Hipkin Journal of Educational Research
http://ejournal-hipkin.or.id/index.php/hipkin-jer/

Potential of the metaverse in enhancing learning experiences

Deden Riandi Putra[1], Ilhamuddin Marzuq[2], Salwa Tsabitah Navisa Eka Putri[3]
[1,2,3]Universitas Pendidikan Indonesia, Bandung, Indonesia
dedendoega26@upi.edu[1], ilhammarzuqqq@upi.edu[2], salwats@upi.edu[3]

ABSTRACT

Metaverse is nothing new, but it has only been widely discussed by people recently. Technology that continues to develop and is driven by influential people has made this technology attract the world's attention for its presence. It cannot be denied that in the current era, humans or not, like or not, live side by side with technology. Technology can be used by people of various ages and in various fields, including the field of education. The increasing demands in the world of education mean that the learning given to students must be more meaningful and reflect the daily life they go through to become functional human beings when they enter society. Metaverse is a new way to provide meaningful learning to students. Metaverse presents an authentic environment in a virtual world that allows students to continue interacting while learning more enjoyably. This can trigger students to be more enthusiastic about learning, and teachers can use various learning methods so the class does not get bored. This research uses a literature study method. This research aims to discover how Metaverse can play a role in the world of education.

ARTICLE INFO

Article History:
Received: 14 Aug 2024
Revised: 10 Nov 2024
Accepted: 17 Nov 2024
Available online: 5 Dec 2024
Publish: 30 Dec 2024
Keyword:
education; Metaverse; technology

Open access
Hipkin Journal of Educational Research is a peer-reviewed open-access journal.

ABSTRAK

Teknologi yang terus berkembang mendorong penggunaannya pada bidang pendidikan untuk memberikan pengalaman pembelajaran yang lebih bermakna dan mencerminkan pada keseharian yang mereka lalui agar dapat menjadi manusia yang dapat berguna saat terjun ke lingkungan masyarakat. Metaverse dapat dijadikan sebagai solusi permasalahan tersebut dengan menghadirkan lingkungan yang sebenarnya pada dunia virtual dan memungkinkan kolaborasi peserta didik. Implementasi metaverse dalam pembelajaran tidak berjalan mulus, terdapat beberapa kendala yang dijumpai. Penelitian ini menyoroti konsep metaverse dalam pendidikan mencakup manfaat penggunaan, platform pembelajaran, tantangan, dan solusi penerapannya. Penelitian ini menggunakan metode studi literatur untuk mendapatkan hasil penelitian secara luas. Sumber yang digunakan berasal dari artikel jurnal ilmiah terbaru yang disaring dengan kriteria khusus. Temuan penelitian metaverse sebagai media pembelajaran yang menyenangkan dan memiliki berbagai platform dengan visual 3D memerlukan dukungan untuk pengembangan sumber daya. Dukungan dari pemerintah untuk menciptakan kurikulum dan kebijakan kemajuan teknologi pendidikan sangat diperlukan untuk mendukung penggunaan metaverse dalam media pembelajaran di Indonesia.

Kata Kunci: *Metaverse; pendidikan; teknologi*

How to cite (APA 7)
Putra, D. R., Marzuq, I., & Putri, S. T. N. E. (2024). Potential of the metaverse in enhancing learning experiences. *Hipkin Journal of Educational Research, 1*(3), 275-286.

Peer review
This article has been peer-reviewed through the journal's standard double-blind peer review, where both the reviewers and authors are anonymised during review.

INTRODUCTION

Technology continues to evolve year after year, bringing new dimensions to everyday life across various sectors, including education. It has now become commonplace for humans to coexist with technology, especially as we enter the era of Society 5.0, introduced by the Japanese government in January 2016. This concept envisions a society in which technology and humans coexist harmoniously to sustainably enhance the quality of life. Society 5.0 emphasizes that technology should not be viewed merely as a machine or a tool for accessing information. Instead, it has become an integral part of human existence. The integration of technology in education can enrich students' learning experiences through enhanced interaction with teachers and peers. (Santoso, 2022).

The rapid advancement of technology has brought the concept of the metaverse to prominence. Although the metaverse is not a new technological phenomenon, it has only recently gained widespread attention, particularly after Facebook founder Mark Zuckerberg rebranded the company as Meta as part of his investment in metaverse technology. The term "metaverse" does not merely refer to a virtual environment operated by a social media company, but encompasses the entire spectrum of augmented realities (Kraus et al, 2022). Note, the metaverse enables people to connect without spatial or temporal boundaries. It can be described as a virtual environment, also known as a Multi-User Virtual Environment (MUVE), that adopts the format of Massive Multiplayer Online Role-Playing Games (MMORPGs). This format allows a large number of individuals to interact within a shared three-dimensional virtual space through their avatars, made possible by the integration of Augmented Reality (AR), Virtual Reality (VR), and the Internet. (Gattullo et al, 2022).

