinitely customizable and allows the design of various educational spaces such as laboratories, workshops, amphitheaters, hospitals, laboratories or clinics. These environments closely resemble physical reality and enable people to interact more effectively. Educational experiences in Metaverse can encourage learners to participate in lessons and research and make learning more enjoyable, attractive and interactive] 9.[

The review of the subject literature in the field of educational activities in Metaverse indicates that the instructors guide and supervise the learners' actions and activities as facilitators. Research has also emphasized the effectiveness of metaverse in foreign language learning. The virtual environment allows people from different countries with different languages to participate in foreign language courses, thus increasing interaction. The highlight of the training in Metaverse goes back to the practical training, where the learner or the skilled learner is supposed to get acquainted with the production or repair of mechanical machines or the maintenance of the aircraft and its parts; Similarly, in chemistry laboratories that are virtual and simulated to provide a wide range of chemistry experiments. Applications based on the Internet and digital space should be integrated with current technologies and various applications, including e-learning systems] 25.[

Metaverse technology has many advantages that can change the style and context of education. Technology plays an essential role in education and helps to empower learners in the future. Through online learning platforms and virtual classrooms, access and learning are enhanced and personalized experiences are provided that meet individual needs and learning styles. Blended learning approaches combine physical and virtual elements and offer flexibility and customization, and interactive and gamification tools make learning engaging and interactive] .26.[

With the change of education towards technology-based learning, recognizing and dealing with problems also becomes important. Technology has great potential in education, but it also brings many challenges. Policy makers and communities need to be aware of digital literacy, cyber security and privacy issues to overcome the changes and transformations caused by digitization. As technology plays an important role in modern education, there are several challenges that need to be addressed: access and infrastructure to bridge the digital divide and ensure equal access to technology and a reliable internet connection for all learners. Improving the level of technology skills can be both an opportunity and a challenge for both students and teachers. Learners from technology-disadvantaged backgrounds may face barriers to accessing technology and may need additional support to fully participate in virtual learning, so ensuring equal opportunities for all students is critical. The digital literacy gap required to effectively interact with technology can be profound, and bridging this gap is essential to ensure that every learner can benefit from technology-based learning. Privacy and security concerns with the use of educational technology are another serious concern and challenge. Addressing privacy concerns and protecting against cyber threats is critical to maintaining the integrity and safety of online learning platforms. Educational adaptation, the integration of technology with educational practices requires changing educational approaches. Acquiring the necessary hardware, software, and infrastructure can be costly, especially for schools and institutions with limited resources, and finding sustainable revenue models is critical to ensuring equitable access to educational technology.

By embracing technology, we can meet the diverse needs of learners, foster innovation,

and create engaging learning experiences that drive academic excellence. In the following, the key reasons for the importance of technology in education and its positive impact on various aspects of the learning process are stated. The first reason is the accessibility and advanced learning of technology by breaking geographical barriers and making education available to a wider range of learners. Technology also promotes inclusiveness by considering diverse learning needs and styles, thus providing personalized learning experiences that consider individual strengths and weaknesses. The second reason is to develop technology readiness skills to integrate technology into education, which equips learners to acquire essential skills, including digital literacy, that are essential for success in the modern world. The third reason is to increase engagement and motivation by providing interactive learning tools, gamification and multimedia resources that enhance learning. Another reason is data-driven learning, which enables data-driven learning technology to provide valuable insights into learner performance, as well as analytics that help educators identify areas for instructional improvement and tailor instruction accordingly. give Using technology, we can increase accessibility and promote inclusiveness and provide personalized learning experiences that meet individual needs. While there are challenges such as the digital divide and the need for digital literacy that must be overcome. Embracing technology in education is not just a trend, but a necessity to prepare learners to succeed in a rapidly evolving digital world.

Digitalized education has had a significant impact on the way materials and content are used in teaching lessons in classes and teaching methods. This effect in the classrooms has also had significant effects on the teachers and has somehow encouraged them to change their traditional teaching methods to use digital technology techniques as teaching tools and materials. Therefore, teachers must have digital literacy skills to provide rich and varied learning experiences to learners by effectively using digital resources and tools. By developing digital literacy skills, learners can support their career development and professional development. These skills can make them more competitive coaches. As a result, understanding the digital literacy levels and pedagogical-technological capabilities of teachers is essential for professional growth, success in the modern classroom, and providing better education to learners] 21.[

Metaverse in education
As a technology that integrates a variety of new technologies and has multi-technology features, the metaverse has social characteristics. Metaverse is a parallel environment and close to the real world in the virtual world with extra-spatial-temporal features. Metaverse is a multi-technological technology in the sense that it provides an immersive experience based on augmented reality technology, while creating an image of the real world based on peer or digital twin technology and launching an economic system based on blockchain technology. The metaverse is social in nature, in the sense that it includes economic systems, cultural systems, and legal systems that are closely related to reality, but each has its own characteristics; And finally, the metaverse has a nature beyond time and space, because the virtual world is parallel to the real world and breaks the boundaries of time and space and offers an open and comprehensive experience to users] 27 .[

