

SYSTEMATIC LITERATURE REVIEW AND BIBLIOMETRIC ANALYSIS OF METAVERSE IMPLEMENTATION IN EDUCATION (2019–2025)

Alifmulya Rahman¹, Muhammad Zidane Ramannur Alfath²

¹Department of Informatic Engineering, Universitas Malikussaleh, Aceh, Indonesia

²Department of Informatic Engineering, Universitas Padjadjaran, Bandung, Indonesia.

*Correspondence author: alifmulya.230170101@mhs.unimal.ac.id

ARTICLE INFO

Article history:

Receive: March 31, 2026

Revised: April 15, 2026

Accepted: April 23, 2026

Available Online:

April 26, 2026

Published:

April 29, 2026

Keyword:

Bibliometric Analysis,
Digital Education,
Metaverse,
SLR,
VOSviewer

ABSTRACT

The advancement of digital technology has introduced transformative opportunities within the education sector through metaverse technology. This study aims to examine research trends and research roadmaps regarding the implementation of the metaverse in education using a Systematic Literature Review (SLR) and bibliometric analysis approach. Data were extracted from the Scopus database covering the period 2019–2025, resulting in 8,379 relevant articles after a rigorous filtering process using the PRISMA protocol. The analysis revealed a significant surge in publications following the COVID-19 pandemic, with primary attention focused on digital learning recovery through immersive environments. Visualization using VOSviewer revealed the dominance of key figures such as Yogesh K. Dwivedi while simultaneously indicating fragmentation in researcher collaboration, which remains divided into small clusters. Co-occurrence analysis of keywords demonstrated a shift in focus from purely technical aspects of Virtual Reality toward the integration of Artificial Intelligence, Blockchain, and inclusivity issues. This study concludes that cross-disciplinary collaboration is necessary to create a more holistic, collaborative, and inclusive educational metaverse ecosystem in the future.

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INTRODUCTION

The development of information and communication technology in the era of the Industrial Revolution 4.0 has brought paradigm shifts across various aspects of life, including education. The demand for flexible, interactive, and high-technology-based learning systems has increased significantly, particularly driven by the global health crisis in 2020, which forced educational institutions to transition massively toward distance learning (Dhawan, 2020). Although conventional digital platforms have been widely

utilized, they possess limitations in providing immersive and socially organic learning experiences.

Within this context, the concept of the metaverse has begun to be conceptualized as a potential solution for the future of education. The metaverse is defined as a persistent and collective virtual space created through the convergence of physical reality and digital worlds (Kye et al., 2021). This technology integrates elements of Virtual Reality (VR), Augmented Reality (AR), Artificial Intelligence (AI), and Blockchain to create three-dimensional (3D) environments that enable real-time interactions through avatars (Mystakidis, 2022).

The implementation of the metaverse in education enables the creation of learning environments that support experiential learning approaches (Kolb, 1984). Through the metaverse, simulations of real-world situations such as virtual laboratory experiments, historical reconstructions, and high-level technical skill training can be conducted without physical risks and geographical limitations (Lee et al., 2021). However, this integration also presents technical and ethical challenges, including infrastructure readiness, digital literacy, and data privacy issues (Kye et al., 2021). This study systematically maps 8,379 scientific documents to comprehensively understand the research direction, challenges, and potential of the metaverse in education.

METHOD

This study employed a mixed-method approach combining Systematic Literature Review (SLR) and bibliometric analysis to ensure objective and measurable data synthesis.

Data Harvesting Protocol

Data harvesting was conducted using the Scopus database as the primary source due to its reputation and broad literature coverage in educational technology research. The search strategy utilized the following Boolean operators:

(“metaverse” OR “virtual reality” OR “augmented reality” OR “immersive technology”) AND (“education” OR “learning” OR “teaching”) AND (“engagement” OR “interaction”).

PRISMA Procedure (Data Screening)

The data filtering process was conducted rigorously to ensure the quality of the analyzed articles:

1. Identification: 17,314 documents were initially identified.
2. Time Filtering: Restricted to the period 2019–2025 to capture the most up-to-date technologies (remaining documents = 14,344).
3. Document Filtering: Only “Article” document types were included to ensure a solid peer-review process (final dataset = 8,379 articles).

