PROPOSALS FOR THE USE OF THE METAVERSE IN EDUCATION

Data de aceite: 02/06/2023

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ABSTRACT: The metaverse is a virtual reality in which students and teachers can interact with educational content in real time. That's why its use in education has been growing in recent years, as it allows for more immersive and personalized learning experiences. One of the main advantages of the metaverse in education is the possibility of creating virtual environments that simulate real-world situations, which allows students to practice and learn safely and without risks. For example, in the metaverse, scientific experiments or medical operations can be simulated without endangering any living beings. Additionally, the metaverse allows students to learn at their own pace and with their own learning style, and teachers can adapt educational content to the individual needs of students and provide real-time feedback. Another great advantage of the metaverse is that it can help overcome geographical and economic barriers in education, as students can access educational content from anywhere in the world, and the costs of learning materials can be significantly reduced. As technology continues to evolve, it is likely that we will see an increase in the use of the metaverse in education, and its potential to improve the quality of education worldwide.
KEYWORDS: Education, metaverse, virtual reality, educational level.

INTRODUCTION

The term metaverse originates from the novel *Snow Crash*, which was published in 1992 by Neal Stephenson[1]. In the novel, the metaverse is described as a synthetic universe based on the real universe, conceived as a successor to the internet and sustained by virtual reality. In Stephenson's novel, people use digital avatars of themselves to explore the digital world, often as a way of escaping from a

1 What Is The Metaverse In Snow Crash? (2021, 5 de novembre). Web: metaversio.io. *https://metaversio.io/what-is-the-metaverse-in-snow-crash/*

dystopian[2] reality, which in the metaverse is a fictional representation of a future society with negative characteristics that are the cause of human alienation. While the concept of the metaverse has evolved significantly in recent years to become an increasingly common topic in popular culture and the tech industry, generally speaking, the metaverse continues to refer to a persistent and collective virtual universe, in which users can interact with each other, as well as with virtual objects and environments, all in real time.

In the early 2000s, *Second Life* was one of the first virtual environments to offer an experience close to the metaverse (Mystakidis, 2022), allowing users to create their own characters, objects, and environments, as well as interact with other users in a virtual space. Since then, technology has advanced significantly, with major companies like Facebook (Fernandez, 2022), Microsoft, Nvidia, and Epic Games working on their own versions of the metaverse, designing platforms that allow users to interact with each other in a virtual space, either through virtual reality glasses or directly from a computer. The metaverse has also attracted the attention of investors and business leaders, who see it as having enormous potential as a market and advertising platform (Egliston & Carter, 2022). Some experts believe that in the medium term, the metaverse could eventually become the evolution of the current internet (Anderson & Rainie, 2022; George, 2022; Suisse, 2022), becoming the primary way people interact and communicate online.

While currently, the metaverse is primarily being used as a gaming space where users can create customized avatars (Shin & Kim, 2022; Mirza-Babaei et al., 2022; Han, Heo & You, 2021), explore detailed virtual environments and participate in a wide variety of activities, from role-playing games to sports competitions, such as Second Life, Minecraft, Roblox, and Fortnite, on the other hand, some companies are using the metaverse for business collaboration and training. There are companies that use the metaverse to create a virtual environment that mimics a physical office, allowing employees to interact and collaborate in real-time, regardless of their geographical location. Recently, the possibilities of the metaverse for education, therapy (Usmani, Sharath & Mehendale, 2022; Cerasa, 2022), and healthcare are also being explored. For example, a virtual environment could be used to simulate complex clinical situations, allowing medical students to practice skills and techniques in a safe environment (Mendiola, 2022). Overall, the metaverse is becoming an increasingly important space for social interaction and creativity, and it is expected that many more applications and uses will develop in the future.

METAVERSE AND EDUCATION

Various studies suggest that the metaverse can have a significant impact on education (Contreras et al., 2022; Hwang & Chien, 2022; Inceoglu & Ciloglugil, 2022; Mendiola, 2022; Sarıtaş & Topraklıkoğlu, 2022; Zhang, Chen, Hu & Wang, 2022), transforming the

2 Derivation from *dystopia*, is the fictional representation of a future society with negative characteristics that cause human alienation.

way students acquire and process knowledge, mainly through the expansion of information networks, the emergence of interactive technologies, and the growing accessibility of mobile devices among the student community; education has long become a space in which this technology can have a great impact on the way students acquire and process knowledge. In particular, the usefulness of using the metaverse and its virtual worlds can be highlighted, allowing users to interact and communicate in real-time through avatars, opening up new possibilities by breaking down the physical barriers of the classroom, even transcending the borders of countries, as through the metaverse, students can connect with people from all over the world, participate in immersive educational experiences, and collaborate in real-time, allowing them to improve their learning and increase participation even for those students who do not normally participate in the classroom..