Performing large-scale remote computing, accessing large databases, or providing shared experiences between users are inextricably linked to the network and communication platform [28]. The fifth generation (5G) and the sixth generation (6G) of communication are the foundation of the Metaverse communication. 5G has the advantages of high speed, low latency, ubiquitous network, low energy consumption, and everything connected, enabling the realization of the metaverse. 6G will break the limitations of time and virtual reality and expand the target services from humans, machines and objects in the physical world to the

environment in the virtual world and realize the interaction between human-machine-objects-environment with network connection. In the 5G and 6G network environment, quantum communication ensures the security of communication in the metaverse. It has been shown in a research that quantum communication provides high security by using a quantum key based on the theorem of quantum non-simulation and the principle of uncertainty [29]. In addition, quantum communication improves overall security due to the superposition properties of qubits. In addition, the Internet of Things (IoT) or better said the Internet of Everything (IoE) plays a vital role in the infrastructure of the Metaverse network] 30.[

The metaverse acts as a bridge between the physical and digital worlds, inextricably linked by supporting identity modeling, decentralized technology, and social computing. In the metaverse, as in the real world, people entering the metaverse need an identity credential, regardless of whether it relates to real identity, which identity modeling technology meets their needs [31]. Users living in the metaverse cannot live without social computing. It is obvious and very clear that the emergence of the metaverse will not replace real social relations with virtual social relations, but will create a new type of social relations that are integrated online and offline.

The need to overcome the space-time limitations that existed in traditional learning environments, Metaverse has been proposed as an "extensive learning environment" where learners can learn without worrying about space and time with creative and inclusive, multi-modal and multi-dimensional and technological learning methods. From a general learning perspective, the metaverse is defined as a "new learning environment" with its own conditions and requirements including: a) the use of wearables; (b) overcoming the limitations of time and space and (c) using digital identity [32]. One of the typical metaverse frameworks in education is provided by the use of augmented reality and through access to wearable devices and the creation of avatars and support by the infrastructure of communication and networking technology, computing and analysis, modeling, interaction and authentication [33.[

However, the metaverse in education as a new research topic requires new theoretical paradigms, conceptual discoveries and learning theories that can explain the cultural, social and symbolic aspects involved in the learning process and knowledge creation. The latest research approaches and reflections suggest three learning styles: the ecosystem model, the cooperative model, and the simplex model [34]. Among the research related to the potential applications of the metaverse in education, there are cases regarding the impact of extended learning educational environments on learners' learning performance and perceptions that require further investigation.

Metaverse uses modeling technologies to visualize abstract concepts and augment learning resources through decentralized technologies, enabling editing, creation, and sharing, and enabling educators to "monitor and monitor the learning process and leverage experiences and information for effective teaching." to achieve". Metaverse-based learning relies on artificial intelligence and big data analytics, allowing learners to showcase their achievements and performance in the digital world. Since the metaverse is more open, more shareable, and more decentralized than traditional virtual spaces, and non-fungible token (NFT) technologies such as blockchain enforce authentication of learners in virtual spaces and prevent privacy violations, in the last three years have received more attention. Another point to consider is that in none of the researches that have been selected for study so far, the relationship between the fifth-generation society and Metaverse has not been specifically investigated. Undoubtedly, Metaverse is part of the components of the fifth-generation society and can advance the goals of this society [35]. The fifth-generation society is defined as a human-centered society that achieves economic progress by solving social problems through a system that strongly integrates virtual space and physical space.

The educational metaverse called Edu-Metaverse is a combination of metaverse and education. This integration will have a great impact on traditional education because technological advances will change the monotonous form of traditional education [7]. Based on this, it is clear that educational metaverse is different from traditional education. The educational metaverse represents a new type of teaching style based on reality and experience. In terms of educational scenarios, it can remove the limitations of time and place and anyone can directly experience, structure and learn. The user can navigate, watch and learn self-identifyingly, like playing a large 3D game. Educators can collaborate with developers to develop new educational models and learners can access rich learning resources, with unlimited spaces and resources and no worries about the problem of uneven distribution of educational resources] 36.[

The use of avatars or virtual characters in Metaverse gives learners a comprehensive experience of virtual space and the feeling of being embodied in the digital space. Realistic learning scenes replicate classroom layouts with respect to educational content and enhance learning experiences for intangible concepts and easily invisible objects; Therefore, it makes the metaverse experience more inclusive for learners and enables them to understand more lessons.

Metaverse is especially suitable for immersive learning because it creates a more active learning environment for the learner. Learners can pass by historical and ancient monuments, travel miles away, and more interestingly, they can travel to the distant past or the near future, witness past customs and even communicate with scientists, all thanks to Metaverse virtual reality technology is possible [37]. The educational metaverse has completely different characteristics than traditional education, as shown in the table below (Table 1).