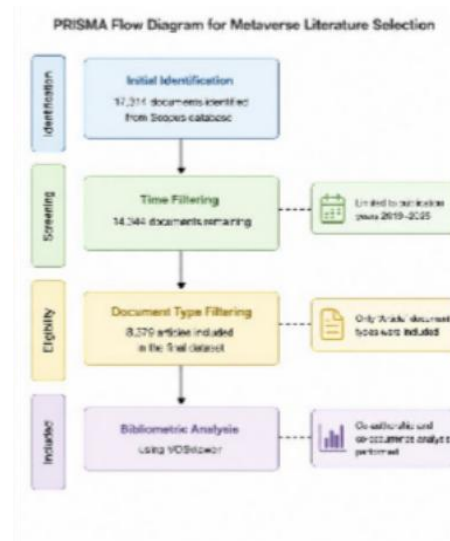


Figure 1. PRISMA Flow Diagram for Metaverse Literature Selection

Bibliometric Analysis and Visualization

Metadata analysis was conducted using VOSviewer version 1.6.20 to map:

1. Co-authorship analysis to identify intellectual collaboration networks;
2. Co-occurrence analysis to map the evolution of key terms within the metaverse research domain.

RESULTS AND DISCUSSION

Analysis of Influential Publications

Based on the extracted data, ten publications with the highest citation impact became the foundation of current metaverse research. Citation dominance indicates that Explainable AI and multidisciplinary challenges are among the most highly referenced issues.

No	Pengarang	Judul Artikel	Tahun	Jurnal	Sitasi
1	Barredo Arrieta, A., et al.	Explainable Artificial Intelligence (XAI): Concepts, taxonomies, opportunities and challenges toward responsible AI	2020	Information Fusion	5.242
2	Dwivedi, Y. K., et al.	Artificial Intelligence (AI): Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy	2021	International Journal of Information Management (IJIM)	1.907
3	Dwivedi, Y. K., et al.	“So what if ChatGPT wrote it?” Multidisciplinary perspectives on opportunities, challenges and implications of generative conversational AI for research, practice and policy	2023	International Journal of Information Management (IJIM)	1.827

4	Dwivedi, Y. K., et al.	Metaverse beyond the hype: Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy	2022	International Journal of Information Management (IJIM)	1.437
5	Dwivedi, Y. K., et al.	Setting the future of digital and social media research: Perspectives and research propositions	2021	International Journal of Information Management (IJIM)	1.091
6	Park, S.-M., & Kim, Y.-G.	A Metaverse: Taxonomy, Components, Applications, and Open Challenges	2022	IEEE Access	1.084
7	Wang, C.-X., et al.	On the Road to 6G: Visions, Requirements, Key Technologies, and Testbeds	2023	IEEE Communications Surveys & Tutorials	862
8	Rudolph, J., Tan, S., & Hessey, S.	ChatGPT: Bullshit spewer or the end of traditional assessments in higher education?	2023	Journal of Applied Learning & Teaching (JALT)	806
9	Kim, M. J., et al.	Exploring Consumer Behavior in Virtual Reality Tourism Using an Extended Stimulus-Organism-Response Model	2020	Journal of Travel Research	806
10	Stevens, P. E., et al. (KDIGO Work Group)	KDIGO 2024 Clinical Practice Guideline for the Evaluation and Management of Chronic Kidney Disease (CKD)	2024	Kidney International	800

Co-Authorship Collaboration Analysis

The network visualization in Figure 2 demonstrates that educational metaverse research possesses central figures such as Yogesh K. Dwivedi and Cheah Jin-Hwa, who function as hubs connecting research clusters.

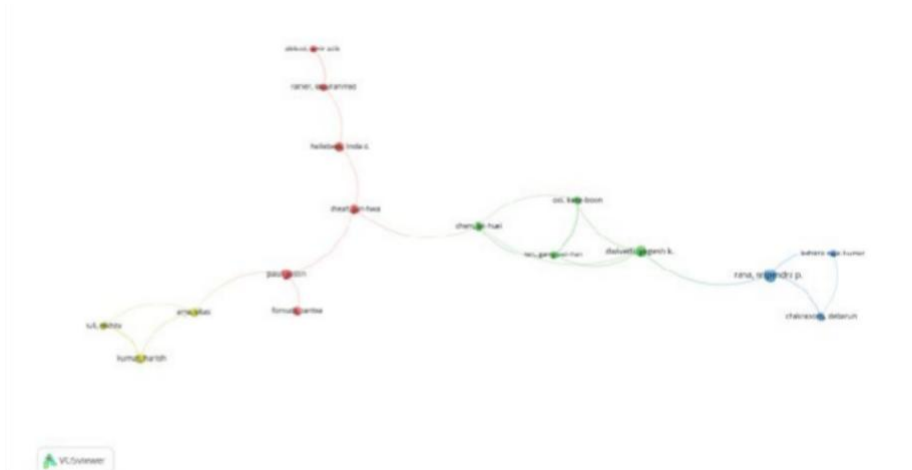


Figure 2. Visualization of Author Collaboration Networks (Co-Authorship)

