The Potential of Educational Metaverse on Educational Organizations

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Abstract

It is a case that cannot be neglected that the metaverse, which can be interpreted as the future of the Internet and the 3-dimensional new generation Internet, has the potential to influence and transform all areas in which human beings are engaged. Undoubtedly, one of the areas that will get the most share from the wave that this relatively new digital evolution can bring will inevitably be education. For this reason, it is important to discuss the possible effects of the metaverse in the context of education in order to understand the potential of this technological step that will shape the future of educational organizations and to make the necessary preparations. This article aims to discuss the educational dimension of the metaverse and to contribute to the understanding of how we can benefit from the metaverse as educational organizations. A customized learning environment adjusted to individual needs, more realistic, more lifelike learning, learning independent of time and space, equality opportunity in education, and getting rid of the financial burden required by physical schools are some of the benefits that metaverse is thought to provide to humanity in the educational sense. In order to benefit optimally from the opportunities and contributions that the metaverse can provide to education, it is necessary to first comprehend the depth and potential of the educational metaverse.

Key Words: Metaverse, Education, Educational Organizations, Metaversity

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Introduction

It is important to note that, as the metaverse is still a relatively new idea to the world, there isn't one definition that is widely agreed upon. Instead, various institutions and organizations have defined it differently based on their own viewpoints and interpretations. Ball (2022) states that the metaverse is a technological space akin to the World Wide Web, however, there is no specific definition of the metaverse that academic groups have come to a consensus or a creator, or an owner. According to whether they approach the metaverse from a technological or philosophical standpoint, their definitions and meanings differ (Li, 2022; Cho 2023; Lee et al., 2021; Clemens, 2022). Tsinghua University Shenyang team (2021) defines the metaverse as a new type of internet application and a social form that enables the adaptation of many new technologies such as augmented reality and virtual reality into our lives. According to Geping (2022), the metaverse represents the latest stage of visual immersion technology, and this online world space, parallel to the real world, is increasingly opening up a more practical space for human development. Clemens (2022) defines the metaverse as virtual environments that allow individuals to interact and communicate and says that the metaverse is an open system where people can produce and share the content they produce without the need for any format. Microsoft's chief executive officer Nadella described the metaverse as "a platform that will turn the whole world into an app tent", while Zuckerberg described it as an inclusive virtual reality that offers individuals the opportunity for social life

experiences together in an environment where physical distance is not an obstacle (Clemens, 2022, p.30). Especially in the early years of metaverse studies, metaverse is a word used in the literature as a substitute for virtual universes, but in some studies conducted in the following years, metaverse has much more complicated meanings beyond virtual universes (Cho et al., 2023). According to Cho et al., the metaverse is not just a virtual world, but a new world that expresses the combination of physical and virtual worlds as a result of the reflection of advanced, immersive technologies such as artificial intelligence, augmented reality, and the Internet of Things.

Lee et al. (2021), who introduced the metaverse as a blended version of reality and digital in line with the possibilities provided by the convergence of the internet, web technologies, and augmented reality technologies at a common point, stated that there are three stages that the metaverse must pass through for its transformation into a double lifestyle that it will offer to human society. These stages are as follows respectively: (I) Digital twins, (II) Digital natives, and finally (III) the joint coexistence of physical and virtual reality, in other words, the surreal society. Figure 1 describes the relationship between these three stages:

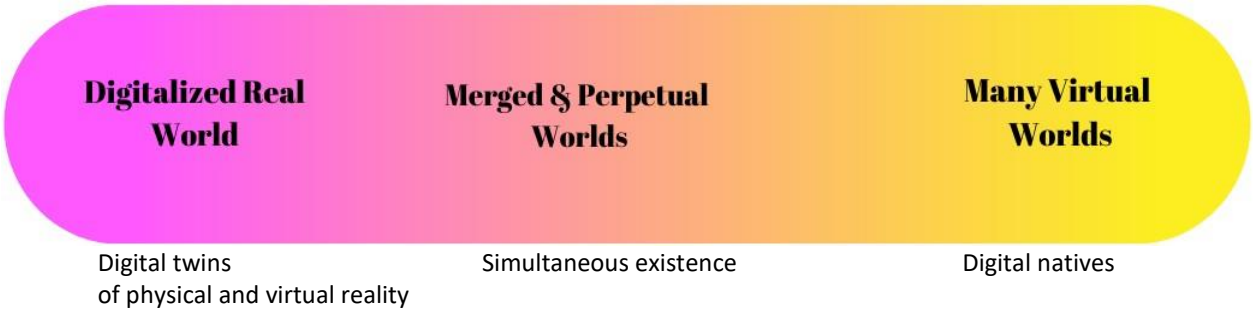

Figure 1. 3-stage development of the twin digital world-local world continuum / Metaverse vision (adapted from Lee et al., 2021, p.1)

Once the digital twin of the physical world is created, which includes reflections of the real world such as smart digital cities, architectures, buildings, and institutions, the next stage will be the process of creating native content within these digital worlds (Lee et al., 2021). According to Lee et al., content creators will participate in these worlds with their avatars, organize new content, and events, and shape these digital worlds with connected ecosystems, digital culture, economy, laws and regulations, and social norms. Lee et al. stated that the third and final stage in the formation is the transformation of the metaverse into a self-sustaining, perpetual virtual world with a high level of freedom and independence, coexisting with the physical world, in a sense, the formation of a surreal world, where we can transfer the content and avatars we create in a virtual universe to other virtual universes, or one step further, we can transfer a content we create in the virtual universe to the physical world and interact with it.

Metaverse technology is the ultimate achievement in the evolution of the internet. The internet adventure of humanity, which started with web 1.0 technology based on reading only for information, continued with web 2.0 technology, which enabled people to write and share information as well as obtain information, and with the introduction of blockchain technology into our lives, the internet evolution has reached the threshold of a digital transformation with web 3.0 technology, which creates the infrastructure for the creation of three-dimensional virtual simulation environments and multi-directional interaction with avatarized representations. Metaverse, which is referred to as a Web 3.0 technology product in many sources, is also seen by some researchers as the beginning of Web 4.0 technology as it is the next stage of the internet (Rawal et al., 2022). Rawal et al. described this evolution of the internet as follows:

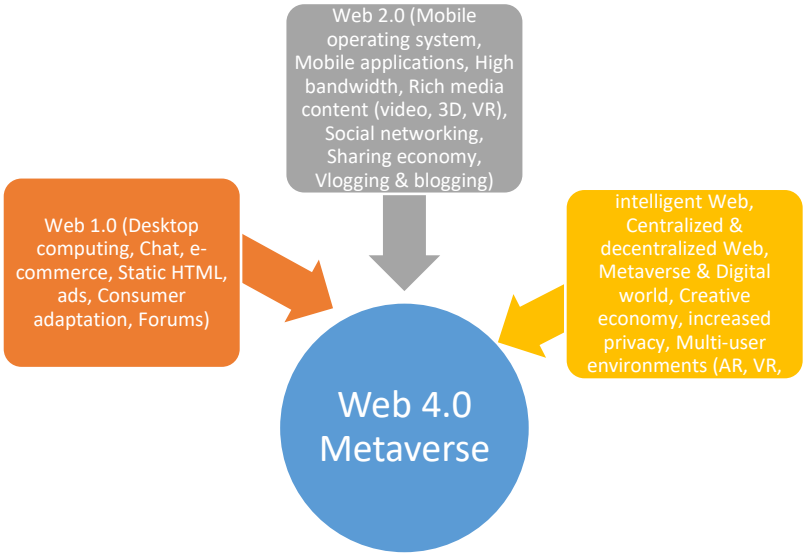

Figure 2. Evolution of the metaverse (adapted from Rawal et al., 2022, p.5)

The metaverse is a structure that includes many advanced technologies such as mirror world, immersive visualization, augmented reality, virtual reality, mixed reality, cloud application, artificial intelligence, big data, 3D visualization, and blockchain (Li, 2022). Li visualizes the core technologies used in the educational metaverse as follows:

Figure 3. The core technologies used in the educational metaverse (adapted from Li, 2022, p.44)

Metaverse technology, which gathers many advanced technologies under its roof, not only offers a space-independent interaction environment but also offers its users the opportunity to create many environments that are difficult, dangerous, complex, costly, or impossible to create in physical conditions in simulation environments with its infrastructure.

