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The Potential of Metaverse Technology in Education as a Transformation of Learning Media in Indonesia

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Abstract: This study aims to analyze the potential of metaverse technology in education to transform learning media in Indonesia. This research used a qualitative approach with descriptive methods. The type of research utilized library search. The secondary data comprised scientific papers indexed by Scopus and Sinta. The data analysis technique used in this research was thematic analysis. The results indicated that the technological metaverse perspective in education could present the best digital technology to support education in Indonesia. Implementing the metaverse in interactive learning media in Indonesia is divided into four types of simulation: lifelong, mirror world, augmented reality (AR), and virtual reality (VR). Opportunities within the metaverse as learning media in education include immersive interactive experiences, visualization, more economical risks and costs, unlimited space, and time, preventing academic violations, personalization, and promoting communication. Meanwhile, the possible challenges that will be faced are in the form of no boundaries for people involved in being lazy to move and other forms of neutral interaction.

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Introduction

After Covid-19, human life has undergone many big changes in society. As a result, the order of life in society has undergone significant changes, especially in education. Problems with various forms of outreach, access, and learning acceptance are among the inevitable effects of the societal disturbance caused by the Covid-19 pandemic regarding educational institutions (Lasmawan, 2019). However, there are still numerous pioneering initiatives being made. Accelerating the adoption of digital transformation in schools and the ecosystems that support them by keeping an eye on the dynamics of various technological advancements, the two-year pandemic, and the need to close access gaps for educational opportunities (Ainun et al., 2019). Education is currently not only collaborating with technology but has become a potential source for developing education in the digitalization

Vol. 9, No. 2 : June 2023
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pp. 396-407
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era. We are now in the fifth industrial revolution, marked by the life of the metaverse (a world of virtual communication without borders), powered by the internet, digital technology, computers, and other devices. This rapid technological advancement is beyond human understanding (Harianto, 2021).

Technology is a potential source to become an initiator of the development of society 5.0. According to Fukuyama Mayumi, the era of Society 5.0 is an era where globalization and the evolution of digital technology are marked by the existence of the Internet of Things (IoT), artificial intelligence and robotics which change values in society to become increasingly complex and diverse (Fuyukama, 2018). One of the challenges in the era of Society 5.0 is innovation in the field of education, where learning technology has become one of the assessment indicators for improving the quality of learning. Technology in learning activities is divided into three functions: as a learning tool, a means of science, and technology as a potential to get unlimited sources of information and communication (Akbar Endarto & Martadi, 2022; Salsabila & Agustian, 2021).

Learning technology that is currently developing is metaverse technology. Metaverse enables educators to explore, gain experience, and interact with others (Hwang & Chien, 2022). Neal Stephenson originally referred to the metaverse in his novel Snow Crash. Linden Labs' video game Second Life, released in 2003, later made the metaverse well known. Since then, the metaverse has manifested itself in numerous ways, but interest in it has risen globally in recent years (Narin, 2021). Even though the term metaverse has been around for a long time since being introduced by Mark Zuckerberg, the term metaverse has gained popularity after he officially launched the idea in October 2021 on his platform. Many academics incorporate future goals and implementation scenarios into their teaching methods (Tlili et al., 2022). Because of this, the metaverse was adopted and increasingly used in educational settings at all levels of education. Students can learn more interesting, entertaining, and participatory in a virtual world that incorporates game components while developing their imagination, individual and collective intelligence, and short-term memory (Diaz et al., 2020; López-belmonte, 2023).

