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Challenges of Metaverse in Education Digitalization

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Abstract. Education digitalization is the use of modern information technology into education for advanced teaching and learning experiences. It involves the use of digital tools, resources and platforms to support communication, teaching, learning and assessment. Metaverse is a new technology for education digitalization, where learners interact with each other in a virtual world. The aim of the paper is to explain the basics of the Metaverse and to point out its benefits and challenges in the education digitalization from a technical, economic and pedagogical points of view to define its potential for transformation of modern teaching and learning.

Keywords. Education, Digitalization, Metaverse, Immersive Technology, Virtual Reality, Artificial Intelligence.

1. Introduction

Digitalization is a complex and ongoing process, which transforms of all aspects of contemporary live. It represents a complex and broad process that involves converting various aspects of people's activity from analog to digital formats [1]. It could include the digitization products and processes, as well as the integration of digital technologies into the daily lives. One of the main ways digitalization occurs is through the digitization of information. Digitalization also involves the creation of new digital products and services. Music and video content can be distributed through online platforms such as Spotify and Netflix, allowing users to access these products from anywhere with an Internet connection [2]. Many businesses have developed digital services such as online banking, e-commerce platforms and a variety of social media networks that enable people to connect, share information, and conduct transactions from their devices.

The automation of processes represents another important aspect of digitalization. Digital technologies, such as Artificial Intelligence (AI), can be used to automate routine tasks, such as data entry or customer service, thus saving time and resources for more complex activities. Digital tools can also be used to streamline workflows and make business processes more efficient, reduce costs and improve productivity [3].

Digitalization also transforms social and cultural lives [4]. Different social media platforms create new forms of online communities and social interactions, while digital technologies such as Virtual Reality (VR) enable new forms of entertainment and immersive experiences.

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One of the major benefits of digitalization is the ability to access and share information more easily and quickly than before. Digitized information can be stored and accessed from anywhere with an Internet connection, making it easier for people to collaborate, learn, and work together. Digitalization can also improve efficiency, reduce costs and increase productivity by automating tasks and streamlining processes.

However, digitalization experiences challenges, such as the need to ensure data security and privacy. As more information is digitized and shared, there is a greater risk of data breaches and cyberattacks.

The aim of the paper is to explain the basics of the Metaverse and to point out its benefits and challenges in the education digitalization from a technical, economic and pedagogical points of view to define its potential for transformation of modern teaching and learning.

2. Challenges to Modern Education

Modern education develops rapidly with latest developments of information and communication technology, but at the same time, it faces significant challenges and obstacles [5].

Technology has the potential to transform education, but it also presents clearly defined challenges [6]. Limited access to technology or inadequate technology infrastructure can limit the use of digital resources in the classroom, as well as concerns about privacy and security can limit the use of certain technologies.

Access to education is still a major challenge in many parts of the world, especially in developing countries. Limited access to technology resources can affect the quality of education.

Education is not equally accessible to all students, particularly to those from poor communities [7]. This can lead to significant disparities in educational achievement and outcomes.

Funding for education is often limited, particularly in regions with low income or during periods of economic slowdown. This can lead to cuts in staff and resources that negatively affect the quality of education.

Shortage of qualified teachers in many regions that can lead to larger class sizes and lower quality instruction.

Diversity and inclusion are important aspects of a modern education, but many schools and universities cope with issues of discrimination, which can lead to a lack of opportunities for underrepresented groups.

Standardized curriculum can limit the ability of educators to personalize learning and meet the needs of individual students [8].

The nature of work changes, so there is an increasing demand for workers with a wide range of skills, including digital literacy.

Lack of vocational training in many education systems, since they are focused primarily on academic subjects, but there is also a need for vocational training to prepare students for careers in different professional fields [9].

Aging workforce of the teaching staff may lead to the lack of enough new teachers to fill the vacant positions.

Mental health of educators is another concern. Many educators experience burnout, stress and other mental health challenges due to the high demands of the professional activities.

Mental health of students becomes a growing concern in modern education, due to the increasing levels of stress, anxiety, and depression.