As the metaverse gains popularity, a series of educational applications are emerging that use this technology to improve education. In these applications, students can explore three-dimensional models of molecular structures, immerse themselves in simulations of historical events, collaborate with other students on design and architecture projects, and connect with experts in specialized fields of knowledge, among other things.

However, despite the benefits of the metaverse for education, there are still a number of challenges that must be addressed before this technology can be fully integrated into education, and one of them is undoubtedly the digital divide that still exists in many countries around the world. For the metaverse to have a real impact on education, it is important to ensure that all students have access to the necessary technologies to access it and that once inside it, they can participate in the educational experiences it offers (Park & Kim, 2022).

Another challenge is the incorporation of the metaverse into appropriate pedagogical models, using the necessary didactic strategies, in order to fully exploit the technology's capabilities (López-Belmonte et al., 2022). This will allow students to learn effectively. In addition, there is also a growing concern about ethical and privacy issues related to the use of the metaverse in education. Before using it massively, it is necessary to ensure that students' privacy is protected and that no discrimination or exclusion occurs to access it (Fernández & Hui, 2022).

Despite these challenges, the potential of the metaverse to improve education is enormous, as highlighted by some of the most recent research cited earlier. The metaverse offers a unique opportunity for students to explore, interact, and learn in a safe and exciting digital environment. By maximizing the potential of the metaverse, education can move towards an era where technology becomes a central element of the educational experience, and where education is more accessible, inclusive, and exciting for all.

As a result of the above, this document presents an analysis of the use of the metaverse in education, generating useful information for teachers, students, and professionals interested in exploring the possibilities of using the metaverse as an educational tool.

Considering that it can transform education, improving the quality of learning and opening up new opportunities for students to acquire exciting and innovative knowledge, skills, and experiences, in a way that has not been effectively achieved in classrooms until today.

CASES OF USE OF THE METAVERSE IN EDUCATION

The metaverse, unlike other technologies used in traditional education, offers great advantages for students, as it is available and online all the time and has the ability to directly involve them in their learning through an immersive three-dimensional virtual world, making it easier for them to acquire knowledge without time restrictions or physical barriers, which expands their possibilities. As a result, some of the main uses found in recently published literature of the possible uses of the metaverse in education are described below, as shown in Figure 1:

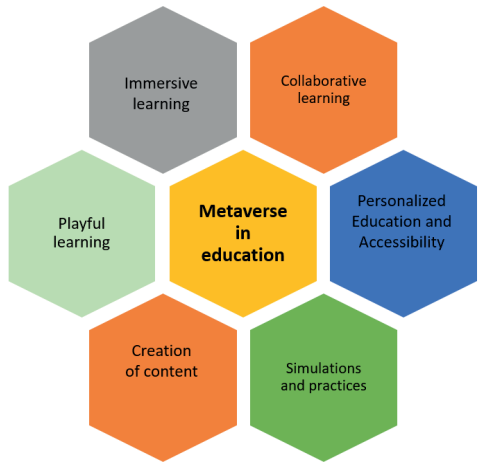

Figure 1. Cases of metaverse use in education.

Source: Own elaboration

Immersive learning: The metaverse has the ability to offer an immersive learning experience (Upadhyay & Khandelwal, 2022; Lin, 2022; Kaddoura & Al-Husseiny, 2023). This means that it is capable of involving more than one human sense in the interaction with the virtual universe, allowing students to interact with educational content in a three-dimensional environment, which facilitates the understanding of complex and abstract concepts, as three-dimensional graphics facilitate visualization and interaction with the topics of study. Immersive learning also facilitates learning through experimentation and exploration, while also allowing the development of the necessary skills to face difficult situations in professional life. Therefore, immersive learning in the metaverse can also be especially useful for those students who learn best through practical and visual experiences,

such as students whose learning style is kinesthetic.