Metaverse and Education

As a new and superior version of the Internet, the metaverse has the potential to create a new system in all areas where human beings are involved. The Metaverse will create a different vision for teaching and learning,

providing an immersive and interactive teaching space to meet all the needs of students and teachers. The integration of the Metaverse and the education field contains endless possibilities for both the academic and individual development of the person, as well as for meeting the employment needs of humanity and raising skilled and qualified individuals. With all the possibilities it contains, the educational metaverse will not be a simple copy of the education and training activities in the human world transferred to the virtual environment or an instructional tool used to better function and color traditional teaching, but a new learning universe that combines virtual and reality in a hybrid world and a new understanding and form of education for humanity within its own ecosystem. Some of the numerous contributions that the metaverse can make to the field of education can be listed as follows:

Metaverse integrates the realistic elements of education content, purpose, role relationship, and management mode into its logical system, and builds a new education system in cyberspace, so that teachers and students can interact with virtual identity in multi-channel, and introduces hardware equipment to simulate audio-visual interaction and other interactive effects to complete learning interaction and communication (Li et al., 2022). As a technological ecosystem that connects virtual and reality, it brings the cooperation link between education and technology closer, provides enriched instructional design, and realizes a more flexible and efficient cooperation mechanism between humans and digital. By connecting the virtual space to the real space and the school system to the social system, the educational metaverse eliminates the wall and boundary between education and society, supports the transformation and development of knowledge and skills, and contributes to the creation of a more dynamic, social and interactive learning environment. It can help eliminate the physical constraints of the classroom and with the support of technology, it allows both the student and the teacher to be present in a digital environment anywhere in the world, expanding their physical space (Pavlik, 2015). Metaverse can facilitate global collaboration between students and educators residing in different parts of the world. In a sense, these virtual universes correspond to an international vision of education in which geographical barriers are completely eliminated, creating a common and rich learning space for individuals with different ethnic and cultural backgrounds, with different perspectives on the world, and creating opportunities for students and educators from all over the world to work on the same projects.

The use of metaverse in education provides opportunities to connect students and teachers and bring them together synchronously, enabling their active participation in the processes of knowledge construction and sharing (De Freitas et al., 2010; Nisiotis, 2015; Kallonis and Sampson, 2010). Advanced graphics and operational features offer interactivity, coexistence, and socialization among users, allowing them to interact and communicate with each other and the environment simultaneously (Nisiotis, 2015).

Interacting and socializing in virtual worlds can be easier for people compared to the real world, and the positive effect of virtual universes on socialization is often expressed (Chesney et al., 2009; Schroeder, 2002; Minocha & Tingle, 2008). In this context, some students who may have difficulty in face-to-face communication will be able to interact more easily verbally or non-verbally in these virtual worlds (Dalgamo & Lee, 2010). One of the necessary conditions for a virtual reality platform to be called a metaverse is that it contains a shared and interactive community. In this context, the metaverse is much more than a simple virtual reality simulation. The existence of an awareness of the presence of other users in metaverse virtual universes, and the sense of coexistence in a community and group will positively affect group dynamics in educational terms and increase motivation and productivity (Bouras & Tsiatsos, 2006; Dalgamo & Lee, 2010).