Table 1. Comparison of Metaverse education and traditional education

Traditional education	Metaverse education
Each course carries costs and it is difficult for educational institutions to provide high added value.	Value is primarily produced and established by interactive teaching content. Schools and institutions can invest in developing better interactive content.
live or recorded broadcast; lack of experiential interaction; boring.	Using VR, 3D, etc. technology as a means; immersive experiential learning; simulation of real interaction; Attractive.
rich technological content; Difficult for competitors to enter.	lack of technological content; low engagement; Intense competition.
Content based on encyclopedia; difficulty in experiencing interesting learning scenes; Access to dangerous learning scenes is difficult to access.	Various technological measures can support different types of learning scenes, such as space flight, volcano adventure, anatomy surgery, etc.
Video content is difficult to distribute widely and has low potential value.	From the sale of interactive teaching content related to Metaverse, various products can be obtained, such as VR learning devices.

-Challenges and opportunities of metaverse in education

Metaverse is an open source project that tries to provide an efficient and effective environment for learning through the collection of educational data from various Internet sources and by processing large language models along with the use of virtual reality and 3D display. According to one of the official international reports, Metaverse is in the early stages

of development between 2021 and 2030 [38]. The maturity stage begins in 2031. Another technical report published by the McKinsey Institute titled "Creating Value in the Metaverse" in 2022 points out that education is one of the top industries among other industries for the future capacity of the Metaverse [39]. Therefore, the impact of the metaverse on education is still under investigation and is a hot topic for researchers to understand the opportunities and challenges.

Metaverse is not just an evolution of our digital experience, but a revolution that offers an unprecedented level of integration between the digital and physical realms. With platforms such as Geppetto, Animal Crossing, and Roblox boasting hundreds of millions of users, the metaverse embodies the social values of Generation Z, where online characters are as significant as their real-life counterparts [40]. However, this growing welcome of users entering the metaverse also means an increase in personal information, which is often surrendered without a comprehensive understanding of the consequences [41]. Unwanted individuals create permanent profiles that exceed the data footprints left on social media platforms. As a combination of several advanced technologies such as artificial intelligence, augmented reality and virtual reality, Metaverse offers a much more immersive experience. Such technologies enable highly personalized and contextual interactions, leading to more sophisticated data collection and indexing.

Exaly is a comprehensive open source project in the field of scient metric data and offers almost all the services of Google Scholar, Web of Science, Publons, Scopus, Crossref and ResearchGate combined. Figures 1 and 2 show the trend of research and research based on the number of published articles and the number of references for the two titles "Metaverse" and "Metaverse in Education" from 2000 to 2023.
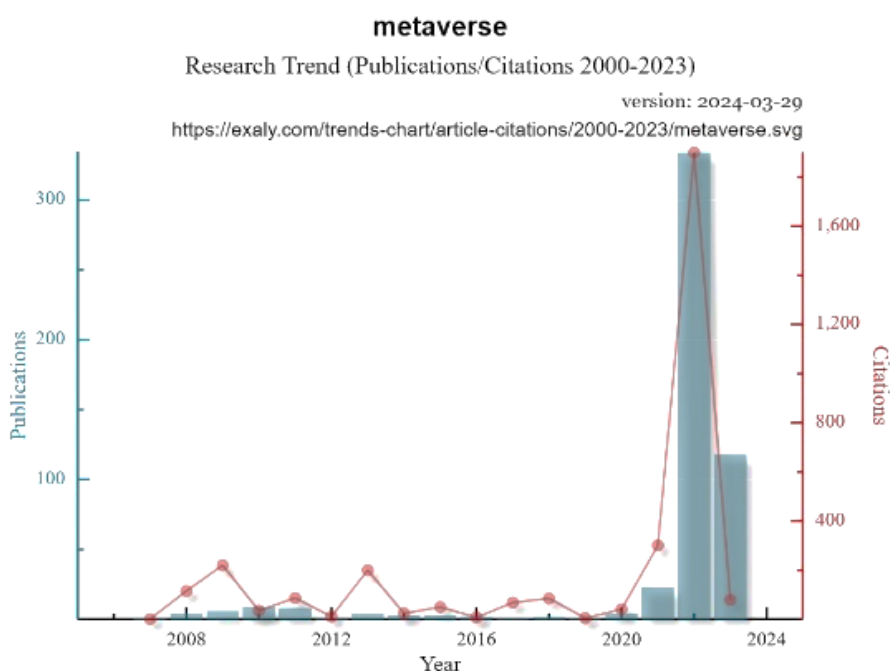