Many countries continue to innovate learning through the metaverse, including Indonesia. The metaverse application to education in Indonesia is still minimal due to several factors. Reporting from Tempo.co, Budi Trikorayanto as an education observer, said that education in Indonesia is still in the era of society 2.0, where conditions in the field occur that teachers are still the main resource, not facilitators, companions and encouragement in the learning system (Tempo.co, 2020). It is also proven from data on the ranking of the quality of education in the world by the World Population Review, attended by 78 countries where Indonesia is ranked 54th in 2021 (World Population Review, 2023). However, Indonesia is still trying to apply the metaverse in education. The creation of the Indonesian metaverse ecosystem will take place in stages within Indonesia (Akbar Endarto & Martadi, 2022). A business that develops augmented reality (AR), virtual reality (VR), and artificial intelligence (AI) technologies called PT WIR Asia Tbk (WIR Group) believes that the Metaverse ecosystem will mature in five to six years. The WIR Group collaborated with several stakeholders to create Indonesia's metaverse ecosystem. As the initial step in creating Metaverse Indonesia in the educational space, one WIR Group is working with Trisakti Multimedia School or Trisakti Communication Media High School (Rachmadtullah et al., 2022). The government continues to make efforts so that Indonesia can adjust itself to enter the era of society 5.0 by providing an independent curriculum in which there is freedom of learning. The independent curriculum is a curricular structure more adaptive to digital

Vol. 9, No. 2 : June 2023
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pp. 396-407
Email: jklppm@undikma.ac.id

developments. This curriculum emphasizes basic knowledge, character development, and student competency (Sakti, 2022).

With the development of this metaverse, it is possible to use it in education, which means that it is necessary to study it in depth to improve the quality of education through the metaverse. Particularly in Indonesia, metaverse-based education is still less common, despite how important it is to increase students' understanding and interest in learning. This study aims to analyze the potential of metaverse technology in education to transform learning media in Indonesia.

Research Method

This research used a qualitative approach with descriptive methods. The type of research used was a literature search. Library research is an information-gathering activity in the form of scientific writing related to a literature review with the nature of the literature (Ridwan et al., 2021). The source of data used was secondary data. The secondary data came from scientific articles indexed by Scopus and Sinta, published within the last five years from January 2018 to February 2023, relating to metaverse implementation in education. A total of 15 articles were determined as primary references, consisting of 6 scientific articles indexed by Sinta and nine scientific articles indexed by Scopus. The data analysis technique used in this research was qualitative data analysis with Braun and Clarke thematic analysis. Thematic analysis is a method for identifying, analyzing, and reporting thematic patterns in data. The thematic analysis steps include introducing data, coding, searching for themes, reviewing themes, and discussing and determining themes (Clarke & Braun, 2021).

Results and Discussion

The research results that will be presented are divided into two tables which will place the journals conducted in the literature review. Table 1 will display the primary references to the research results, including the article's year of publication, the journal's name, and the publication type. After that, table 2 will display the results of the literature review analysis, including the author's name, research design and results.

Table 1. The Main References to the Research Results

Year	Journal's name	Number of articles	Issue type
2021	Journal of Educational Evaluation for Health Professions	1	Q2
2022	International Conference on Information and Communications Technology (ICOIACT)	1	Q2
2023	International Journal of Innovative Research and Scientific Studies	1	Q3
2023	Journal of Computers in Education	1	Q1
2022	Interactive Learning Environments	1	Q1
2023	Procedia Computer Science	1	Q2
2022	Jurnal Kewarganegaraan: Universitas Sultan Ageng Tirtayasa	1	S5
2022	Jurnal Basicedu	1	S5
2022	JIIP (Jurnal Ilmiah Ilmu Pendidikan)	1	S4
2023	Kesatria: Jurnal Penerapan Sistem Informasi (Komputer dan Manajemen)	1	S4

Table 1 explains the year the journal was published, the journal's name and the index of the journal. Furthermore, table 2 below will reveal the authors' names, research methods and research findings related to implementing the metaverse in the education sector.