Another element that will increase students' motivation in the metaverse environment and enable them to participate more effectively in the learning process is the presence of personalized avatars. Unlike the two-dimensional internet environment and social networks, avatars in metaverse platforms enable students to participate in online learning environments not only as spectators but also with their entire physical and spiritual being. Avatars reinforce and make more tangible the feeling of being and existing in virtual worlds by providing a sign that visualizes the physical presence of individuals in cyberspace (Hayes Jr, 2014; De Lucia et al., 2009; Dickey, 2005; Nisiotis, 2015; Bailenson et al., 2008; Schultze & Rennecker, 2007; Tseng et al., 2013; Schlemmer, & Backes, 2015). Personalized avatars attract students' attention and interest and encourage their participation in group activities (Hew & Cheung, 2010; McCaffery et al., 2011). In other words, metaverse universes with avatarized representations can create more immersive, more engaging, more visual, more dynamic, more effective, and lasting learning environments that encourage participation and socialization, and that are more

visually enriched and dynamic than both learning environments in the physical universe and online learning environments offered by two-dimensional platforms. Fields that require hands-on training, such as healthcare, engineering, or professional skills, can benefit from metaverse simulations. In these environments, students can chat with historical figures in simulation environments where ancient periods are visualized, explore distant planets with a sense of being there, travel between the layers of the earth or in the internal organs of a biological being, and perform experiments that would pose a danger in the real world in realistic virtual environments.

One of the most significant contributions of the metaverse to education is its potential to create a customized learning environment for each individual. By offering personalized educational experiences, metaverse technologies can provide an education system tailored to individual learning styles and preferences. AI-powered systems can analyze student performance, speed, and learning style, take into account individual differences, and adjust content and activities according to student needs, making learning more efficient and effective. In other words, the metaverse is a post-reality cosmos that combines physical reality and digital virtuality in a continuous and persistent multi-user context and has the potential to address the main drawbacks of both web-based virtual environments and physical environments (Kaddoura & Al Husseiny, 2023). The metaverse can allow the curriculum to be customized according to the needs of the learner (Mistretta, 2022) or it can transform the entire world into a virtual global school, leaving curricular programs behind the times (Kaddoura & Al Husseiny, 2023). The Metaverse is a gateway to a more ideal understanding of education where the student is the subject and center of learning, not the object of learning, where the individual is in control of his/her own learning process, where he/she learns by experiencing and discovering in fun and immersive environments, and where participation is voluntary rather than compulsory.

The economic costs of educational practices in the physical classroom environment, the procurement of school supplies, and increasingly expensive field trips necessitate the implementation of low-cost digital solutions, and it is becoming increasingly important for future teachers to use free and easily accessible technologies that can provide transformative, personalized learning experiences for students (Arbogast, 2019). From the simple educational materials used by students and teachers in the classroom to the cost of constructing school buildings, it is clear that physical education requires a significant budget on a global scale. It should also be noted that individuals from different socio-economic backgrounds do not have equal access to the physical facilities necessary to receive education. The educational metaverse has the power to eliminate all these educational inequalities if it can be planned within the framework of ethical values, and it also has the power to bring unlimited education to all segments of society at a much lower cost. Students from all over the world, regardless of their level of development, can access vast educational resources and libraries, virtual museums and archives can be easily explored, and students can access rich information and cultural experiences at very low costs. In addition, the metaverse allows individuals to participate in virtual workshops, conferences, and skill-building sessions without the need for physical travel, thus reducing costs and increasing accessibility for participation in educational activities on a global scale.

One of the other contributions of the educational metaverse in the context of social equity in education is the possibility of creating equal educational opportunities for individuals with disabilities. Especially by providing facilities for students with physical disabilities, it can ensure that everyone has equal access to educational opportunities. In this direction, metaverse technologies have the structural framework that can make education more inclusive and egalitarian.