The Metaverse, along with other supporting technologies, allows users to experience the sensation of being in a highly realistic virtual environment. However, three aspects distinguish the Metaverse from AR or VR. First, VR focuses on physical approaches and rendering, whereas the Metaverse emphasizes services that provide content with sustained social meaning. Second, although it can integrate AR and VR technologies, the Metaverse can also exist independently, meaning it does not necessarily require AR or VR to function. Third, the Metaverse is a scalable environment, capable of accommodating large numbers of people simultaneously, which is crucial for supporting and reinforcing the social significance that the Metaverse has promoted from its inception (Pangestu & Rahmi, 2022).

The field of education has also been profoundly influenced by technological advancements, making the two inseparable. Innovators have leveraged emerging information technologies to enhance educational standards. The integration of technology, particularly the metaverse, has made educational implementation more accessible and engaging. The metaverse introduces new experiences and creates realistic learning environments for students (Endarto & Martadi, 2022). Several design principles must be applied when developing metaverse-based learning media using AR and VR technologies, including typography, layout, design principles, color, and the perception of space and form. The use of virtual reality (VR) in distance learning has become increasingly widespread, aiming to bridge the gap between students and teachers, as well as among students themselves. (Putri et al, 2024).

The development of metaverse-based learning media has fostered innovation that advances the field of education. However, this progress does not necessarily ensure the smooth implementation of the metaverse in learning contexts. One study identifies technology as the primary challenge in applying metaverse-based education in Indonesia (Putri et al, 2024). Other research indicates a growing interest in supporting the use of metaverse-based learning media (Setyowati et al, 2023). Building upon these findings, further investigation is needed to address the challenges and propose viable solutions for implementing metaverse technologies in educational media and learning platforms. Accordingly, this study

explores the concept of the metaverse in education, focusing on its benefits, learning platforms, challenges, and practical solutions for effective integration.

LITERATURE REVIEW

The Concept of the Metaverse in Education

The metaverse is a conceptual virtual environment composed of digital worlds that facilitate interaction among users through digital media such as Augmented Reality (AR), Virtual Reality (VR), and online virtual spaces. In the context of education, the metaverse serves as a platform where learners and educators can engage in immersive three-dimensional environments. The origins of the metaverse can be traced back to science fiction literature and the conceptualization of virtual worlds. Initially, the metaverse existed only as a futuristic idea depicted in novels and films. However, with the advancement of technologies such as the internet, artificial intelligence, and virtual reality, this concept has begun to materialize within the digital realm. In recent years, the metaverse has garnered significant attention in the educational sector as a medium for enhancing teaching and learning processes. By providing more immersive and engaging learning experiences, the metaverse holds the potential to transform the overall paradigm of education. (Putri et al, 2022).

The application of the metaverse in education involves the utilization of VR, AR, and virtual world technologies to create more interactive and immersive learning environments. Educators can present instructional materials in three-dimensional formats, enabling students to engage directly with the content. The metaverse offers numerous advantages for the educational sector by providing more profound learning experiences that facilitate students' understanding of abstract concepts. Other benefits include enhanced student engagement, real-time feedback, and the development of practical skills through virtual simulations. Moreover, the metaverse integrates technologies such as virtual reality, augmented reality, and 3D virtual environments to deliver more engaging teaching methods. Educators can design learning experiences tailored to individual learning styles, thereby improving information retention and conceptual understanding. The metaverse also introduces flexibility in structuring and accessing learning materials, as virtual spaces allow students to learn anytime, anywhere, and in ways that best align with their personal learning preferences. (Elman, 2024).

The Benefits of Using the Metaverse

When designed and implemented effectively by educators, the metaverse can yield optimal outcomes, benefiting both students and teachers, as well as all stakeholders involved in the learning process. The integration of the metaverse in education offers several distinct advantages: a) Expanding learners' freedom and experiences without limitation. Students are encouraged to engage in autonomous learning, enabling them to explore their questions and curiosities independently, fostering endless opportunities for inquiry and discovery; b) Providing diverse and enriching learning experiences. The metaverse serves as an alternative to overcome the limitations of conventional online learning, offering an enjoyable and interactive approach through 3D media that enhances engagement and motivation; c) Creating new experiences that transcend space and time. This technology enables the simulation of real-world environments that would otherwise be challenging to replicate in a classroom setting, providing students with novel experiences. Furthermore, metaverse-based learning can occur anytime and anywhere, as long as an internet connection is available; and d) Addressing the limitations of conventional virtual technologies. Traditional 3D-based virtual technologies often fail to deliver an optimal learning experience when students navigate virtual worlds. The metaverse overcomes these shortcomings by providing a more immersive, realistic, and interactive learning environment. (Kurniawan & Sutabri, 2024).