Lack of student engagement since many students are disengaged from their education and feel disconnected from the material they are learning. This can lead to lower motivation, decreased achievement and a lack of interest in pursuing further education.

Environment challenges such as climate change and sustainability are increasingly important in modern education, but many educational systems do not integrate these topics into their curriculum.

Emerging and existing pandemics, such as the COVID-19, present unique challenges to education systems around the world, including disruptions to learning, increased demands on teachers and significant changes to the way that learning content is delivered.

Globalization leads to an increased need for intercultural competence and global awareness, but many education systems do not prepare students for these challenges in a suitable manner. This can lead to a lack of understanding and appreciation for diverse cultures and perspectives.

Addressing the above challenges requires a complex approach that involves collaboration between technologists, educators, students, policymakers and communities to create a more responsive and effective educational system.

3. Education Digitalization

Education digitalization represents the integration of digital technologies into the teaching and learning process. It involves using digital tools and platforms to deliver and enhance educational content, as well as to facilitate communication and collaboration among students and teachers. The aim of education digitalization is to improve the quality and accessibility of education, while in parallel to provide students with the skills they need to succeed in an increasingly digitalized world.

A number of typical solutions for education digitalization already exist, which are nevertheless subject to future development [10, 11, 12, 13].

E-learning makes it possible to deliver educational content online, allowing students to learn at their own pace and at their own schedule. This can include everything from online courses and tutorials to interactive educational games and simulations.

Collaborative learning through digital tools, such as video conferencing, chat and shared online workspaces, would allow students to collaborate and communicate with each other and with their teachers regardless of their geographic location. This can promote more active and engaging learning experiences.

Personalized learning through digital technologies can be used to personalize the learning experience for each individual student. This can include adaptive learning algorithms that will adjust the difficulty of the content based on the student's performance, as well as tools that allow the student to track his progress and to set corresponding learning goals.

Virtual and Augmented reality are used to create immersive learning experiences that can simulate real-world environments and scenarios.

Assessment and feedback through digital technologies can be used to provide feedback that is more accurate to students, allowing them to better understand their

achievements and weaknesses and to plan for improvements. This can include automated grading tools, real-time feedback and personalized mentoring.

The education digitalization also offers certain benefits, such as [14, 15]:

- Accessibility - the education digitalization can increase the access to education for students who are not able to attend traditional classroom learning. Digital technologies remove the geographic barriers, thus allowing students to access learning resources from anywhere with an Internet connection.
- Integration with traditional learning - many educational institutions integrate digital tools and technologies into their existing teaching systems in order to provide a more diverse and engaging learning experience for the students.
- Cost-effectiveness - education digitalization can also be more cost-effective than traditional classroom-based learning since it can reduce the need for physical infrastructure and resources.
- Skills for the future - education digitalization can help prepare students for the future workforce. By using digital tools and platforms to learn, students can gain valuable digital literacy skills that are in high demand in many industries.

It should be noted that a main concern of the education digitalization is the need to ensure that digital technologies are accessible to all students, regardless of their social status. Educational institutions can provide more accessible, engaging and cost-effective learning experiences for students by incorporating digital technologies into the teaching environment [16].

4. Metaverse as a New Technological Environment

Metaverse is a term used to describe a hypothetical virtual reality space where users can interact with a computer-generated environment and with other users in real-time [17]. It is a term suggested by science fiction author Neal Stephenson in his 1992 novel "Snow Crash", but the concept has ever since been explored and developed by many IT professionals and scientists [18].

In the Metaverse, users can create their own digital avatars, or virtual representations of themselves, and explore a vast and immersive digital world that is shared by millions of other users [19]. The digital world can include everything from virtual cities and landscapes to virtual buildings and objects, all of which can be created and manipulated by users. In the Metaverse, the users could attend virtual entertainments, attend virtual conferences, conduct virtual business meetings, to teach and learn [20].