The transformation of Universities: Metaversity

With the Metaverse, universities will undergo major transformations and revolutions, and eventually all education and training activities will move to the Metaverse. Physical buildings will be replaced by VR campuses, books and teaching materials will be replaced by digital materials, classical, traditional assessment and evaluation methods will be replaced by personalized, individualized and practice-based VR methods, and students in classrooms will be replaced by avatars. After a period of time, we will stop calling a higher education institution a university in the metaverse era, just as the terms academia and madrasa were replaced by university, and we will start calling it a metaversity.

The term 'metaversity', which is a newly introduced concept in the literature and is thought to have already influenced teaching paradigms, is defined as digital campuses that mimic physical classroom environments and physical buildings, metaverse-based higher education institutions that allow us to live XR experiences in the classroom environment, and are created by configuring digital twins of real environments in virtual environments (Sutikno & Aisyahrani, 2022; Ruwodo et al., 2022). Sutikno and Aisyahrani (2022) interpret the metaversity as the first step in a higher education iteration that will eventually become part of a full, global metaverse, and see it as the next generation of universities where physical boundaries are completely removed, teaching is personalized, and students experience immersive XR technologies that enable more effective and lasting learning. Metaversities have the potential to immerse the world's students in the same learning environment, transforming the entire world into a single virtual classroom.

Types of Educational Metaverse

In 2006, the Stanford International Research Institute organized a summit to draw a roadmap for the future of the metaverse technology, and academics, technology architects, entrepreneurs, and futurists from different fields participated in this summit to make predictions and prepare a strategic plan for what the internet will look like in the future (Metaverse Roadmap Summit, 2006). Following this summit, the Acceleration Studies Foundation (ASF), a metaverse research organization for accelerating technological change, announced its metaverse roadmap in 2006, proposing to think of the metaverse as a nexus or fusion of the real world and virtual reality, and outlining four types of metaverse (Kye et al., 2021). In ASF's metaverse roadmap, two axes are presented to explain the types of metaverse, one is 'augmentation and simulation' and the other is 'internal and external' (Smart et al. 2007).

Augmentation technology refers to a technology that adds a new function to an existing real system, in other words, adding more information to the physical environment we perceive; in contrast to augmented technology, simulation technology refers to technology that provides a unique environment by modeling reality, aiming to use the simulated world as a space for interaction (Kye et al. 2021). The metaverse is further divided into an inner world and an outer world; the inner world focuses on the identity and behavior of an individual or object, and technology is used in the metaverse to enable the completion of the inner world. In contrast, the external world focuses on aspects of the user-centered external reality that are usually the subject of the metaverse. As such, it involves technology related to the display of information about the world around the user and how to control it. These internal and external frames become another axis for dividing applications depending on whether the metaverse technology is focused on the user's internal world or the world around them. Based on these 2 axes, the metaverse roadmap categorizes the metaverse into 4 types: augmented reality, lifelogging, mirror world, and virtual reality (Smart, 2007; Kye et al., 2021; Tlili, 2022).

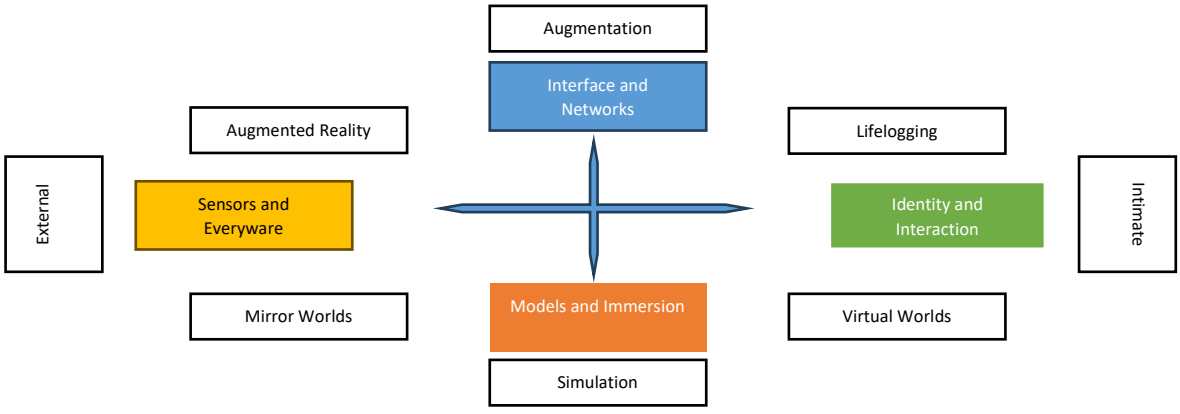

Figure 4. A diagram of the 4 Metaverse types according to the Metaverse Roadmap Summit (adapted from Kye et al., 2021, p.2)