Below are some examples of metaverse uses for immersive learning:

a) Laboratory simulations: Students can use the metaverse to perform laboratory simulations that may be costly or dangerous in the real world (Ricci, Scarcelli, & Fiorentino, 2023). For example, chemistry students can perform virtual laboratory experiments in which they manipulate elements and compounds without the associated risks.

b) Historical recreations: Through this type of recreation, students can travel back in time and explore historical environments recreated in the metaverse, such as Ancient Egypt or the Industrial Revolution era (Huggett, 2020). This not only allows them to be spectators but also interact with characters and elements of the era and better understand historical events.

c) Space travel: Students can explore the surface of planets and satellites in the solar system through a space simulation, allowing them to learn about astronomy and planetary sciences in a more immersive way (Zaman, Koo, Abbasi, Raza & Qureshi, 2022).

d) Architecture and design: Architecture and design students can use the metaverse to create and experiment with architectural and interior designs in a virtual environment, allowing them to visualize and modify their designs in real-time, until arriving at the final design (Fischer, 2022).

e) Art and music: Students can interact with artwork and musical pieces in a virtual environment, allowing them to explore different styles and forms of art in a more interactive way (Turchet, 2023).

Collaborative learning: The metaverse allows students and teachers to collaborate in real-time in a virtual space (Jovanović & Milosavljević, 2022), regardless of their geographic location, which is particularly useful in remote learning scenarios. Students can work together on projects, discuss ideas, and receive real-time feedback while being supervised by teaching staff within the collaborative space. Below are some examples of how this can be used.

a) Teamwork on common projects: The metaverse offers a virtual space where teams can effectively collaborate on projects, working together in real-time to create and edit content, which allows them to make faster decisions and share ideas more fluidly (Lee et al., 2023).

b) Virtual conferences and meetings: The metaverse can be used as a platform for conducting virtual conferences and meetings, enabling participants from all over the world to connect and collaborate in real-time (Radford, 2022). Users can use avatars to interact with each other and present information through shared screens.

c) Collaborative workspaces: The metaverse can be used to create collaborative workspaces where users can interact and work together in real-time (Zhu, Vennemeyer, Xu, & Wu, 2023). This can be especially useful for companies and

organizations that have employees in different geographical locations.

d) Collaborative learning spaces: The metaverse can also be used to create collaborative learning spaces where students can interact and work together in real-time (Kye et al., 2021). Users can share information, collaborate on projects, and learn more effectively in an immersive virtual environment.

e) Virtual events and exhibitions: The metaverse can be used to create virtual events and exhibitions, allowing participants from all over the world to connect and collaborate in real-time (Turchet, 2023). Students can explore virtual spaces, interact with other users, and participate in activities and games.

In general, the metaverse offers a virtual space where students and teachers can interact and collaborate effectively in real time. By fostering collaboration, the metaverse can help improve productivity and creativity of users, which can be especially useful for companies, organizations, and workgroups. Additionally, the metaverse's ability to connect users from around the world offers unprecedented opportunities for global collaboration and networking.

Simulations and practices: The metaverse can be used to create simulations and practices in virtual environments, allowing students to practice skills and make decisions in a safe and controlled environment (Kaddoura, Al Husseiny, 2023), where their physical integrity is not at risk. This can be particularly useful for fields such as medicine and engineering.

a) Emergency situation simulations: The metaverse can be used to create simulations of emergency situations, such as fires, earthquakes, or traffic accidents (Mitsuhara & Shishibori, 2022). Users can practice how to respond to these situations in a safe and controlled environment, which can help improve responsiveness in real-life situations.

b) Medical simulations: The metaverse can also be used to create medical simulations, such as surgeries or diagnoses (Chengoden & et al., 2023). Students can practice how to perform medical procedures in an immersive virtual environment, which can help improve accuracy and safety when faced with real-life situations.

c) Flight simulations: The metaverse can be used to create flight simulations for pilots and other aviation professionals (Lee, Woo, & Yu, 2022). Users can practice how to fly planes in a realistic virtual environment, which can help improve flying skills and reduce safety risks.

d) Job interview practice: The metaverse can be used to conduct job interview practices in a virtual environment (Laeeq, 2022). Users can interact with avatars that simulate interviewers and receive immediate feedback on their performance, which can help improve interview skills.

e) Design and construction simulations: The metaverse can be used to create simulations of design and construction of buildings, roads, and other infrastructure projects (Schumacher, 2022). Users can practice how to design and construct these

projects in an immersive virtual environment, which can help improve efficiency and safety in real-life projects.

In general, the metaverse offers an immersive virtual environment that allows users to practice and simulate real-life situations in a safe and controlled setting. Simulations and practices in the metaverse can help improve users' skills and responsiveness in real-life situations, which can be particularly useful for professionals in fields such as medicine, engineering, aviation, and construction.