The metaverse fosters deeper and more sustainable knowledge acquisition. Additional benefits that can be derived from its implementation include: a) Reducing costs. Distance learning through the metaverse eliminates the need for students to incur expenses on transportation or other physical costs. Learners can participate in classes comfortably from their own locations, making education more accessible and cost-effective; b) Accommodating unforeseen circumstances. In everyday life, unpredictable situations—such as the COVID-19 pandemic that once disrupted global activities, including education—can significantly hinder learning processes. With the metaverse, both educators and students can continue the learning experience seamlessly, regardless of external disruptions; and c) Reducing racial discrimination. Students often face challenges adapting to new environments, particularly when studying in different cities or abroad, where racial bias may occur. The metaverse mitigates such risks by enabling learners to interact and engage in virtual spaces without the necessity of face-to-face encounters, thereby fostering a safer and more inclusive educational environment. (Dewi, 2024).

Metaverse Platform

Several major platforms have emerged to support the integration of the metaverse into the educational field. These include VRChat, AltspaceVR, and virtual environments such as Decentraland. Each platform offers distinct features, allowing educational institutions to select solutions that best meet their pedagogical and technical needs. The metaverse provides virtual spaces that facilitate collaboration between students and educators. Within these environments, participants can engage in real-time discussions, share ideas, and collaborate on joint projects. This opens opportunities for teachers to create collaborative and problem-solving spaces that foster active learning. Augmented Reality (AR) technology has also been introduced as a key element in educational metaverse platforms. AR integrates digital elements into the physical world, producing more interactive and visually engaging learning experiences. By overlaying digital information onto physical objects, AR enriches educational content and enhances students' comprehension of complex scientific concepts through dynamic visual representations (Gonaygunta et al, 2023).

Augmented Reality (AR) technology enhances student engagement through visual interaction. The ability of learners to observe and interact with physical objects enriched by digital information creates more engaging and contextually relevant learning experiences. In supporting virtual collaboration, AR enables students to work together on shared projects, exchange ideas, and co-construct knowledge within educational metaverse environments. Metaverse platforms should be carefully designed to align with instructional materials and learning objectives established in official curricula. When selecting or developing metaverse platforms for educational purposes, it is essential to ensure they are adaptable to diverse user needs. This includes accessibility for students with varying skill levels, learning preferences, and individual requirements. The integration of AR in education offers realistic and immersive experiences through three-dimensional imagery, fostering a more profound understanding and active participation in the learning process (Syahputra et al., 2024).

Challenges and Barriers of the Metaverse in Education

Considering the numerous advantages embedded within the metaverse concept, this medium stands out as a platform with significant potential to enhance the quality of education. In promoting more effective learning, particularly within experience-based educational contexts, the metaverse offers an appealing solution. Learning models that require students to go beyond traditional methods, such as reading and observing, by engaging in active interaction, can be effectively supported through metaverse-based environments. However, alongside its positive potential, the integration of the metaverse in education presents several challenges. Its borderless nature creates limitless virtual spaces that demand higher

levels of engagement, while simultaneously introducing new complexities that educators and institutions must address. Moreover, inequality of access remains a significant barrier, particularly given the diverse socioeconomic conditions among learners. The adoption of the metaverse in education may also reshape established educational paradigms, necessitating broader societal understanding and acceptance of this emerging technology (Solechan & Putra, 2022).

Although the metaverse offers limitless opportunities for participation, not everyone may have equal access in the metaverse era. A simple example can be seen when university students experience internet connectivity issues during online classes, indicating that technical and infrastructural barriers remain significant challenges to implementing the metaverse in education. Addressing these issues requires deliberate efforts to ensure that all participants are equipped to overcome potential technical constraints. However, the challenges of integrating the metaverse into education extend beyond technical and connectivity concerns. Other issues include the rise of cybercrime, data security and privacy risks, and the physical side effects some individuals may experience when using metaverse devices, such as motion sickness. Therefore, despite its vast potential, implementing the metaverse in education requires a careful and holistic approach to navigate these challenges effectively. Such an approach is essential to cultivate graduates who are not only technologically adept but also possess strong character and broad intellectual insight (Herlambang & Abidin, 2023).