Although the metaverse is a new concept that is still developing, the core technologies of the metaverse - augmented reality, virtual reality, and artificial intelligence technologies - have a history of decades and have been used as an educational tool at different levels and in different areas of education for a long time.

Considered the first open and free virtual reality platform and the first extraordinary virtual world, Second Life, developed by Linden labs in 2003, has been used as an educational tool by many educational institutions and teachers at different levels since its launch, and some of the world's top universities, such as Harvard University, have built virtual campuses through Second Life to pave the way for relevant research (Li et al., 2022). Following Second Life, a growing number of metaverse platforms applied for educational practices have been opened and a considerable amount of educational metaverse projects have been started by prestigious educational organizations in the world since 2003. Virtual worlds such as Whyville, Quest Atlantis, River City Project, and Revolution are examples of educational metaverse used in different countries around the world, designed to teach social studies, history, mathematics, and science to elementary school children, offering them opportunities to test and apply what they learn in school (Araullo, 2013). One of the most invested metaverse platforms in the context of the educational metaverse is Eduverse, which focuses more on pre-tertiary education. A revolutionary online learning environment that aims to provide a content-rich, safe, and secure metaverse for schools, Eduverse allows students to explore immersive and engaging virtual worlds in an inclusive metaverse environment.

Conclusion

In the Metaverse, people can interact socially, create discussion platforms, share experiences, play games, design and create projects or games, shop, visit virtual cities, create or participate in events, and create learning content that is not possible in the physical world (Hwang & Chien, 2022). Considering the extent of the possibilities offered by the metaverse universe, it is an indisputable scenario that educational activities will create a wide range of applications in this universe. For example, in the not-too-distant future, a history teacher will be able to teach the subject of migration to Anatolia by teleporting to the simulation environment of migration caravans within seconds with his students in a virtual classroom environment with avatars, while in another virtual classroom, a geography teacher will be able to teach the subject of erosion by offering a virtual life experience to his students in an erosion simulation with avatars.

On the other hand, although not yet widespread in developing countries, Metaverse applications and games in information technology pioneer countries have already opened up a space for themselves as a teaching and learning tool that goes beyond socializing and entertainment.

Metaverse virtual universes, which can be considered the common living space of this new society and the biggest digital revolution of the new century, have started to open up new application areas in the field of education (Lee et al., 2021). However, our current education system and educational organizations are experiencing difficulties in the process of adapting to this new network society and are following the innovations far behind. The new society will also require a new education process and a new educational management approach. It is indisputable that when metaverse starts to be used in all areas of life when people start to attend school, work, entertainment, libraries, panels, and concerts from their homes, today's institutions, organizations, and structures will change and educational organizations will also undergo this structural change. For that reason, it is the time for all kinds of educational organizations to consider all the possibilities, opportunities, and challenges that the metaverse will bring to the table and to get ready for it by doing more research, planning well, preparing the organizational infrastructure, and enabling digital innovation.

Disclosure Statement
No potential conflict of interest was reported by the authors.