However, overall scientific collaboration still demonstrates significant fragmentation. Many researcher clusters tend to form closed circles (silos) based on institutional or geographical affiliations. This indicates the necessity of cross-country research integration efforts for global metaverse curriculum standardization.

Co-Occurrence Analysis: Topic Trends and Novelty

Keyword analysis (Figure 3) revealed shifts in research focus. Between 2019–2021, research was dominated by fundamental technical terms such as “Virtual Reality” and “Augmented Reality.” Entering the 2023–2025 period, emerging keyword trends included “Blockchain,” “NFT,” “Artificial Intelligence,” and “Digital Twin” within educational contexts. This demonstrates that the metaverse is now viewed not merely as a visualization tool but as a digital ecosystem requiring data security and precise replication of physical assets for student competency assessment.

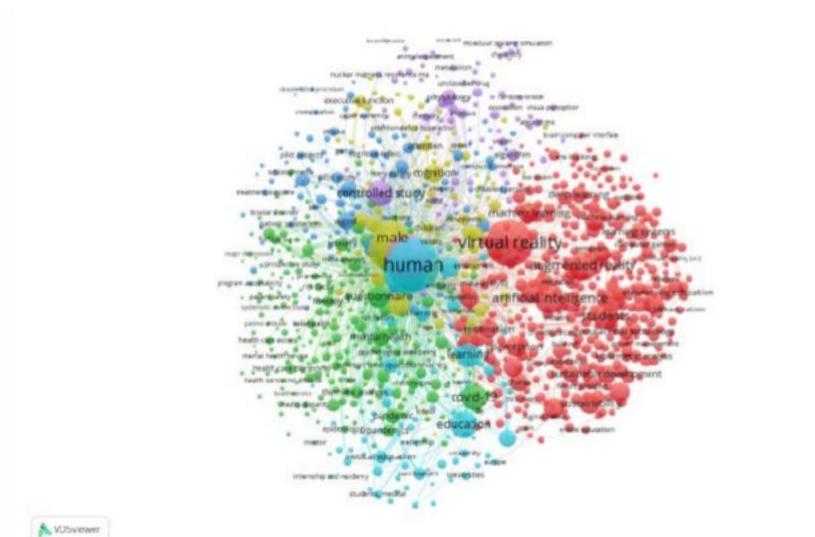


Figure 3. Visualization of Metaverse Keyword Trends (Co-Occurrence)

CONCLUSION

Based on the literature review and bibliometric analysis of 8,379 articles, it can be concluded that the implementation of the metaverse in education possesses significant potential to transform conventional learning experiences into more immersive and

interactive environments. Publication trends indicate a consistent increase following the pandemic, signaling the acceptance of immersive technology as a crucial component of the future educational landscape. However, challenges related to fragmented collaboration among researchers and infrastructure limitations in developing countries remain substantial barriers. A multidisciplinary approach involving technology experts, educators, and policymakers is required to create an inclusive, secure, and sustainable educational metaverse ecosystem.

RECOMMENDATION

This section presents suggestions for future research as well as potential limitations or factors that may influence future study outcomes.

AI Use Statement

The authors declare that no generative AI tools were used in the writing, editing, or peer-review process of this manuscript.

Funding Information (Mandatory)

This research received no external funding

Author Contributions Statement (Mandatory)

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Alifmulya Rahman	✓	✓	✓	✓	✓	✓		✓	✓	✓			✓	
Muhammad Zidane		✓				✓		✓	✓	✓	✓	✓	✓	

Abbreviations:
C : Conceptualization
M : Methodology
So : Software
Va : Validation

Fo : Formal Analysis
I : Investigation
R : Resources
D : Data Curation
O : Writing – Original Draft

E : Writing – Review & Editing
Vi : Visualization
Su : Supervision
P : Project Administration
Fu : Funding Acquisition

Conflict of Interest Statement

The authors declare that there is no conflict of interest regarding the publication of this paper.

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