Teacher Training in the Metaverse

Recognizing the profound transformation that the metaverse brings to education, teacher training has become increasingly essential. Enhancing digital literacy and developing a deep understanding of the metaverse's potential will enable educators to integrate this technology into their teaching strategies effectively. Teachers must cultivate technological competencies that include familiarity with metaverse platforms, proficiency in using virtual tools, and the ability to design learning environments that leverage these technologies. Training programs focused on these aspects can help teachers become effective facilitators within metaverse-based learning contexts. Well-structured professional development initiatives can equip educators with strategies to utilize the metaverse in education more meaningfully. By leveraging unique features such as simulations, virtual field trips, and online collaboration, teachers can create more engaging, memorable, and contextually relevant learning experiences for their students (Rewara et al., 2024).

Teacher training must also encompass a thorough understanding of the ethical considerations involved in the use of the metaverse. Educators should be equipped with ethical knowledge to guide their behavior within virtual environments, particularly in terms of managing student data security and privacy. Training within the metaverse can catalyze enhanced collaboration among teachers, fostering the exchange of knowledge and successful strategies that collectively support the integration of technology in educational settings. Evaluating the effectiveness of teacher training is a critical step, as determining whether the program has achieved its objectives allows for continuous improvement and adjustment of training initiatives. Furthermore, teacher training in the metaverse must be supported by curriculum reforms and educational policies that facilitate the integration of technology. This process requires close collaboration among educational institutions, government bodies, and other key stakeholders to ensure the sustainable and ethical implementation of metaverse-based education (Rewara et al, 2024).

The Future of the Metaverse in Education

In the future, the metaverse is expected to continue evolving as a significant driver of virtual learning, enhancing educational processes and making them more effective and efficient. Virtual learning has already gained widespread use, particularly in the fields of education and professional training. The metaverse holds immense potential to revolutionize education through personalized learning experiences. By integrating artificial intelligence, the metaverse can tailor educational content to meet the unique needs, preferences, and learning styles of individual students. Metaverse-based environments also enable virtual simulations and experiments, providing learners with immersive, hands-on experiences that carry no physical risk. Such applications enhance the understanding of complex concepts and bring academic material to life. Currently, the development of virtual reality (VR) and artificial intelligence technologies continues to advance, aiming to deliver increasingly innovative and transformative learning experiences (Kurdi, 2021).

The metaverse has the potential to eliminate geographical boundaries in education, enabling learners from around the world to access the same educational resources without requiring physical presence in a specific location. The integration of accessibility features within the metaverse can further support students with special needs, fostering an inclusive environment that promotes diversity and equal access to learning opportunities. Moreover, the metaverse enables global collaboration among schools, allowing students to work together on joint projects with peers from around the world. Such interactions broaden cultural understanding and facilitate the exchange of ideas. Through the metaverse, learners can virtually visit educational sites worldwide, such as museums and historical landmarks, without leaving their own classrooms. These virtual field trips not only reduce the financial burden associated with traditional educational travel but also expand students' perspectives on diverse cultures and educational systems (Kurdi, 2021).

METHODS

The method employed in this study is a literature review, aimed at synthesizing theories and insights derived from relevant readings that align with the research focus. The use of the literature review method is appropriate for gaining a comprehensive theoretical understanding of the Metaverse (Ridwan et al, 2021). A literature review involves a series of activities related to collecting library data, reading, taking notes, and managing research materials. The steps in this study include searching for reading materials published within the last five years using the keyword "Metaverse education." The collected sources are then filtered according to specific criteria, namely, written in Indonesian, published in scientific journals, and containing discussions relevant to the themes of the Metaverse and education, to ensure the focus remains consistent with the research topic. Subsequently, content analysis is conducted by examining the discussions presented in the selected articles. The findings are then organized and presented in a tabular format to facilitate analysis, followed by the formulation of conclusions based on the reviewed materials.

RESULTS AND DISCUSSION

The results of the literature review in **Table 1** indicate that the implementation of the Metaverse began during the COVID-19 pandemic and has continued to evolve to this day, with various supporting platforms emerging. However, the implementation of the Metaverse in education in Indonesia has not proceeded smoothly, as several obstacles have been encountered, one of which is limited resources. The following table presents the findings from various pieces of literature related to the Metaverse, its challenges, and its future in the field of education:

Table 1. Results of the Literature Study

No.	Author	Research Results
1.	Rewara, N., Faridah, N. A., & Wijay, T. T. (2024)	The implementation of the Metaverse in education in Indonesia has not been smooth, as several challenges hinder its development, including the availability of infrastructure, institutional support, and the technological competence of human resources. Therefore, psychological, motivational, and social support are required.
2.	Hasannah, N., Afina, A. F., Nuraeni, P, & Hadiapurwa, A. (2024)	The COVID-19 pandemic, which affected the entire world, became a significant factor in the adoption of the Metaverse in education, leading to the rise of AR- and VR-based learning media. The concept of virtual learning through the Metaverse has enabled a more interactive and innovative learning experience.
3.	Yuda, U. W., Rhamadani, M., Pratama, M. B., & Sutabri, T. (2024)	The implementation of the Metaverse in learning has been proven to enhance student engagement, enrich learners' knowledge through innovative approaches, and facilitate collaborative distance learning.
4.	Erdwiyana, N. V., Fadhilah, A. I., & Bukhori, F. B. S. (2024)	The development of the Metaverse in learning is closely related to the era of Society 5.0, which has experienced rapid technological advancements, thereby supporting the emergence of interactive learning media that enhance motivation and promote enjoyable collaboration.
5.	Humaira, A., Haq, M. J., & Fitri, T. N. (2024)	The integration of the Metaverse into learning media has the potential to enhance interactive and creative learning experiences in higher education. The Metaverse is likely to support the effectiveness of learning media in improving learning outcomes.
6.	Setyowati, E., Fuada, S., Anwar, K., Danuarteu, M. D., Purba, S. T. F., & Wijaya, A. (2023)	The evaluation results of a public lecture addressing the theme of technology, particularly the Metaverse, indicate a strong interest among students in understanding the material, as the topic is currently gaining widespread attention.
7.	Wijayanto, P., Thamrin, H., Haetami, A., Mustoip, S., & Oktiawati, U. (2023).	The implementation of the Metaverse in learning supports the perspective of educational technology in Indonesia. The application of Metaverse-based learning media can be categorized into four main areas: lifelong learning, virtual screens, augmented reality (AR), and virtual reality (VR). However, this learning medium may also have adverse effects, such as reduced physical activity and decreased direct social interaction.
8.	Miko, N. A., Subroto, D. E., Rahayu, T. B., Umar, Z. A. M., & Nurhidayah, N. (2024)	Most students in Makassar experience anxiety when considering the potential use of E-learning (Metaverse) rather than utilizing it wisely.
9.	Kurniawan, C., & Sutabri, T. (2024).	The obstacles in implementing the Metaverse in learning do not have a significant impact, as in reality, this learning medium creates engaging learning experiences and supports students in collaborating.
10.	Saufi, A. ., & Santiani, S. (2024)	Research developments related to Islamic education within the Metaverse have increased significantly over the past five years, alongside growing interest in research topics involving AR and VR.
11.	Cahyani, D. A., Sari, D. M., & Rahma, D. F. (2024)	The use of GoMeta as a Metaverse learning platform is considered adequate and is expected to enhance the quality of learning.
12.	Putri, M. R., Farhan, A. A., & Hanif, S. M. (2024)	The use of the Metaverse in virtual learning enables direct interaction between students and teachers and can enhance learning outcomes. The main challenge in developing the Metaverse for educational purposes lies in the limitations of technological infrastructure.
13.	Susanti, D. A., Saleh, H. B., & Winoto, Y. (2023).	Not only can the Metaverse be applied in learning, but libraries can also utilize it to enhance their services. However, such implementation must take into account the readiness of librarians and the existing library infrastructure.

No.	Author	Research Results
14.	Praja, W. N., Affandi, A. F. M., & Gumelar, A. (2024)	The use of Augmented Reality (AR) in local wisdom-based learning media demonstrates students' interest in learning local wisdom interactively, thereby enhancing their motivation to learn.
15.	Panuntun, S., & Sipayung, Y. R. (2023)	The use of the Metaverse in learning offers significant opportunities to develop and advance education in Indonesia.
16.	Alinata, R. H., & Marsudi, M. (2024)	The development of online game-based promotional media (Roblox) utilizing VR has been found effective in promoting SMP Negeri 3 Sumenep.
17.	Judijanto, L., Sitepu, E., & Baruno, Y. H. E. (2024	International collaboration in facilitating innovation and implementing VR technology in education has had a significant impact on advancing the field of education, despite facing various challenges.
18.	Amirurrahmah, S. D. E., Zakha, F. & Bayani, N. (2024)	The implementation of the Metaverse in education has demonstrated positive impacts, supporting interactive learning environments that enable future career development, educational innovation, and paradigm shifts.
19.	Khaira, M., Lesmana, D. C., & Agustina, P. (2024)	Challenges in implementing the Metaverse in the field of education need to be addressed carefully to ensure optimal learning benefits.
20.	Fauziah, D. P. N., Yulianto, M. D., & Fasha, S. A. (2024)	The implementation of the Metaverse in education is highly beneficial, providing lasting impacts by enabling students to participate actively in learning. Therefore, curriculum adjustments are necessary to integrate the use of the Metaverse in education.