References

Araullo, J. (2013). *Educators' Experiences: The Process of Integrating Virtual World Technology in Higher Education* [Ph.D. Dissertation, Boston University]. ProQuest. https://www.proquest.com/

Arbogast, M. A. (2019). *Immersive technologies in preservice teacher education: the impact of augmented reality in project-based teaching and learning experiences* [Ph.D. Dissertation, The University of Toledo]. ProQuest. https://www.proquest.com/

Bailenson, J. N., Yee, N., Blascovich, J., Beall, A. C., Lundblad, N. & Jin, M. (2008). The Use of Immersive Virtual Reality in the Learning Sciences: Digital Transformations of Teachers, Students, and Social Context. *The Journal of the Learning Sciences,* 17, (1), 102-141.

Ball, M. (2022). *The Metaverse and How It will Revolutionize Everything*. Liveright Publishing Corporation.

Bouras, C., Giannaka, E., Panagopoulos, A. & Tsiatsos, T. (2006). A Platform for Virtual Collaboration Spaces and Educational Communities: The Case of Eve. *Multimedia Systems,* 11, (3), 290-303.

Chesney, T., Coyne, I., Logan, B. & Madden, N. (2009) Griefing in Virtual Worlds: Causes, Casualties and Coping Strategies. *Information Systems Journal,* 19, (6), 525548.

Cho, Y., Seunghyun, H. Kim., M. & Kim, J. (2022). Dave: Deep Learning-Based Asymmetric Virtual Environment for Immersive Experiential Metaverse Content. *Electronics,* 11*(16), 2604.* https://doi.org/10.3390/electronics11162604

Clemens, A. (2022). *Metaverse For Beginners A Guide To Help You Learn About Metaverse, Virtual Reality And Investing In NFTs*.

Dalgamo, B. & Lee, M. J. W. (2010). What Are the Learning Affordances of 3D Virtual Environments? *British Journal of Educational Technology,* 41, (1), 10-32.

De Freitas, S., Rebolledo-Mendez, G., Liarokapis, F., Magoulas, G. & Poulovassilis, A. (2010). Learning as Immersive Experiences: Using the Four Dimensional Framework for Designing and Evaluating Immersive Learning Experiences in a Virtual World. *British Journal of Educational Technology,* 41, (1), 69-85.

De Lucia, A., Francese, R., Passero, I. & Tortora, G. (2009). Development and Evaluation of a Virtual Campus on Second Life: The Case of Second DMI. *Computers & Education,* 52, (1), 220-233.

Dickey, M. D. (2005). Three-Dimensional Virtual Worlds and Distance Learning: Two Case Studies of Active Worlds as a Medium for Distance Education. *British Journal of Educational Technology,* 36, (3), 439-451.

Geping, L., Gao Nan, H., & Hanlin, Q.Y. (2022). Metaverse, E.: Features, mechanisms and application scenarios. *Open Educ. Res.* 1, 24–32.

Hayes Jr, P. (2014). *Virtual Environmental Factors and Leading Global Virtual Teams* [Ph.D. Dissertation, Indiana Institute of Technology].

Hew, K. F. & Cheung, W. S. (2010). Use of Three-Dimensional (3-D) Immersive Virtual Worlds in K-12 and Higher Education Settings: A Review of the Research. *British Journal of Educational Technology,* 41, (1), 33-55.

Hwang, G. J. & Chien, S. Y. (2022). Definition, roles, and potential research issues of the metaverse in education: An artificial intelligence perspective. *Computers and Education: Artificial Intelligence,* 3, 100082.

Kaddoura, S., & Al Husseiny, F. (2023). The rising trend of Metaverse in education: challenges, opportunities, and ethical considerations. *PeerJ Computer Science*, *9*, e1252. https://doi.org/10.7717/peerj-cs.1252

Kallonis, P. & Sampson, D. (2010) Implementing a 3D Virtual Classroom Simulation for Teachers' Continuing Professional Development. *Proceedings of the 18th International Conference on Computers in Education, Putrajaya, Malaysia.* 36-44.

Kye B, Han N, Kim E, Park Y, Jo S. (2021). Educational applications of metaverse: possibilities and limitations. *Journal of Educational Evaluation for Health Professions* 2021;18.