The Metaverse is not a single platform or technology, but rather a concept that encompasses a wide range of virtual and augmented reality technologies, as well as social and collaborative platforms. It is seen as the next step in the evolution of the Internet, beyond the current 2D web and even beyond the 3D virtual worlds [21].

The Metaverse is a complex and evolving ecosystem that encompasses a wide range of technologies, platforms and applications [22, 23].

Virtual Reality (VR) is a technology that creates a fully immersive, computer-generated environment that simulates a user's physical presence in a digital space [24]. This technology is a core component of the Metaverse since it allows users to interact with virtual environments and other users in a way that feels natural and intuitive.

Augmented Reality (AR) is a technology that overlays digital content onto the user's real-world environment, typically through a mobile device or headset. This technology can be used to enhance the user's experience of the physical world or to create interactive digital experiences that mix seamlessly with the user's surroundings.

Blockchain is used in the Metaverse to enable secure and transparent transactions between users, as well as to manage digital assets and identity verification. Blockchain technology provides a decentralized system for managing transactions, which is essential in a virtual economy where trust and transparency are critical.

Cloud Computing in the Metaverse is used to support the large-scale data processing and storage needs of virtual environments and applications. Cloud computing provides scalable and flexible computing resources that can be accessed remotely, which is essential for supporting the high-performance computing needs of the Metaverse.

Artificial Intelligence (AI) is used in the Metaverse to create intelligent agents, virtual assistants, and other digital entities that can interact with users in a more natural and intuitive way. AI is also used to analyze data and generate insights about user behavior, which can help to improve the user experience and optimize the performance of virtual environments.

Natural Language Processing (NLP) is a technology that enables computers to understand and interpret human language, typically through machine learning algorithms. In the Metaverse, NLP is used to create virtual assistants and chatbots that can interact with users in a more natural and intuitive way, such as by responding to voice commands or text messages.

Spatial Computing is a technology that combines AR, VR and other technologies to create immersive and interactive digital experiences that are spatially oriented. The technology enables users to interact with virtual objects and environments in a way that is more natural and intuitive and it can help create a more immersive and engaging user experience [25].

Internet of Things (IoT) is a network of interconnected devices and sensors that are embedded in the physical world, such as wearables. In the Metaverse the IoT is used to enable seamless integration between the digital and physical worlds, and to create interactive and personalized experiences for users.

3D Modeling and Animation are used to create the virtual objects and environments that populate the Metaverse. They enable the creation of highly detailed and realistic virtual assets, such as buildings, landscapes and characters [26].

Motion Tracking is used to capture and analyze the movements of users within the virtual environment, typically using sensors or cameras. The technology enables users to interact with virtual environments in a more natural and intuitive way, such as by using hand gestures or body movements to control virtual objects.

Multiplayer Networking enables users to connect and interact with each other in real time within the virtual environment. It is essential for creating social experiences within the Metaverse.

However, there are clearly defined challenges in the development of the Metaverse. They can include technical challenges, such as the need to create scalable virtual worlds that can support millions of users simultaneously, protecting the privacy and security of all users in the environment [27]. Despite these challenges, the Metaverse can be regarded as a disruptive and transformative technology that has the potential to revolutionize the way people live, work, and interact with each other in the digital age [28].

5. Metaverse in Education Digitalization

The concept of the Metaverse has significant implications for education as it has the potential to create immersive and engaging learning environments that go beyond the traditional classroom settings. The Metaverse in education refers to the use of VR and AR technologies to create digital learning environments that are shared by students and teachers from around the world [29].

In the Metaverse, students can create their own digital avatars and explore virtual worlds that are designed to teach them about a wide range of topics - from mathematics and science to history and literature. These virtual worlds can include everything from simulations of historical events and scientific phenomena to interactive games that teach students problem-solving and critical thinking skills [30, 31]. The use of the Metaverse in education has several advantages over the traditional classroom settings [32].

Interoperability allows different virtual worlds and platforms seamlessly to connect and interact with each other [33]. This would enable users to move their avatars and digital assets between different virtual worlds and to interact with users who are using different platforms.