Source: Research, 2024

Discussion

The history of the Metaverse dates back to science fiction literature and the concept of virtual worlds. However, with technological advancements, particularly in the internet, artificial intelligence, and virtual reality, the Metaverse has become a reality in the digital realm. In recent years, particularly during the era of Society 5.0, rapid technological development has garnered significant attention from the education sector as a means to enhance innovative teaching and learning methods (Erdwiyana et al., 2024). The Metaverse contributes to educational development, although its implementation must still address issues such as data security, ethics, and potential gadget addiction (Camilleri, 2023; Lin et al., 2022; Zhang *et al.,* 2022). The pandemic has had a significant impact on the development of the Metaverse in education (Hasannah et al, 2024). The Metaverse creates a platform where learners and educators can interact within immersive 3D environments, enhancing learning experiences and transforming the overall educational paradigm (Kurdi, 2021).

The utilization of VR, AR, and virtual world technologies within the Metaverse creates a more interactive and immersive learning environment. Educators can present instructional materials in 3D formats, allowing students to interact directly with the content. The advantages of the Metaverse in education include more profound learning experiences, increased student engagement, immediate feedback, and the development of practical skills through virtual simulations (Yuda et al, 2024). The application of the Metaverse in learning provides distinct and engaging experiences, which can potentially enhance students' learning outcomes. (Humaira et al., 2024).

Several benefits of using the Metaverse in education include: 1) Independent learning experiences: The Metaverse allows students to explore their own questions, providing in-depth self-directed learning (Fauziah et al, 2024); 2) Innovative learning experiences: The Metaverse serves as an engaging alternative to 3D-based digital learning, offering unique and enjoyable learning experiences (Kurniawan & Sutabri, 2024); 3) Boundless in space and time: It enables learning to occur anytime and anywhere (Yuda

et al, 2024); 4) Overcoming limitations of 2D virtual learning: By presenting 3D learning concepts, the Metaverse delivers optimal learning experiences for students (Hasannah et al, 2024); 5) Reducing transportation and accommodation costs: It makes field-based learning more affordable (Kurdi, 2021); 6) Accommodating unforeseen circumstances: The Metaverse ensures learning continuity during events such as pandemics (Hasannah et al, 2024); and 7) Protecting students from racial discrimination: This is particularly beneficial for learners in unfamiliar environments (Dewi, 2024).

Major platforms, such as VRChat, AltspaceVR, GoMeta, E-learning, and Decentraland, support the integration of the Metaverse in education, providing virtual spaces for collaboration between students and teachers (Cahyani et al., 2024). AR technology is also integrated to offer more interactive and visually engaging learning experiences (Praja et al, 2024). However, the use of the Metaverse in education faces several challenges. Its borderless nature demands higher levels of engagement while introducing new complexities. Challenges include unequal access, data security and privacy concerns, and individual physical responses to Metaverse devices. These challenges must be carefully addressed to support Metaverse-based learning media effectively (Khaira, 2024).

The challenge of limited resources supporting Metaverse-based learning media needs to be addressed with careful solutions. Adequate infrastructure, including technological devices, must be provided by educational institutions, particularly schools (Putri et al., 2024). To overcome teachers' limitations in applying technology, professional development in educational technology can be implemented. Teacher training is crucial for integrating the Metaverse into education. Educators need to develop technological competencies as well as an understanding of ethical considerations in the use of the Metaverse (Susanti et al, 2023). Curriculum adjustments and supportive educational policies are also necessary to accelerate the development of Metaverse-based learning media in Indonesia (Fauziah et al, 2024).

The future of the Metaverse in education promises further development to continuously support virtual learning, revolutionize education through personalized learning, enhance geographical inclusivity, and foster global collaboration. Government support in providing adequate infrastructure and training to develop technological proficiency is essential. Additionally, such support must be accompanied by policies and curriculum reforms that promote innovative and creative learning. The implementation of the Metaverse in education requires a careful approach, sufficient teacher training, and collaboration among all stakeholders to ensure that the use of this technology delivers maximum benefits. The application of the Metaverse in education can support the development of advanced, innovative, and adaptive educational systems (Panuntun, 2023).

CONCLUSION

In a series of studies on the Metaverse in education, the revolutionary potential of this technology in enhancing learning experiences has been highlighted. The Metaverse creates immersive 3D environments through AR, VR, and online virtual worlds, enabling profound and distinctive learning experiences. Its advantages include facilitating independent learning, overcoming the limitations of 2D virtual technologies, and transcending spatial and temporal boundaries. Other benefits include cost reduction, accommodating unforeseen circumstances, and minimizing racial discrimination. Despite its significant potential, the use of the Metaverse in education faces challenges such as unequal access, data security concerns, individual physical responses to Metaverse devices, and proficiency in operating technological tools. These challenges must be carefully addressed, as the development of Metaverse-based learning media continues. Further research is needed to explore the creation of Metaverse-based learning media aimed at improving learning outcomes.