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pp. 396-407
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Table 2. Table of results of analysis of research articles

No	Author	Method	Research findings
1	Bokyung Kye, Nara Han, Eunji Kim, Yeonjeong Park, Soyoung Jo	Qualitative	Metaverse can be implemented in the field of education, 4 types of metaverse that can be used: augmented reality, lifelogging, mirror world, and virtual reality.
2	Dyandra Maheswari, Frangklyn Blair Febri Ndruru, Dewi Sri Rejeki, Jurike V. Moniaga, Bakti Amirul Jabar	Systematic literature review	Metaverse can be implemented in the field of education by integrating the Internet of Things (IOT) into learning.
3	Reza Rachmadtullah, Bramianto Setiawan, Andarmadi Jati Abdhi Wasesa, Jatu Wahyu Wicaksono	Descriptive qualitative	Metaverse can be implemented in the field of education, especially to help improve learning performance for teachers
4	Raghad Alfaisal, Haslinda Hashim, Ummu Husna Azizan	Systematic literature review	Metaverse can be implemented in the field of education. The strong influence of the metaverse in higher education facilities on student achievement and educational outcomes.
5	Zhisheng Chen	Qualitative	Metaverse can be implemented in the field of education, but there are problems encountered, including difficulties in technology development, interaction problems, content production, game addiction, privacy, and ethics
6	Cindy Amanda Onggirawan, Jocelyn Michelle Kho, Arya Putra Kartiwa, Anderies, Alexander A S Gunawan	Systematic literature review	Metaverse can be implemented in the field of education, can develop skills in the use of technology and increase the value of significant student practice
7	Fadilah Hapidz, Fadly Mulyana Akbar ,Waisul Kurni Maulidi, Roulina Magdalena Siburian, Hesti Puspitasari	Survey	Metaverse can be implemented in the field of education, but in practice metaverse reaps pros and cons. In big cities, adaptation to the metaverse will take place quickly. On the other hand, in villages where there is not much access to technology, many of them have difficulty adapting.
8	Yose Indarta, Ambiyar Ambiyar, Agariadne Dwinggo Samala, Ronal Watrianthos	Study of literature	Metaverse can be implemented in the field of education, it is believed that it can overcome the limitations that exist in the world of education, such as limited class capacity due to the pandemic, limited distance and time to enter class, and so on
9	Dodi Setiawan	Study of literature	Metaverse can be implemented in the education sector, Metaverse's popularity has peaked in recent months, and the acceleration of

			Metaverse technology in the world of education can be observed with the application of digital learning media based on augmented reality and virtual reality
10	Brian Sebastian Salim, Filbert Ivander, Alex Cahyadi	Descriptive qualitative	Metaverse can be implemented in the field of education, this can be done by increasing platforms and supporting media through training and introduction to the world of distribution, communication, and evaluation of current work for future changes

Technological Metaverse Perspective in Education

Currently, the world of media is home to the world of education. How we learn has evolved from conventional approaches, such as lectures, to more contemporary methods, such as interactive learning media. If implemented correctly and with students' requirements in mind, the Metaverse can deliver the best digital technologies to help education (Hirsh-pasek et al., 2022). STEM education, lab simulation, and the development of procedural skills (like surgery) are early applications of a metaverse in education that have remarkable results regarding training speed, performance, and retention with metaverse technologies (Logishetty et al., 2019). To transcend the limitations of 2D platforms, new distance learning models that leverage the Metaverse may also emerge. Co-owners in this virtual environment and co-creators of customized and flexible curricula in virtual online 3D rich alternative known as meta-education are students who were enabling having active learning experiences (Aripidi et al., 2022).

The existence of Metaverse can improve existing learning technologies and media, especially in increasing their effectiveness. Because of the simulations it generates, Metaverse is even more helpful in encouraging soft skills development and promoting increased self-awareness. While the Metaverse is another option for distance learning, it currently lacks success because it does not allow teacher and student interaction during the learning process (Setiawan, 2022).

Implementation of Metaverse in Interactive Learning Media

The most well-liked metaverse application now employed in education is audiovisual-based instruction. In experience-based education, for example, it is vital to see and read and feel. Therefore, learning will be more successful if there is a hands-on activity or simulation. Metaverse technology can help with this simulation (Indarta et al., 2022). Currently, there are four types of simulations in the metaverse that can become potential in the world of education, namely life longing, mirror world, augmented reality (AR), and virtual reality (VR), where these four simulations can become types of services to bring together new technologies (Iswanto et al., 2022).