***Accessibility*:** The metaverse can make education more accessible for those facing physical barriers such as visual or hearing impairments. For example, students with visual disabilities can use accessibility tools like screen readers to explore virtual environments (Zallio & Clarkson, 2022).

The metaverse offers various accessibility tools and solutions to ensure that all people can participate in virtual experiences inclusively. Here are some examples of accessibility in the metaverse:

a) Customized avatars: With this option, students can create avatars that reflect their identity, which can help ensure that all people feel included in the metaverse (Spajić et al., 2022). In addition, avatars can be personalized to include physical characteristics and adaptations for people with disabilities.

b) Automatic translation systems: The metaverse offers automatic translation tools that allow users to communicate with people who speak a different language, which can help ensure that all people can participate in experiences in an inclusive way (Nwakanma, Njoku, & Kim, 2022).

c) Visual accessibility solutions: The metaverse offers tools for people with visual disabilities, such as screen readers and color contrast solutions to ensure that visual information is accessible to everyone (Fernandes & Werner, 2022).

d) Hearing accessibility solutions: The metaverse also considers people with hearing disabilities, offering them tools such as subtitles and transcriptions to ensure that auditory information is accessible to everyone (Teófilo, Lourenço, Postal, & Lucena, 2018).

e) Accessibility controls: The metaverse offers accessibility controls to ensure that all people can navigate and control virtual experiences in an accessible way (Si, Zhao, Han, Lam & Liu, 2022). For example, users can customize motion controls and interaction options to suit their needs, as well as restrict the interaction options that other users have with them.

The metaverse offers a wide range of accessibility tools and solutions to ensure that everyone can participate in virtual experiences in an inclusive way. From customized avatars to automatic translation systems and visual and auditory accessibility solutions, metaverse providers are continuously working to remove access barriers and create a truly inclusive virtual environment.

Personalized education: The metaverse can be used to provide more personalized education, adapting content and activities to the individual needs and abilities of students (Sá & Serpa, 2023). One of the main benefits of the metaverse in education is the possibility of offering personalized education tailored to the needs and preferences of each student. Here are some examples of how this can be achieved in the metaverse:

a) Personalized learning materials: In the metaverse, students can access personalized learning materials that adapt to their skill level, interests, and learning preferences. For example, students can receive recommendations for books, activities, audiovisual materials, and playful activities that meet their needs and preferences (Shu & Gu, 2023).

b) Personalized learning environments: The metaverse allows for creating personalized learning environments for each student. For example, a student who learns better in a quiet and distraction-free learning environment can have a personalized virtual classroom that adapts to their needs (Sá & Serpa, 2023), while another student who requires hands-on activities for their learning can enjoy them.

c) Personalized tutoring: Tutors can use the metaverse to offer personalized tutoring to students (Zhang, Chen, Hu & Wang, 2022). For example, an AI-based smart tutor can create a virtual environment to teach specific skills, such as programming, as well as personalize the learning experience for each student.

d) Individualized assessments: In the metaverse, teachers can create qualitative and quantitative assessments or a mix of both that adapt to each student's needs. For example, an assessment can include different types of questions, such as multiple-choice questions, open-ended questions, and game-based questions, to evaluate different skills and learning preferences.

The metaverse offers a wide range of tools and solutions to provide personalized education tailored to the needs and preferences of each student. From learning materials to personalized learning environments and tutoring, the metaverse has the potential to transform education and provide more effective and personalized learning experiences.

Creation of educational content: The metaverse can also be used for creating educational content, allowing educators to create and share resources in an engaging and interactive virtual environment (Hirsh-Pasek et al., 2022).

a) *Virtual World Creation*: In the metaverse, virtual worlds can be created to allow students to explore and learn about different topics interactively (Mystakidis, 2022). For example, a virtual world can be created to teach about the history of a country or a particular era, where students can interact with historical figures and explore different places and events.

b) *3D Object Creation*: The metaverse allows for the creation of three-dimensional objects that can be used to teach about different topics (Lo & Tsai, 2022). For example, a 3D model of the solar system can be created to teach about planets and their characteristics, or that of an electrical machine that would serve to teach

students about this device in the metaverse.

c) *Educational Game Creation*: In the metaverse, educational games can be created to teach about different topics (Sánchez-López, Roig-Vila & Pérez-Rodríguez, 2022). For example, an educational game about mathematics can be created to teach students about fractions and decimal numbers.

d) *Simulation Creation*: In the metaverse, simulations can be created that allow students to experiment with different situations and learn interactively (Trunfio & Rossi, 2022). For example, a simulation about how internal combustion engines work can be created to teach about the physics and engineering involved in this machine.

e) *Tutorial and Guide Creation*: In the metaverse, tutorials and guides can be created to teach students how to perform different tasks and processes. For example, a tutorial can be created on how to use specific software to teach students how to use digital tools for content creation (Bobier et al., 2022).