AUTHOR'S NOTE

With the submission of this article, we declare that the manuscript is original, free from plagiarism, and has not been published in any scientific media. The listed authors have made significant contributions to the research, and there are no financial or other conflicts of interest. We extend our gratitude to all who assisted in the preparation of this article as part of the final project.

REFERENCES

Alinata, R. H., & Marsudi, M. (2024). Pemanfaatan Roblox sebagai media promosi sekolah Metaverse SMP Negeri 3 Sumenep. *Malcom: Indonesian Journal of Machine Learning and Computer Science*, *4*(1), 57-70.

Amirurrahmah, S. D. E., Zakha, F. & Bayani, N. (2024). Metaverse integration in higher education curriculum: A systematic literature review. *Hipkin Journal of Educational Research, 1*(2), 177-188.

Cahyani, D. A., Sari, D. M., & Rahma, D. F. (2024). Literature review study: Effectiveness of using GoMeta for Metaverse learning media. *Hipkin Journal of Educational Research, 1*(2), 127-138

Camilleri, M. A. (2024). Metaverse applications in education: A systematic review and a cost-benefit analysis. *Interactive Technology and Smart Education, 21*(2), 245-269.

Dewi, K. S. (2024). Pendidikan di era Metaverse: Tantangan dan solusi. *Cendikia: Jurnal Pendidikan dan Pengajaran*, *2*(6), 153-163.

Elman, M. (2024). Inovasi pembelajaran pendidikan agama Islam berbasis Metaverse. *Dirosat: Journal of Islamic Studies*, *9*(1), 97-108.

Endarto, I. A., & Martadi, M. (2022). Analisis potensi implementasi Metaverse pada media edukasi interaktif. *Barik-Jurnal S1 Desain Komunikasi Visual, 4*(1), 37-51.

Erdwiyana, N. V., Fadhilah, A. I., & Bukhori, F. B. S. (2024). Metaverse in education in the era society 5.0: A systematic literature review. *Hipkin Journal of Educational Research, 1*(1), 37-48

Fauziah, D. P. N., Yulianto, M. D., & Fasha, S. A. (2024). Analysis of the effectiveness and potential of the learning media tool in the modern era. *Hipkin Journal of Educational Research, 1*(2), 203-214.

Gattullo, M., Laviola, E., Evangelista, A., Fiorentino, M., & Uva, A. E. (2022). Towards the evaluation of augmented reality in the metaverse: Information presentation modes. *Applied Sciences, 12*(24), 1-14.

Gonaygunta, H., Meduri, S. S., Podicheti, S., & Nadella, G. S. (2023). The impact of virtual reality on social interaction and relationship via statistical analysis. *International Journal of Machine Learning for Sustainable Development*, *5*(2), 1-20.

Hasannah, N., Afina, A. F., Nuraeni, P, & Hadiapurwa, A. (2024). Is education possible in the metaverse especially in Indonesia?. *Hipkin Journal of Educational Research, 1*(1), 13-24.

Herlambang, Y. T., & Abidin, Y. (2023). Pendidikan Indonesia dalam menyongsong dunia Metaverse: Telaah filosofis semesta digital dalam perspektif pedagogik futuristik. *Naturalistic: Jurnal Kajian dan Penelitian Pendidikan dan Pembelajaran*, *7*(2), 1630-1640.

Humaira, A., Haq, M. J., & Fitri, T. N. (2024). Metaverse in higher education. *Hipkin Journal of Educational Research, 1*(2), 87-100.

Judijanto, L., Sitepu, E., & Baruno, Y. H. E. (2024). Analisis Bibliometrik tentang penggunaan realitas virtual (VR) dalam pendidikan. *Sanskara Pendidikan dan Pembelajaran*, *2*(3), 150-162.

Khaira, M., Lesmana, D. C., & Agustina, P. (2024). Utilization of the metaverse in the context of interactive learning. *Hipkin Journal of Educational Research, 1*(2), 151-162.

Kraus, S., Kanbach, D. K., Krysta, P. M., Steinhoff, M. M., & Tomini, N. (2022). Facebook and the creation of the metaverse: Radical business model innovation or incremental transformation?. *International Journal of Entrepreneurial Behavior & Research*, *28*(9), 52-77.

Kurdi, M. S. (2021). Realitas virtual dan penelitian pendidikan dasar: Tren saat ini dan arah masa depan. *Cendekia: Jurnal Ilmu Sosial, Bahasa dan Pendidikan*, *1*(4), 60-85.