1) Lifelogging

Lifelogging is part of the metaverse that performs functionally like social media. Examples of lifelogging include Instagram, Twitter and Facebook applications (Kye et al., 2021). An example of the use of lifelogging in education is "Classting", an artificial intelligence (AI) created in Korea. This "Classting" application can allow users to

Vol. 9, No. 2 : June 2023
E-ISSN: 2442-7667
pp. 396-407
Email: jklppm@undikma.ac.id

analyze students' learning achievements and provide learning appropriate to the level of ability in all subjects studied (Barlian et al., 2022).

2) Mirror world

The metaverse's mirror world is a depiction of the real world, bringing its appearance, content, and physical structure into the virtual realm as a simulation of real-world daily life (Yu, 2022). Examples of the use of the metaverse mirror world used in the field of education are "digital laboratories" and "virtual educational spaces". *Digital Laboratories* are a technology that can bring together users to contribute to the scientific field of research through games. Virtual educational spaces are part of the mirror world commonly found; applications such as Zoom, google meet, and Teams are part of virtual educational spaces (Kye et al., 2021).

3) Augmented Reality (AR)

A metaverse technology called augmented reality (AR) can project or show two or three-dimensional virtual items in the real world in real time (Sari et al., 2020). The augmented reality subsystem is one of the uses of augmented reality in biology learning. It focuses on helping students comprehend the construction of a microscope and master their experimental techniques before entering the laboratory. The goal is mobility and simplicity. From cell analysis to experimental results, the augmented reality subsystem positively impacts students' knowledge of theoretical lectures; it can be used before or after school without being limited by space or time (Zhou et al., 2020).

4) Virtual Reality (VR)

Technically, virtual reality is a computer-generated 3D environment presented to users interactively. It refers to a computer simulation featuring an environment where a person can walk and interact with the computer-generated objects and people being simulated (avatars). Virtual reality tries to manipulate the real world into 3D environmental phenomena and displays (Kamińska et al., 2019). One of the uses in education is the field of nursing education. The combination of virtual and physical components allows students to practice clinical case scenarios safely both in class and in the laboratory (Rachmatullah & Sukihananto, 2020).

Opportunities and Challenges of the Metaverse as a Medium of Learning in the Field of Education

The advancement of metaverse technology has impacted many facets of human existence, including communication, entertainment, travel, social media, gaming, and education. The employment of new technology will undoubtedly have both good and bad consequences for its users. Metaverse technology is projected to give several benefits and advantages. Nevertheless, this does not imply that the metaverse has been executed flawlessly, as there are flaws. The high cost of equipment, degrees of security and privacy, identity crises, effects on user psyche and physical health, and consequences on morals and ethics are all examples of metaverse flaws (Pratiwi Amalia Putri, 2021).

Metaverse technology, a new technology implemented in the world of education, requires the education system to make a revolution to maintain accessibility and expand its existence. Metaverse educational opportunities include immersive interactive experiences, visualization, more economical risks and costs, unlimited space and time, preventing academic violations, personalization, and promoting communication (Lin et al., 2023). Furthermore, in research conducted by Indarta, it was shown in his study that the Metaverse is considered capable of overcoming limitations, opportunities, and challenges in the field of education, such as limited class capacity, limited distance, and time of attendance in class due

Vol. 9, No. 2 : June 2023
E-ISSN: 2442-7667
pp. 396-407
Email: jklppm@undikma.ac.id

to the pandemic. With the help of the virtual world concept, online learning can be carried out more interactively without eliminating students' learning experience. The Metaverse is expected to enter many areas of human life in the next 10-15 years (Indarta et al., 2022).

There are four benefits to using metaverse education. First, training and practicing hazardous actions, such as piloting an aeroplane or carrying out procedures with a high chance of failure and severe repercussions. Second, relive unpleasant or counterproductive scenarios, such as dealing with difficult students or a demanding corporate client. Third, attempt the impossible, such as examining the human body's interior organs, travelling through space and time, studying history online, and gaining additional real-world experiences. Fourth, immersive VR is also recommended for experiences that are rare or prohibitively expensive, such as group field trips to tropical jungles or underwater wrecks (Mystakidis, 2022; Pangestu & Rahmi, 2022).