Figure 1. Number of publications as a function of their corresponding citations for the keyword "metaverse
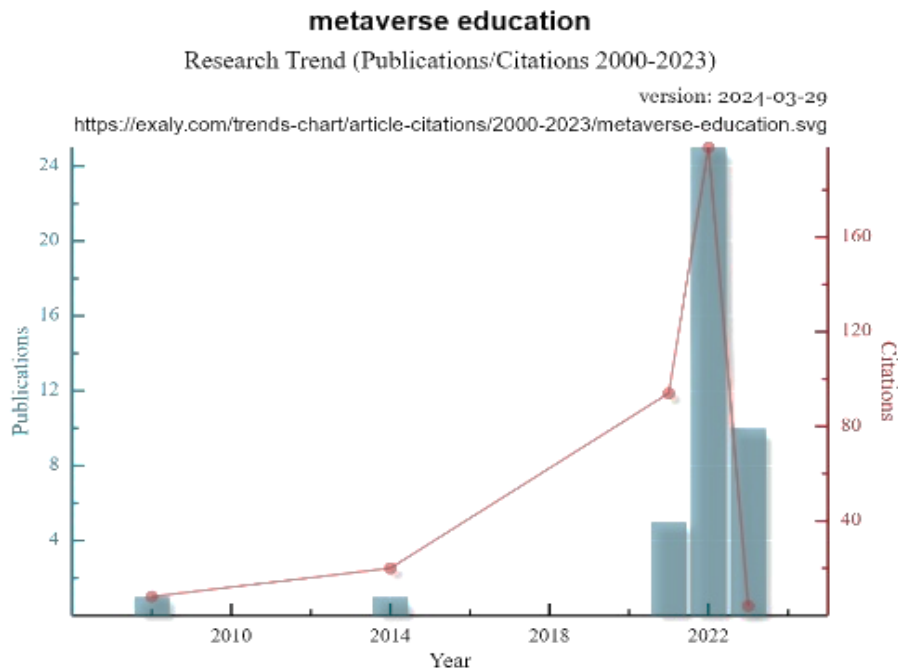
Figure 2. Number of publications as a function of their corresponding citations for the keyword "teaching-metaverse"

Also, based on the search trends of words in Google, Figure 3 shows the graph of the search frequency of the queries "met averse", "artificial intelligence", "digital transformation" and "met averse-education" from 2004 to 2024.
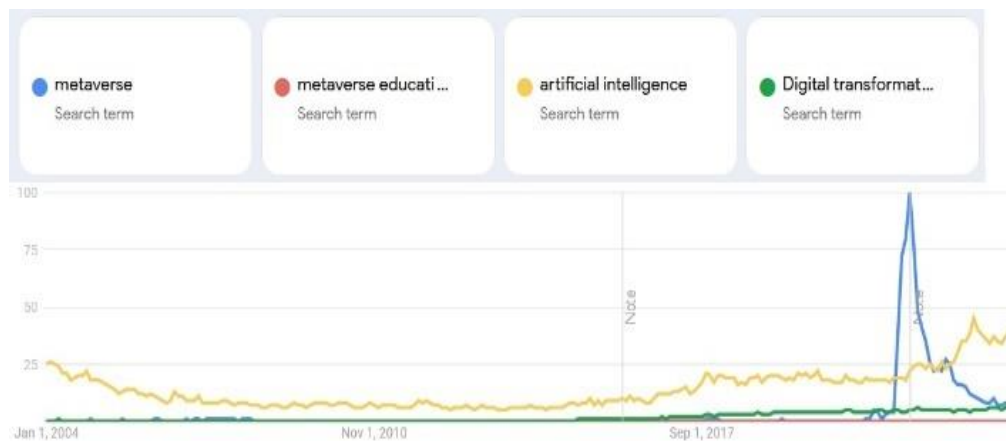

Figure 3. Frequency of queries with the titles "Metaverse", "Artificial Intelligence", "Digital Transformation" and "Metaverse-Education"

Web of Science, as one of the scientific information databases, includes a variety of major academic journals that have the greatest impact in various research fields such as natural sciences, engineering technology, and biomedicine. If we count the number of publications related to the metaverse published in this database (Figure 4), in order to analyze the development process of the metaverse, the development of the metaverse can be divided into four stages: the emergence stage, the initial stage, the decline stage. and growth stage] 27.[
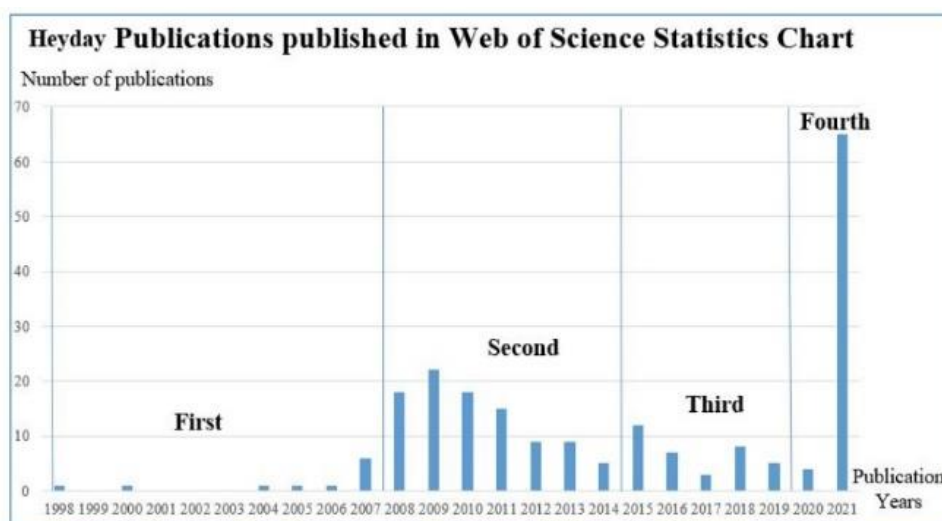
Figure 4. Metaverse publications in Web of Science statistics chart