Real-world simulations can be used to create highly realistic simulations of real-world scenarios, such as scientific experiments [34]. This allows students to explore complex concepts and ideas in a safe and controlled environment, and can help prepare for real-world experiences they encounter later in life.

Decentralization of the education environment, which is not controlled by a single organization [35]. This would require the use of blockchain or some other decentralized technology to ensure that Metaverse application is open and accessible to all users.

Personalized learning experiences through which students can progress at their own pace and explore topics that interest them in greater depth [35].

Collaborative learning helps students to work together in virtual teams to complete assignments and projects, and they can learn from each other in a shared digital space [36]. This builds a sense of community and engagement among students and encourages them to take a more active role in learning.

Immersive language learning can also be used to create immersive language learning experiences, where students can practice their language skills in a simulated environment [37].

Accessible learning can help make education more accessible to students who may face barriers to learning, such as students with disabilities or those who live in remote areas [38]. By using VR and AR, educators can create learning experiences that are more engaging and accessible to all students, regardless of their physical location or abilities.

Data collection and analysis can be used to collect and analyze data about student learning performance [39]. By tracking student progress and behavior in a virtual environment, educators can gain insights into how students learn and use this information to improve their teaching methods and educational programs.

Economic opportunities are enabled by the Metaverse where users can earn money through a variety of activities, such as creating and selling digital assets, providing virtual services to other users [40].

Social implications of the Metaverse in education digitalization raises important social and ethical questions about the impact of virtual reality on society, that could affect relationships among participants in the educational process and their sense of identity [41].

Despite the obvious benefits of the Metaverse application, there are also challenges associated with the use of the Metaverse in education.

The Metaverse infrastructure can be expensive, while not all students may have access to the necessary hardware and Internet connectivity to use it effectively [42, 43].

The Metaverse is still a relatively new technology and there may be technical issues that arise when using it for educational purposes [44]. These could include glitches, bugs, or connectivity problems that disrupt the learning experience.

Integration of Metaverse with existing educational systems can be complex and time-consuming. It will require significant changes to curriculum and teaching methods [45, 46].

Content creation for the Metaverse can be challenging and time-consuming, especially for teachers who may not be familiar with the technology. This could result in a lack of high-quality educational resources within the Metaverse [47, 48].

Cost of implementation and maintenance of the Metaverse for educational purposes can be expensive [49]. The cost may be spread among students or schools, which could limit access for those who cannot afford it.

The use of a Metaverse in education digitalization raises privacy concerns, as student data could be collected and stored by third-party providers. There is a risk of this data being mishandled or shared without proper consent.

Safety and security are of a particular concern when of using a Metaverse for educational purposes, since there are risks associated with online interactions with strangers.

Pedagogical approach of the Metaverse in education digitalization will require a different pedagogical approach than the traditional classroom teaching. Teachers should adapt their teaching methods to ensure that the technology is used effectively and in a way, that enhances learning outcomes. This approach of the Metaverse focuses on creating immersive, collaborative, personalized, and engaging learning experiences [50]. The Metaverse has the potential to revolutionize education and enhance learning outcomes for learners of all ages by using the unique capabilities of the virtual worlds.

Learning outcomes of the Metaverse can prove not always to be the most effective way for achieve learning outcomes. Students may find it difficult to learn in virtual environments and the lack of physical interaction with teachers could lead to a less personalized and effective learning experience. Some students may prefer traditional forms of learning and they may not be motivated to participate in the virtual world.

6. Conclusion

The concept of using Metaverse in education digitalization offers new enhanced opportunities to create immersive and engaging learning experiences for students [51]. The Metaverse has the potential to revolutionize the way of teaching and learning by offering an interactive and collaborative virtual environment where students can explore and engage with educational content. It is essential to address important challenges, such as the pedagogical approach, limited engagement, learning outcomes, content creation, access, technological issues, cost, integration, safety and security, privacy, etc. to ensure the effectiveness of the Metaverse in supporting teaching and learning outcomes. Taking into account all those milestones, the disruptive potential of the Metaverse in education digitalization can be fully implemented.

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