The metaverse offers many tools and solutions for creating interactive and effective educational content, from the creation of virtual worlds and 3D objects to the creation of educational games and simulations. The metaverse has the potential to transform the way we teach and learn online. Educators and content creators have the opportunity to leverage these tools to create innovative and effective educational experiences for their students.

Virtual tours: The metaverse can be used to take students on virtual trips to places they otherwise could not visit. This can be especially useful for those students living in rural areas or who cannot travel for various reasons (Allam et al., 2022; Go & Kang, 2022; Monaco & Sacchi, 2023).

a) Visit to museums and galleries: In the metaverse, museums and art galleries can be recreated where students can explore works of art and learn about different artistic movements and periods (Varinlioglu, 2022).

b) Virtual trips to historical places: In the metaverse, historical and archaeological sites can be recreated so that students can explore them interactively and learn about the history and culture of different periods (Zhang, 2022).

c) Virtual excursions to remote places: The metaverse allows students to explore places that would be difficult or impossible to visit in person, such as the ocean floor or outer space (Aboelmagd, 2023).

d) Visit to universities and research centers: In the metaverse, universities and research centers can be recreated so that students can learn about different academic disciplines and explore research and career opportunities (Braud, Fernández & Hui, 2022).

e) Visit to companies and organizations: In the metaverse, companies and organizations can be recreated so that students can learn about different sectors of the economy and explore employment and entrepreneurship opportunities (Hwang, Shim & Lee, 2022).

The metaverse offers many possibilities for virtual visits and educational excursions, from visits to museums and historical sites to exploration of remote locations and academic and career opportunities. The metaverse has the potential to transform the way online learning and education are experienced. Educators and content creators have the opportunity to take advantage of these tools in the metaverse to create innovative and effective educational experiences for their students.

Playful learning: The metaverse can be used for playful learning by creating educational games in virtual environments. This can make learning more enjoyable and engaging for students.

a) Educational games: In the metaverse, interactive educational games can be created that teach students about different topics, from science to history and mathematics (Srisawat & Piriyasurawong, 2022).

b) Simulations and role-playing activities: In the metaverse, simulations and role-playing activities can be created that allow students to learn about different topics in a fun and immersive way (Jovanović & Milosavljević, 2022).

c) Educational escape rooms: In the metaverse, educational escape rooms can be created that challenge students to solve puzzles and riddles to learn about different topics (Trunfio & Rossi, 2022).

d) Educational competitions and tournaments: In the metaverse, educational competitions and tournaments can be organized that promote collaboration and teamwork among students (Abed & Rinkevic, 2022).

e) Project-based learning: In the metaverse, educational projects can be created that challenge students to create innovative solutions to real-world problems and learn practical skills (Sharon, 2022).

The metaverse can be used for gamified learning through the creation of educational games in virtual environments. This can make learning more fun and engaging for students. In the metaverse, educators and content creators have the opportunity to use these tools to create innovative and effective educational experiences for their students. Gamified learning in the metaverse can foster creativity, curiosity, and a passion for learning, and help students develop skills and knowledge in an exciting and effective way.

PROPOSALS FOR THE USE OF THE METAVERSE BY EDUCATIONAL LEVEL

The metaverse, as a shared virtual reality, has the potential to change the way teaching and learning occur at all educational levels, as shown in Figure 2 and in the following paragraphs, where some examples of how the metaverse could be implemented at different educational levels are presented.:

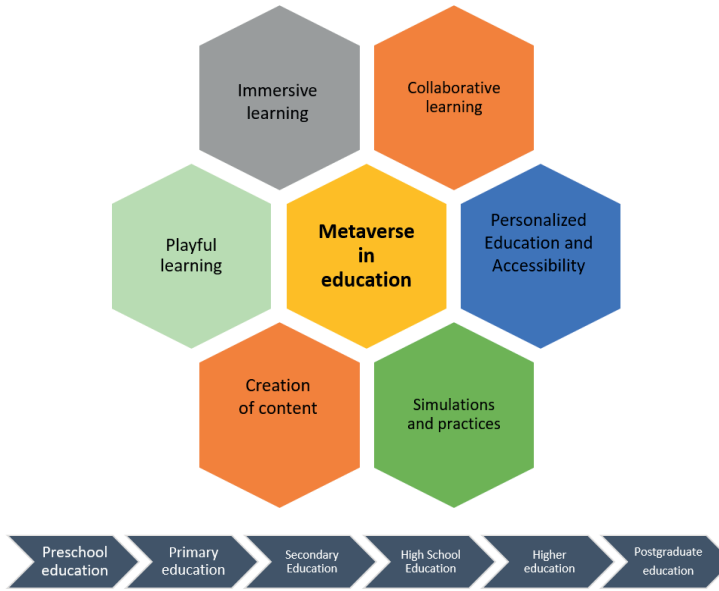

Figure 2. Proposals for the use of the metaverse by level of education

Source: Own elaboration

Preschool education

In the metaverse, young students would have the possibility to explore and learn in an interactive and safe environment, where they would have the opportunity to visit different places in the world and learn about different cultures, as well as interact with animals and plants in a more immersive way without leaving their classroom. Below are some examples of how the metaverse could be used in this educational level:

a) *A virtual garden*: Within this space of the metaverse, children could explore an interactive virtual garden, where they could learn about different types of plants, flowers, and trees, as well as interact with animals and insects in a safe and controlled environment, even seeing the growth of some species in a simulation of a short amount of time.

b) *A virtual zoo*: Children could visit a virtual zoo, where they could learn about different animals and their natural habitats, as well as interact with them, even interacting with animals that lived in the past or that live in other geographic regions (Neethirajan, 2023).

c) *A virtual museum*: Children could explore a virtual museum, where they could learn about different works of art, science, and technology, as well as interact with exhibits and even learn about the history of the artists who created them (de Sousa, Figueiredo & Souto-e-Melo, 2023).

d) *A virtual classroom*: Children could participate in a virtual class, where they could

interact with their teacher and classmates, solving a challenge collaboratively as a team, as well as explore different learning topics from their various subjects.

e) *A virtual house*: Children could play in a virtual house, where they could learn about different areas of the house, such as the kitchen, bathroom, and bedroom, as well as interact with the objects present.

f) *A virtual underwater world*: Children could explore a virtual underwater world, where they could learn about different types of fish and sea creatures, as well as interact with them, even getting to know species that are found many meters deep.

g) *A virtual amusement park*: Children could visit a virtual amusement park, where they could learn about different attractions and how they work, as well as interact with them, learning scientific aspects of their operation, such as wheels, gears, and motors (Niu & Feng, 2022).

h) *A virtual trip*: Children could take a virtual trip to different places around the world, where they could learn about different cultures, traditions, and customs, as well as interact with the people who live there (Koo et al., 2022).

i) *A virtual theater*: Children can watch virtual theater plays, where they can learn about different stories and characters, as well as interact with the actors.

The above are just some examples of how the metaverse could be implemented in preschool education, offering new opportunities for exploration and learning at this school stage.

Primary education

For this educational level, the metaverse could facilitate students with the possibility of visiting different periods of history and experiencing firsthand how life was like in those times. They could also learn about science and technology issues in a more practical and visual way, for example, by exploring the solar system and other galaxies, and getting to know the different elements that make them up. The following are some examples of the possibilities of applying the metaverse in this educational level:

a) *A virtual journey through time*: Students could travel through time and learn about different historical periods, such as the Stone Age or the Industrial Revolution, even allowing for interaction with historical figures, experiencing first-hand what life was like at that time.

b) *A virtual space journey*: Students could explore the solar system and learn about planets, stars, and galaxies, interacting with astronauts and space scientists (Nijjer et al., 2023).

c) *A virtual laboratory*: Students could experiment with different materials and chemicals in a virtual environment, learning about different chemical reactions and their effects (Gruson et al., 2023).

d) *A virtual language learning environment*: Students could practice and improve

their fluency in a foreign language, interacting with native speakers and learning about the culture and traditions of the country (Godwin-Jones, 2023).

e) *A team science project*: Students could work together on a science project, where they could experiment with different hypotheses and theories and present their results in a virtual environment.

f) *An interactive virtual classroom*: Students could participate in a virtual class, interacting with their teacher and classmates, and learning about different subjects in a more visual and practical way.

g) *A virtual music environment*: Students could learn to play different musical instruments and compose songs in a virtual environment, interacting with musicians and music producers.

h) *A virtual theme park*: Students could visit a virtual theme park, where they could learn about different science and technology themes, interacting with interactive attractions and exhibits.

i) *A virtual art workshop*: Students could experiment with different forms of art, such as painting, sculpture, and photography, in a virtual workshop, interacting with artists and art critics (Kang, Choi & Nam, 2022).