Metaverse reduces the cost of education, because it can simulate expensive devices and specialized laboratories for teaching and learning assistance, and can be used in physical experiments, surgical simulation, and reconstruction of precision instruments, and significantly reduce the cost of experiments] 42.[

The learning environment and the ideal classroom in Metaverse will increase the teaching efficiency and the students' interest in learning. The teacher can design and implement any image and video he deems appropriate, for example, the lecturer of the physics course is Albert Einstein. Each response can be converted into a visual symbol, such as the appearance of a question mark when a student expresses uncertainty about the teacher's explanation, which allows the teacher to provide timely feedback] 43.[

-Patterns and style of education in Metaverse
• Online classes with a sense of reality

Metaverse is able to create realistic online classrooms, especially effective in fields such as history, geography, biology, and medicine, where by enabling scenarios, it increases interaction and immersive learning and access to the learning process [33]. For many students and teachers, online teaching and learning can be difficult. However, using Metaverse, online classes can feel as "real" as possible.

In the Metaverse, learners will be able to study other subjects from around the world, and real professors will become Metaverse teachers, collaborating with developers to create new learning models for learners. Learners will no longer be confined to an institution and school or university and physical environment, but instead will be drawn to endless learning resources and the metaverse learning platform that may impact the traditional form of academic education.

•Personal learning

The evolution of artificial intelligence technology makes it possible for a person with more knowledge than the learners to become a teacher [44]. Educational institutions or educational collaborations can enhance the teaching models and experiences of the best teachers of each discipline in the country through artificial intelligence technology to become virtual digital teachers with different styles and adapt to the needs of different types of students [45]. In Metaverse, each learner is free to set his own learning speed for each lesson based on his personal ability and interest and even based on the teacher. According to the level of skills and knowledge of the individual, based on learning ability, based on country and language,

and ideally based on culture and religion, the validation system should design the training scenario, which is a measure to adapt to the speed of individual learning.

Learners are no longer limited to a school - in the sense of physical space - but join the Metaverse educational platform with endless resources [46]. The unique identity system that results from the use of blockchain and other technologies creates a dynamic effect in the metaverse to each student's learning experience and draws a roadmap for real teaching activities.

Teachers can observe practical exercises of learners and thus make learning more targeted in the teaching process. The online assessment system also automatically evaluates the correct or incorrect actions of the students and provides suggestions for their correction in real time. At the end of the training, an evaluation report is also produced to inform the learner about areas for improvement.

• 3D scenes

Volumetric video technology is an important part of the educational metaverse infrastructure, as a way to capture dynamic, realistic and efficient human data in the real world, and also as a way to replicate the details of human movement in 3D space] 17.[

While traditional video contains static images at 30 frames per second, volumetric video contains a continuous 3D model at 30 frames per second. This technology records all movements and actions of the learner in 3D space and saves them as a full-angle 3D scene. There is no fixed view and students can freely move through the scene and view objects in the scene from any angle, distance, and position] 47.[

In Table 2, it is presented the relationship of each of the Metaverse elements in Metaverse educational spaces. The left side depicts the Metaverse elements while the right side represents the goals to achieve. For instance, the use of AI and machine learning assess adaptive learning and decision-making. The central part exhibits the processes which form the overall learning methodology.

Table 2. Role of Metaverse elements in Education

Metaverse Elements	Edu- Metaverse processes	Features
Gamification	Education Game Application	Collaboration and Connectedness
Bigdata and Analytics	Analytics based on Sensors data and Transactions	Data-driven Decision making
Blockchain	Blockchain Transactions	Security and Privacy
AI and Machine Learning	Data Acquisition	Adaptability/ Decision Making
Internet of Things	Virtual Schooling	Flexibility and Accessibility
VR and AR	Immerse Education	Accessibility and Personalized Learning

Advantages and disadvantages of metaverse in education

The metaverse can be organized as a space where the real world is augmented by virtual reality. The real world is connected to the virtual reality, the real world is reproduced in the virtual reality, or the virtual reality is considered as another world. Functionally, Metaverse retrieves information and integrates SNS elements. SNS stands for Social Network Service and is an online platform that connects people from all over the world. Typically, these people gather in a specific platform to share their interests or even establish relationships online [48].

They create a profile with their personal information and from there connect with other interested people. Historically, the Metaverse is a combination of the Internet with 5G technology and virtual convergence, representing a world that has expanded and expanded in response to the Covid-19 virus. Technically, Metaverse is a set of virtual reality technologies. In the world of marketing, we must know what audience is suitable for our business. That's why you should try to spend your money and time in a way to find the right customers. Customer avatar, which many people know by titles such as buyer persona, target audience and ideal client profile, is a tool that helps in this field. From a social point of view, the metaverse is a space where the members of the digital generation have left effects in their daily and economic lives with their different appearances in the 3D-based Internet world.

However, the use of metaverse comes with challenges and weaknesses, some of which are mentioned below:

1 .Accuracy and reliability

 - The models produced by Metaverse may reduce the accuracy and validity of the model in some cases due to the collection of data from various sources whose authenticity and quality have not been measured.