The many advantages of using the metaverse do not mean the technology is without drawbacks or risks. A common problem with using metaverse technology is that there are no limits to the people involved in laziness and other forms of neutral interaction. So, there are various challenges resulting from implementing the metaverse, especially those that occur in the field of education. Like offline lectures, education in the metaverse era faces challenges to students' moral education. Using metaverse-based technology will reduce the interaction between teachers and students, making it difficult to achieve such a learning ethos. If metaverse-based education is to be achieved, including managing students' time so that they are not negatively affected by metaverse technology, Parents must optimally carry out their supervisory function. The development of Indonesian education entering the metaverse era is a challenge that the government must prepare for. The readiness of human resources (HR), technology and infrastructure must be ready to support the implementation of digital education. In responding to technological developments in the metaverse era, universities must move positively towards regulating technology use (Ali et al., 2022). Metaverses that offer unlimited or unlimited space create greater levels of engagement that need to be achieved. As education moves into the metaverse, we must prepare for broader international engagement. Another challenge is the socio-economic status of the community. In the age of the metaverse, only some have access to it (Hapidz et al., 2022).

The Metaverse's Potential for Educational Growth in Indonesia

As a result of the availability of metaverse technology as a learning medium, the potential for learning outcomes and student motivation will be enhanced. It is possible to implement this technology in Indonesian schools, and the future of education will be enhanced as a result. Metaverse technology as a learning medium not only has the power to immerse us in a new environment, but also has the potential to enhance the quality of education by providing greater learning opportunities than ever before (Rachmadtullah et al., 2023)

Several pertinent studies discuss the implications of the metaverse in Indonesia, Indarta et al. (2022) show that the metaverse is believed to be able to overcome the limitations that exist in the world of education, such as limited class capacity due to the pandemic, limited distance and time to enter class, and others. With the notion of the virtual world, online learning may be conducted in a more participatory manner without removing the learner's learning experience. Moreover, according to Aripidi et al. (2022), augmented reality in health education takes the shape of virtual clothing, which may be used as an anatomy laboratory simulation to explore areas inside the body. Usage in the learning environment includes new social communication spaces, more flexible production and

Vol. 9, No. 2 : June 2023
E-ISSN: 2442-7667
pp. 396-407
Email: jklppm@undikma.ac.id

sharing environments, and extra virtual experiences. According to Barlian et al. (2022), education in the metaverse period is no longer constrained by place and time; thus, all educational institutions will compete internationally, with the winner being determined by the quality of education provided.

Table 3. Conceptual technology from the metaverse of augmented reality types and educational implications

Conceptual technology	Practical implications in education
Overlay virtual objects in the real world to create 3D and real objects	Learn visually and 3-dimensional invisible parts through virtual digital information, and solve problems effectively
Adding fantasy to threads	Through experience, students might get a profound comprehension of topics that is difficult to notice or express in writing
Successfully highlights and promotes information and convenience	Immersion in the learning environment enables interactive activities such as reading, writing, and speaking

Table 4. Conceptual technology from the metaverse of the type of lifelogging and educational implications

Conceptual technology	Practical implications in education
One's everyday life and ideas are constructively pleased and shared through social media and SNS	Reviewing and reflecting on one's everyday activities, enhancing one's capacity to represent and use knowledge in suitable ways, and receiving feedback from others on social networks all result in reinforcement and appreciation
Network technologies establish links with others online, facilitate rapid communication, and document a variety of social activities	Examine diverse facts on the lifelogging platform with skepticism and creatively rebuild information using collective intelligence
Personal activity data is gathered and analyzed using a variety of internet-connected sensors of items and wearables to generate added value	Instructors promote personalized learning based on student learning log data, offer necessary help, and reduce dropouts