These are just some examples of how the metaverse could be implemented in primary education, offering new opportunities for exploration, learning, and creativity, in line with the age of the students.

Secondary education

High school students could use the metaverse to explore different careers and professions, interacting with professionals in those fields of knowledge, gaining a deeper understanding of the skills and knowledge required in different fields. They could also participate in simulations to develop leadership, problem-solving, and decision-making skills. Below are some examples of this:

a) *A virtual journey through literature*: Students could explore fictional worlds from popular books, interacting with characters and experiencing plots and themes firsthand.

b) *A virtual physics laboratory*: Students could conduct physics experiments in a virtual environment, learning about concepts such as mechanics, thermodynamics, and electricity (Ma, 2023).

c) *A cultural immersion experience*: Students could immerse themselves in different cultures around the world, learning about their history, customs, and traditions.

d) *A business simulator*: Students could learn about economics and finance by operating a virtual business and making strategic decisions (Durana, Krulicky & Taylor, 2022).

e) *A virtual world of geography*: Students could explore the world and learn about

different geographical features, from continents to rivers and mountains.

f) *An educational history game*: Students could play an educational game based on history, learning about important events and influential people.

g) *A virtual reality language learning experience*: Students could interact with native speakers of foreign languages, improving their language skills through practice and interaction (Wu, Zhang & Lee, 2023).

h) *A city simulator*: Students could design and build virtual cities, learning about urban planning and making important decisions about development.

i) *A virtual reality art education experience*: Students could experiment with different artistic techniques and styles in a virtual environment, interacting with artists and designers.

j) *A virtual world for scientific exploration*: Students could explore the natural world, learning about the biology, chemistry, and physics of nature.

These are just some examples of how the metaverse could be implemented in secondary education, offering new opportunities for learning, exploration, and creativity.

High school education

a) *An advanced business simulator*: Students could participate in an advanced business simulator, making strategic decisions in a virtual company, allowing them to learn about business management in a more practical and realistic way (Durana, Krulicky & Taylor, 2022).

b) *A virtual biology laboratory*: Students could explore biology through a virtual laboratory, conducting experiments and observing biological processes in a more interactive and visual way.

c) *A virtual world of mathematics*: Students could learn mathematics in a virtual environment, solving problems and developing problem-solving skills in a more creative and experimental way.

d) *An online language learning program*: Students could learn new languages online through an interactive learning program in a virtual world, where they could practice language skills with native speakers (Wu, Zhang & Lee, 2023).

e) *An engineering simulator*: Students could experiment with engineering and technology in a virtual environment, designing and building prototypes, solving problems, and working in teams (Lee, Woo & Yu 2022).

f) *A leadership skills training program*: Students could participate in a leadership skills training program in a virtual world, where they could interact with successful leaders and entrepreneurs.

g) *A virtual reality experience for arts education*: Students could explore different artistic disciplines in a virtual world, interacting with artists, designers, and musicians.

h) *A virtual world for learning history*: Students could travel through time to different

historical eras, experiencing history in a more visual and interactive way.

i) *A psychology simulator*: Students could explore psychology and human behavior through a psychology simulator, interacting with virtual characters and solving real-time problems.

j) *A virtual world for learning social sciences*: Students could explore different cultures and societies of the world through a virtual world, learning about anthropology, sociology, and politics.