Kurniawan, C., & Sutabri, T. (2024). Implementasi teknologi Metaverse dengan metode kualitatif pada Man Insan Cendekia Oki. *Merkurius: Jurnal Riset Sistem Informasi dan Teknik Informatika*, *2*(6), 234-242.

Lin, H., Wan, S., Gan, W., Chen, J., & Chao, H. C. (2022). Metaverse in education: Vision, opportunities, and challenges. *2022 IEEE International Conference on Big Data (Big Data), 1*(1), 2857-2866. IEEE.

Miko, N. A., Subroto, D. E., Rahayu, T. B., Umar, Z. A. M., & Nurhidayah, N. (2024). Metaverse era: Analisis mahasiswa generasi Z Kota Makassar terkait anxiety for online learning. *Innovation and Applied Education Journal*, *3*(2), 31-38.

Pangestu, D. M., & Rahmi, A. (2022). Metaverse: Media pembelajaran di era society 5.0 untuk meningkatkan kualitas pendidikan Indonesia. *Journal of Pedagogy and Online Learning*, *1*(2), 52-61.

Panuntun, S., & Sipayung, Y. R. (2023). Transforming education in Indonesian higher education through the use of metaverse to improve learning quality. *International Journal of Multidisciplinary Research and Analysis, 6(7)*, 2987-2993.

Praja, W. N., Affandi, A. F. M., & Gumelar, A. (2024). Pelatihan aplikasi Metaverse berbasis kearifan lokal untuk memperkuat karakter siswa di era Society 5.0. *Jurnal Pengabdian kepada Masyarakat, 4*(2), 112-119.

Putri, M. R., Farhan, A. A., & Hanif, S. M. (2024). Use of Metaverse as innovation into educational technology to drive curriculum progress. *Hipkin Journal of Educational Research, 1*(1), 25-36.

Rewara, N., Faridah, N. A., Wijay, T. T. (2024). Inhibiting factors of metaverse adoption in Indonesian education: A literature review. *Hipkin Journal of Educational Research, 1*(1), 75-86.

Ridwan, M., Suhar, A. M., Ulum, B., & Muhammad, F. (2021). Pentingnya penerapan literature review pada penelitian ilmiah. *Jurnal Masohi*, *2*(1), 42-51.

Santoso, G. (2022). Revolusi pendidikan di era society 5.0: Pembelajaran, tantangan, peluang, akses, dan keterampilan teknologi. *Jurnal Pendidikan Transformatif*, *1*(2), 18-28.

Saufi, A. ., & Santiani, S. (2024). Analisis Bibliometrik perkembangan pendidikan agama Islam berbasis Metaverse menggunakan VosViewer pada tahun 2020-2024. *Jurnal Ilmiah Multidisiplin, 3*(3), 95-102.

Setyowati, E., Fuada, S., Anwar, K., Danuarteu, M. D., Purba, S. T. F., & Wijaya, A. (2023). Introducing 6G technology to support Metaverse for telecommunication engineering students in Universitas Pendidikan Indonesia. *Community Empowerment*, *8*(2), 210-222.

Solechan, A., & Putra, T. W. A. (2022). Literatur peview: Peluang dan tantangan Metaverse. *Informatika: Jurnal Teknik Informatika dan Multimedia*, *2*(1), 62-70.

Susanti, D. A., Saleh, H. B., & Winoto, Y. (2023). Analisis kesiapan perpustakaan perguruan tinggi Indonesia dalam mengadaptasi teknologi Metaverse melalui teknik Delphi. *Media Pustakawan*, *30*(1), 43-55.

Syahputra, F., Naufal, T., Haqnizo, E., Ramadhi, W., Pranatasyah, N., Fachruzi, F., & Virenzia, R. (2024). Penggunaan teknologi augmented reality pada aplikasi bangun ruang sederhana berbasis unity dan vuforia engine. *Neptunus: Jurnal Ilmu Komputer dan Teknologi Informasi*, *2*(4), 84-95.

Wijayanto, P. W., Thamrin, H. M., Haetami, A., Mustoip, S., & Oktiawati, U. Y. (2023). The potential of metaverse technology in education as a transformation of learning media in Indonesia. *Jurnal Kependidikan: Jurnal Hasil Penelitian dan Kajian Kepustakaan di Bidang Pendidikan, Pengajaran dan Pembelajaran, 9*(2), 396-407.

Yuda, U. W., Rhamadani, M., Pratama, M. B., & Sutabri, T. (2024). Implementasi Metaverse pada proses pembelajaran. *IJM: Indonesian Journal of Multidisciplinary*, *2*(1), 1-12.

Zhang, X., Chen, Y., Hu, L., & Wang, Y. (2022). The metaverse in education: Definition, framework, features, potential applications, challenges, and future research topics. *Frontiers in Psychology, 13*(1), 1-18.