2 .Presuppositions of cultural and geographical aspects

 - Metaverse works based on data collected from the Internet. Therefore, geographic and cultural presuppositions and attitudes may affect the generated models and pay less attention to cultural and belief differences in different communities] 49.[

3 .Risk of inappropriate interference

 - If the model gains access to unwanted or inappropriate training items due to the collection of diverse and sensitive data, it may interfere in the production of outputs with objectionable content or unethical advertisements] 46.[

4 .Protection of privacy and personal data of people

 - In the data collection stages, privacy and personal data of people should be carefully considered. Improper use of personal or even incomplete information can lead to legal and ethical problems.[٥٠ ,٤١]

5 .Challenge in setting and updating

 - The models produced by Metaverse need to be adjusted and updated continuously to keep pace with new developments in language and cultures and benefit from the latest information.

6 .Maintaining balance in content

 - Models produced by Metaverse may lose balance in content production and move towards producing content containing bias or moral problems.

When using metaverse, it is important to be aware of these challenges and pay attention to the ethical and legal standards governing the use of linguistic models] 51.[

-Metaverse limitations in education
Metaverse has made it possible for users to gather and communicate even in real-life situations such as social communication. However, these social connections in the metaverse are weaker than interactions in the real world. In Metaverse, instead of showing "me as I am", information the user doesn't want to share is removed to create "the me I want to show". In addition, privacy violation is also a problem to be considered in social activities in the metaverse, where various information not generated in real world interactions are collected and processed in real time] 43.[

The high degree of freedom, which is an advantage of Metaverse, makes Metaverse users more dangerous than users of existing online services and games. The administrator cannot predict all user actions due to the high degree of freedom. Due to the basic characteristics of the metaverse - virtual space and anonymity - guilt about mistakes is reduced in society. There

is concern that new crimes will emerge that are more vicious than the real world. A person who participates in the virtual world may appear and participate as an extension of reality, but may participate as a self with a different appearance and perspective. The term "sub-character-additional character-" can be interpreted as the concept of avatar. Because the life in which the virtual world and reality are combined becomes common, it is expected that in a virtual space where the identity of the user is not revealed in any way, the degree of freedom of people's identity will gradually increase. People are limitedly recognizable compared to reality. In a metaverse where there is a greater degree of freedom, it is possible that the countless information created and shared by users around the world, of a criminal nature, will not be identified and deleted one by one, and it is possible that the metaverse will become a lawless area.

When the distinction between virtual and real worlds is blurred, users may become confused about their "real self" identity. They may not be able to properly adapt to virtual reality. If one gets too immersed in human relationships in virtual reality or is satisfied with human relationships in virtual reality, there is a danger that one will neglect one's real relationships (Table 3).

Table 3. Advantages and disadvantages of Metaverse educational environment

Features of Metaverse	Advantages	Disadvantages
New social communication space	When relationships are established with others, a game-centric relationship is formed that is weaker than real-world interaction, and privacy issues arise due to the collection and processing of various personal information.	Even if schools are closed due to covid-19, students can be activated as a communicative social space and communicate beyond real limits.
High degree of freedom	Due to the high degree of freedom, platform administrators cannot predict all users' actions, and they may be subject to various criminal defamation cases due to the virtual space and anonymity of the metaverse.	Expand students' autonomy in the learning process by providing experiences from content consumers to content creators
Deep immersion through virtualization	Identity disorientation, escape from reality, and real-world maladjustment may occur for students whose identity is not formed.	Providing a new experience that transcends the boundaries of time and space and increasing the interest and immersion of students to expand active participation in learning.

-Discussion and summary

Traditional online training relies on some platforms such as Zoom, Google Meet, and TeamViewer for communication between the learner and the instructor; While these platforms have achieved their designed goals, they often result in limited interaction and socialization of learners. These platforms and teaching style rely on interactions and even tools such as cameras, and as a result, they diminish the interactive nature of the learning environment and often lead to mental fatigue and, in the case of asynchronous learning, even emotional isolation and reduced creativity, and finally, this It leads to a high dropout rate in e-learning courses [2]. In contrast, Metaverse offers a 3D virtual environment and a different and potentially richer educational experience. In Metaverse, learners are present in the

educational space through avatars and increase their sense of presence and interaction. In addition, Metaverse removes physical barriers and limitations and provides access to an endless virtual world and helps to improve the quality of education. A review of published scientific articles and also a review of keyword search trends in search engines such as Google show that the metaverse has gone through four periods: the first, the beginning, decline and growth, and the peak of the metaverse's flourishing period has been predicted from 2030 onwards. Metaverse in education has other significant advantages that are suitable for use in immersive learning in 3D virtual worlds, including saving training costs and increasing efficiency. Its educational programs include reality-based online classes, personalized teaching and learning models, realistic 3D identities, interactive communication, and the use of gamification and gamification technology.