These are just some examples of how the metaverse could be implemented in preparatory education, offering new opportunities for learning, exploration, and creativity

Higher education

The metaverse could be used to create virtual collaborative learning environments, allowing students to work in teams on projects and discuss ideas with peers from around the world. Teachers could also use the metaverse to deliver classes and lectures, interacting with students in a more immersive and personalized way.

a) A virtual campus: Students could access a virtual campus in the metaverse, where they could interact with professors, classmates, and other university resources virtually.

b) A virtual science lab: Students could conduct experiments in a virtual science lab, using advanced tools and equipment that may not be available in the real world.

c) A medicine simulator: Medical students could learn to diagnose and treat diseases in a virtual simulator, interacting with virtual patients in realistic situations (Wu & Ho, 2022).

d) A distance learning platform: Universities could offer classes and distance learning programs through a metaverse platform, allowing students to connect from anywhere in the world.

e) A virtual world for language learning: Students could practice and improve their language skills in a virtual world, interacting with native speakers and participating in everyday situations (Wu, Zhang & Lee, 2023).

f) An entrepreneurial skills training program: Students could learn entrepreneurial and business skills in a virtual environment, working on business projects and collaborating with other students.

g) A virtual engineering lab: Engineering students could design and test prototypes in a virtual lab, interacting with advanced technologies and design tools (Lee, Woo & Yu, 2022).

h) A virtual world for learning art history: Art history students could explore different artistic movements and works of art in a virtual world, interacting with other students and experts in the field.

i) A leadership skills training program: Students could participate in a leadership

skills training program in a virtual environment, learning from successful leaders and entrepreneurs and working on business projects.

j) A programming and software development learning program: Students could learn to program and develop software in a virtual environment, using advanced tools and technologies to develop practical projects.

These are just some examples of how the metaverse could be implemented in higher education, offering new opportunities for learning, exploration, and collaboration.

Graduate level education

In the postgraduate education field, the metaverse has become increasingly relevant in education, where new forms of learning and collaboration are being explored in an immersive and highly interactive virtual environment. From simulating complex business situations to collaborative research, the metaverse offers a wide range of possibilities for advanced education, which could transform the way students learn and teachers teach in the future. Below are a series of examples of metaverse applications in postgraduate education:

a) AI-based learning environments: Virtual environments could use artificial intelligence to personalize the learning experience and offer adaptive real-time feedback (Ahuja et al., 2023).

b) Blockchain-based learning environments: Students could access a decentralized and secure educational platform that allows them to obtain verified and portable academic credits (Huynh-The et al., 2023).

c) Augmented reality-based learning environments: Students could interact with the physical and virtual world in an integrated way, allowing them to experience a more immersive learning environment.

d) Neuroscience-based learning environments: Virtual environments could use neuroscience to improve information retention and long-term learning (Poore, 2023).

e) Gamification-based learning environments: Students could learn through highly interactive educational games that allow them to experience different scenarios and situations (Srisawat & Piriyasurawong, 2022).

f) Mixed reality-based learning environments: Students could interact with the physical and virtual world in an integrated mixed reality experience, allowing them to effectively experience complex concepts (Siyaev & Jo, 2021).

g) Quantum computing-based learning environments: Students could experiment with advanced quantum computing concepts in a secure and controlled virtual environment (Kwon, El-Azzaoui & Park, 2022).

h) Data science-based learning environments: Students could learn through advanced data analysis and statistics in a virtual environment that allows them to experiment with complex datasets (Tyagi & Saxena, 2022).

i) Hyper-realistic virtual reality-based learning environments: Students could interact with hyper-realistic environments that allow them to experience highly realistic and complex situations, enabling them to learn more effectively (Yu, Chua & Zhao, 2023).

In summary, the metaverse has the potential to transform the way education is currently taught and learned at all levels, offering new opportunities for exploration, collaborative learning, and innovation

CONCLUSIONS

The metaverse has the potential to transform education by providing students and educators with a virtual space where they can explore and experiment with a variety of concepts and skills. By doing so, students can learn more effectively and meaningfully, while also developing important skills and competencies in the digital world. There is evidence that when the metaverse is used in education, teachers can create more immersive and engaging learning experiences that stimulate the curiosity and creativity of students, which can lead to improved retention of information and understanding of concepts that has not been effectively achieved by traditional systems, resulting in better academic outcomes. The metaverse can be a valuable tool for promoting collaboration and teamwork, as students can interact with each other in a shared virtual space. This contributes to developing important social and emotional skills, as well as improving communication and problem-solving. However, it is important to consider that the use of the metaverse in education also presents challenges and limitations. For example, it may be difficult for some students to access the metaverse due to technological or connectivity limitations in their social environments. Additionally, there are still concerns about the security and privacy of student data in a shared virtual space, especially when they are minors. Finally, it can also be concluded that although the use of the metaverse in education is an exciting and promising idea that can transform the way we teach and learn, it is important to carefully consider how it is used and how the challenges and concerns that may arise are addressed, in order to fully leverage the potential of the metaverse to improve education and prepare students for an increasingly complex and imminent digital future.

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