Table 5. Conceptual technology of the mirror world metaverse and educational implications

Conceptual technology	Practical implications in education
Combines GPS and network technologies to extend the actual world	Learning occurs in the metaverse of a mirror world to overcome the geographical and physical constraints of teaching and learning
Real-world cyberspace implementations resemble reflections for a specific purpose	Real-time online courses facilitated by online video conferencing and collaboration platforms (Zoom, WebEx, Google Meet, Teams) that replicate the real world
effectively expand the real world to enhance fun and play, flexibility in management and operations, and collective intelligence	With mirror worlds, students may actualize "learning via creation" (for example, in Minecraft, students construct and rebuild historical monuments such as Bulguksa, Gyeongbokgung, Cheoyeongdae, Taj Mahal, and Eiffel Tower). People may interact with their digital legacy and increase their knowledge of history and culture.

Vol. 9, No. 2 : June 2023
E-ISSN: 2442-7667
pp. 396-407
Email: jklppm@undikma.ac.id

Table 6. Conceptual technology of the metaverse of virtual reality types and educational implications

Conceptual technology	Practical implications in education
Using improved computer graphics, particularly in a virtual world utilizing 3D technology, players may enjoy a variety of games through interfaces that are seamlessly integrated	Exercises can be conducted via virtual simulation in situations that are costly and dangerous to produce (e.g., fire locations, flight controls, hazardous operations, etc.)
In spaces, eras, civilizations, and characters built differently from reality, they function as avatars as opposed to their genuine selves, and have numerous personalities	Users can enjoy immersive experiences of time and space, such as the past or the future, that cannot be experienced in reality
Virtual reality includes chat and communication capabilities for communicating and collaborating with AI characters and others	Users develop their strategic and comprehensive thinking skills, problem-solving abilities, and real-world skills through playing games based on 3D virtual environments (according to the features and types of games designed)

Conclusion

This study concludes that the existence of the metaverse can improve existing learning technologies and media in Indonesia, especially in increasing their effectiveness. Metaverse, if used properly and by considering the needs of students, will have the potential to present the best digital technology to support education. Implementing the metaverse in interactive learning media in Indonesia is divided into four types of simulation: lifelong, mirror world, augmented reality (AR), and virtual reality (VR). Lifelogging is part of the metaverse, which generally has the same functional performance as social media. The mirror world is a simulation of real everyday life. AR is a metaverse technology integrating two-dimensional or three-dimensional objects into a real environment. VR is a computer-generated 3D environment that is presented to users interactively. Opportunities for the metaverse as a medium of learning in the field of education include immersive interactive experiences, visualization, more economical risks and costs, unlimited space, and time, preventing academic violations, personalization, and promoting communication. Meanwhile, the possible challenges that will be faced are in the form of no boundaries for people involved in being lazy to move and other forms of neutral interaction.

Recommendation

The findings of a potential study on the metaverse's involvement in the transformation of learning media may be used by educational activists to maximize the usage of metaverse technology across all subject areas. Educational curriculum creators may incorporate metaverse applications as teaching tools for educators to build a good learning environment in the classroom. Additionally, education policymakers must carefully examine how students perceive the metaverse, what they want to accomplish there, why they enjoy it, and how much value they place on their virtual reality avatars. It is vital to investigate student activity patterns and the influence they have on student learning activities. Additionally, one of the most influential and intriguing aspects of the metaverse is that it allows us to experience impossible or constrained situations in the actual world. Nonetheless, there is room for naively adopting content creators' or service designers' goals rather than students' cognitive

Vol. 9, No. 2 : June 2023
E-ISSN: 2442-7667
pp. 396-407
Email: jklppm@undikma.ac.id

talents and creativity. To solve issues or carry out projects collaboratively and creatively, instructional designers and instructors who seek to use the metaverse for education must have a strong grasp of each sort of technological characteristic and class design of the metaverse. Therefore, creating an educational metaverse platform is required to avoid exploiting student data. A data-gathering assessment study is also required to assist the teaching and learning process.

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