Of course, there are challenges, obstacles and limitations in the communities in the way of the expansion and effectiveness of Metaverse in the field of education. The most important of them are the skill level of learners and teachers and their awareness and mastery of tools, knowledge and emerging technologies, information and communication technology, and digital literacy. Some governments have mandated or approved the Ministry of Higher Education to teach educational units related to information and digital technology, others have made it possible to study a major field and a field related to information technology at the same time, even with the support and subsidy of the government sector of that country. have brought Another limitation is the challenge of infrastructure, both information technology infrastructure and communication infrastructure. The transformation in the field of metaverse-based education requires infrastructure to support the Internet of Things, fast processing and broadband Internet. Another obstacle is the issue of data and information security and the protection of people's privacy, which is one of the daily issues facing the digital world in the scientific community, these days in scientific circles and facing issues such as productive artificial intelligence and the emergence of chatbots. has become a concern. However, the development of the concept of education in the metaverse in some societies, including in our country, requires a series of cultural attachments and its connection to upstream documents, including the comprehensive scientific map of the country, and the precise determination of the appropriateness and correspondence of this style of education with concepts such as education and training. Because many researchers in the field of educational sciences believe that humans should not be viewed as robots, many educational components and intellectual growth and human excellence occur in the context of teacher-student, student-student, and student-society interactions. And removing these connections leads to neglecting an important part of the human education system.

References
[1] Kye, B., et al., *Educational applications of metaverse: possibilities and limitations.* Journal of educational evaluation for health professions, 2021. 18.
[2] Mystakidis, S., *Metaverse.* Encyclopedia, 2022. 2(1): p. 486-497.
[3] Sui, D. and M. Goodchild, *The convergence of GIS and social media: challenges for GIScience.* International journal of geographical information science, 2011. 25(11): p. 1737-1748.
[4] Go, S.-Y., et al., *Concept and developmental direction of metaverse.* Korea Inf Process Soc Rev, 2021. 28: p. 7-16.
[5] Jovanović, A. and A. Milosavljević, *VoRtex Metaverse platform for gamified collaborative learning.* Electronics, 2022. 11(3): p. 317.
[6] Boschert, S. and R. Rosen, *Digital twin—the simulation aspect.* Mechatronic futures: Challenges and solutions for mechatronic systems and their designers, 2016: p. 59-74.

[7] Asad, M.M., et al., Virtual reality as pedagogical tool to enhance experiential learning: a systematic literature review. Education Research International, 2021. 2021: p. 1-17.

[8] Zuckerberg, M., *Founder's letter.* Meta, 2021. 28(10).

[9] Díaz, J., C. Saldaña, and C. Avila, *Virtual world as a resource for hybrid education.* International Journal of Emerging Technologies in Learning (iJET), 2020. 15(15): p. 94-109.

[10] Qadir, A.M.-A., *Virtual Worlds, Real Skills: Is the Metaverse the Future of Accounting Education?* Tuijin Jishu/Journal of Propulsion Technology. 44(3): p. 2023.

[11] Han, H.-W., *A study on typology of virtual world and its development in metaverse.* Journal of Digital Contents Society, 2008. 9(2): p. 317-323.

[12] Karacan, C.G. and K. Akoglu, Educational augmented reality technology for language learning and teaching: A comprehensive review. Shanlax International Journal of Education, 2021. 9(2): p. 68-79.

[13] Raouna, K. *30 Best Online Learning Platforms for 2024.* [cited October 30, 2023; Available from: https://www.learnworlds.com/online-learning-platforms/.

[14] Nishino, K., et al., Consideration on the Relationship between Changes in Learners' Learning Preferences and the Differences in e-Learning Modes of a Course, in Advances in Knowledge-Based and Intelligent Information and Engineering Systems. 2012, IOS Press. p. 1121-1130.

[15] Hyun, J.J., *A study on education utilizing metaverse for effective communication in a convergence subject.* International Journal of Internet, Broadcasting and Communication, 2021. 13(4): p. 129-134.

[16] Lee, J.Y., *A study on metaverse hype for sustainable growth.* International journal of advanced smart convergence, 2021. 10(3): p. 72-80.

[17] Lee, L.-H., et al., All one needs to know about metaverse: A complete survey on technological singularity, virtual ecosystem, and research agenda. arXiv preprint arXiv:2110.05352, 2021.

[18] Watson, D.M., Pedagogy before technology: Re-thinking the relationship between ICT and teaching. Education and Information technologies, 2001. 6: p. 251-266.

[19] Ascough, R.S., Designing for online distance education: Putting pedagogy before technology. Teaching theology & religion, 2002. 5(1): p. 17-29.

[20] Fawns, T., *An entangled pedagogy:* Looking *beyond the pedagogy—technology dichotomy.* Postdigital Science and Education, 2022. 4(3): p. 711-728.

[21] Orakova, A., et al., The Relationships between Pedagogical and Technological Competence and Digital Literacy Level of Teachers. Journal of Curriculum Studies Research, 2024. 6(1): p. 1-21.

[22] Brown, A., Digital technology and education: Context, pedagogy and social relations, in International handbook of comparative education. 2009, Springer. p. 1159-1172.