Lee, L. H., Braud, T., Zhou, P., Wang, L., Xu, D., Lin, Z., & Hui, P. (2021). All One Needs to Know about Metaverse: A Complete Survey on Technological Singularity, Virtual Ecosystem, and Research Agenda. *Journal of Latex Class Files,* 14(8).

Li, X. (2022). Research on the Application and Risk Prevention of Metaverse in Vocational Education. In Liang J.Z. (Ed.) *Metaverse 2022*. Springer.

Li, Y., Wei, W., & Xu, J. (2022, December). The Exploration on Ethical Problems of Educational Metaverse. *In International Conference on Metaverse (pp. 29-38).* Cham: Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-23518-4

McCaffery, J., Miller, A., Allison, C. & Yu, T. (2011). Virtual Worlds as a Platform for 3D Application Development. Proceedings of Researching Learning? *Immersive Virtual Environments,* 141-153.

Metaverse Roadmap Summit, (2006). Elon University. https://www.elon.edu/u/imagining/event-coverage/Metav erse/

Minocha, S. & Tingle, R. (2008). Socialisation and Collaborative Learning of Distance Learners in 3-D Virtual Worlds. *Learning in Virtual Environments International Conference,* 216-227.

Mistretta S. (2022). The Metaverse—an alternative education space. *AI, Computer Science and Robotics Technology 1–23 DOI 10.5772/ACRT.05.*

Nisiotis, L. (2015, April). The Use of Cyber Campus Environments to Support Access and Participation to Education. *Methods Research Students Conference,* Sheffield Hallam University.

Pavlik, J. V. (2015). Fueling a third paradigm of education: The pedagogical implications of digital, social and mobile media. *Contemporary Educational Technology*, *6*(2), 113-125.

Rawal, B. S., Ahmadand, S., Mentges, A., & Fadli, S. (2022, December). Opportunities and Challenges in Metaverse the Rise of Digital Universe. In *International Conference on Metaverse* (pp. 3-17). Cham: Springer Nature Switzerland.

Ruwodo, V., Pinomaa, A., Vesisenaho, M., Ntinda, M., & Sutinen, E. (2022, October). Enhancing software engineering education in Africa through a metaversity. In *2022 IEEE Frontiers in Education Conference (FIE)* (pp. 1-8). IEEE.

Schlemmer, E., & Backes, L. (2015). Learning in metaverses: Co-existing in real virtuality. *IGI Global*. https://doi.org/10.4018/ 978-1-4666-6351-0

Schroeder, R. (2002). Social interaction in virtual environments: Key issues, common themes, and a framework for research. In *The social life of avatars: Presence and interaction in shared virtual environments*. 1-18. Springer.

Schultze, U. & Rennecker, J. (2007). Refraining Online Games: Synthetic Worlds as Media for Organizational Communication. *Virtuality and Virtualization.* 335-351. Springer.

Smart, J., Cascio, J., Paffendorf, J., Bridges, C., Hummel, J., Hursthouse, J., & Moss, R. (2007). A cross-industry public foresight project. Proc. *Metaverse Roadmap Pathways 3DWeb*, 1-28.

Sutikno, T., & Aisyahrani, A. I. B. (2023). Non-fungible tokens, decentralized autonomous organizations, Web 3.0, and the metaverse in education: From university to metaversity. *Journal of Education and Learning, 17*(1), 1-15.

Tlili, A., Huang, R., Shehata, B., Liu, D., Zhao, J., Metwally, A. H. S., ... & Burgos, D. (2022). Is Metaverse in education a blessing or a curse: a combined content and bibliometric analysis. *Smart Learning Environments*, *9*(1), 1-31.

Tseng, J.-J., Tsai, Y.-H. & Chao, R.-C. (2013). Enhancing L2 Interaction in Avatar- Based Virtual Worlds: Student Teachers' Perceptions. *Australasian Journal of Educational Technology, 29*, (3), 357-371.

Tsinghua University: New Media Research Centre, (2021). Metaverse Development Research Report. 14-14.