[23] Ching, G.S. and A. Roberts, *Evaluating the pedagogy of technology integrated teaching and learning: An overview.* International Journal of Research, 2020. 9(6): p. 37-50.

[24] Kohli, V., et al., A review on Virtual Reality and Augmented Reality use-cases of Brain Computer Interface based applications for smart cities. Microprocessors and Microsystems, 2022. 88: p. 104392.

[25] Dahan, N.A., et al., Metaverse framework: A case study on E-learning environment (ELEM). Electronics, 2022. 11(10): p. 1616.

[26] Joshi, S. *The Role Of Technology In Education, Post Pandemic.* June 22, 2023]; Available from: https://elearningindustry.com/the-role-of-technology-in-education-post-pandemic.

[27] Ning, H., et al., A survey on the metaverse: The state-of-the-art, technologies, applications, and challenges. IEEE Internet of Things Journal, 2023.

[28] Lee, L.-H., et al., Towards augmented reality driven human-city interaction: Current research on mobile headsets and future challenges. ACM Computing Surveys (CSUR), 2021. 54(8): p. 1-38.

[29] Chowdhury, M.Z., et al., 6G wireless communication systems: Applications, requirements, technologies, challenges, and research directions. IEEE Open Journal of the Communications Society, 2020. 1: p. 957-975.

[30] Shi, F., et al., Recent progress on the convergence of the Internet of Things and artificial intelligence. IEEE Network, 2020. 34(5): p. 8-15.

[31] Ning, H., et al., *A survey of identity modeling and identity addressing in Internet of Things.* IEEE Internet of Things Journal, 2020. 7(6): p. 4697-4710.

[32] Kumpulainen, K. and A. Mikkola, *Researching formal and informal learning: From dichotomies to a dialogic notion of learning.* IJREE–International Journal for Research on Extended Education, 2015. 3(2): p. 13-14.

[33] Zhang, X., et al., The metaverse in education: Definition, framework, features, potential applications, challenges, and future research topics. Frontiers in Psychology, 2022. 13: p. 1016300.

[34] Agrati, L.S. Tutoring in the metaverse. Study on student-teachers' and tutors' perceptions about NPC tutor. in Frontiers in Education. 2023. Frontiers.

[35] Rosenstand, C.A.F.G., J. Brix, and C. Nielsen, *Metaverse and Society 5.0: Pivotal for future business model innovation.* Journal of Business Models, 2023. 11(3): p. 62-76.

[36] Kuss, D.J. and M.D. Griffiths, *Internet gaming addiction: A systematic review of empirical research.* International journal of mental health and addiction, 2012. 10: p. 278-296.

[37] Chen, Z., Artificial intelligence-virtual trainer: Innovative didactics aimed at personalized training needs. Journal of the Knowledge Economy, 2023. 14(2): p. 2007-2025.

[38] Metaverse report—Future is here. Deloitte China.

[39] *Value creation in the metaverse*. 2022, McKinsey & Company.

[40] Park, S.-M. and Y.-G. Kim, A metaverse: Taxonomy, components, applications, and open challenges. IEEE access, 2022. 10: p. 4209-4251.

[41] Vladimirov, I., et al. Security and privacy protection obstacles with 3D reconstructed models of people in applications and the metaverse: A survey. in 2022 57th International Scientific Conference on Information, Communication and Energy Systems and Technologies (ICEST). 2022. IEEE.

[42] Collins, C., *Looking to the future: Higher education in the Metaverse.* Educause Review, 2008. 43(5): p. 50-52.

[43] Kanematsu, H., et al. *Practice and evaluation of problem based learning in Metaverse.* in *EdMedia+ Innovate Learning.* 2009. Association for the Advancement of Computing in Education (AACE).

[44] Chen, Y., et al., Artificial intelligence (AI) student assistants in the classroom: Designing chatbots to support student success. Information Systems Frontiers, 2023. 25(1): p. 161-182.

[45] Lin, H., et al. Metaverse in education: Vision, opportunities, and challenges. in 2022 IEEE International Conference on Big Data (Big Data). 2022. IEEE.

[46] Duan, H., et al. Metaverse for social good: A university campus prototype. in Proceedings of the 29th ACM international conference on multimedia. 2021.

[47] Schreer, O., et al. Capture and 3D video processing of volumetric video. in 2019 IEEE International conference on image processing (ICIP). 2019. IEEE.

[48] *Metaverse Market Size, Opportunities, Growth Analysis 2030*. Available from: https://www.snsinsider.com/reports/metaverse-market-1002.

[49] Falchuk, B., S. Loeb, and R. Neff, *The social metaverse: Battle for privacy.* IEEE technology and society magazine, 2018. 37(2): p. 52-61.

[50] Babu, M.A. and P. Mohan. Impact of the metaverse on the digital future: people's perspective. in 2022 7th International Conference on Communication and Electronics Systems (ICCES). 2022. IEEE.

[51] Gogolin, G., E. Gogolin, and H.-J. Kam, *Virtual worlds and social media: Security and privacy concerns, implications, and practices.* International Journal of Artificial Life Research (IJALR), 2014. 4(1): p. 30-42.