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The metaverse in Moroccan education: a bibliometric review

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Abstract

Immersive technologies, and particularly metaverses, are gradually changing education around the world, but their integration in Morocco remains limited and scientific production remains embryonic. This study proposes a bibliometry to measure the penetration of the metaverse in Moroccan education. The methodology followed the PRISMA protocol for systematic reviews, and research was conducted in the Scopus and Web of Science databases. The consolidated corpus consists of four distinct scientific articles: two concerning the Moroccan context, and two others from different national contexts. To examine the co-occurrences of keywords and determine the main thematic clusters, we used the VOSviewer tool. The results show that artificial intelligence, adaptation systems and virtual reality play a central role in the development and recycling of learning. The study also indicates that adoption differs by gender, professional experience and geographical location of teachers. Four areas structure the research identified: innovation and educational immersion, virtual reality and distance teaching, active and collaborative learning, as well as emerging themes such as monitoring digital life. This research offers a synthetic vision and useful reference for decision-makers, teachers and researchers.

I. Introduction

The convergence of virtual reality (VR), augmented reality (AR), generative artificial intelligence (AI), blockchain, and high-speed digital infrastructure has accelerated the emergence of immersive environments(Qian et al., 2023; Uddin et al., 2024). This dynamic has fostered the rise of the metaverse, understood as a set of persistent and interconnected digital environments populated by avatars and open to social, economic, and cultural interactions (Dey et al., 2026; Dionisio et al., 2013). In the educational field, this trend gave rise to the "Edu-Metaverse", designing the application of these environments to educational and training engineering purposes(M. Wang et al., 2022).

Morocco has committed itself, through several reforms (Conseil supérieur de l'education, de la formation et de la recherche scientifique, 2015), to a proactive policy of digitization of the education system. In 2024, more than 94% of schools were connected to the Internet and over 90% had basic digital infrastructure (Ministère de l'Éducation nationale, du Préscolaire et des Sports, 2025). This dynamic has been reinforced with the launch of the Maroc Digital 2030 plan, which aims to train young people massively in digital skills and AI (Ministère de la Transition Numérique et de la Réforme de l'Administration, 2025). However, the integration of immersive technologies such as metaverses remains marginal, mainly driven by isolated university initiatives (CHAOUI & al., 2026). In higher education, a recent survey shows that AI is the most widely used technology, while VR remains confined to specific uses (health, engineering), and that blockchain is seen as promising but still underexploited (Saga & Elmqaddem, 2022).

The present study proposes a bibliometric analysis of indexed publications associating metaverses, education and Moroccan context, to offer a rigorous and reproductable inventory to inform educational policies and research agendas.

Its central issue is the following: what is the thematic structure of research on the metaverse in Moroccan education, and what does it indicate about the conditions for an effective and equitable integration of these technologies?

Theoretical frameworks

Conceptual foundations and evolution of the metaverse

The term "metaverse", initially forged in fiction, has been gradually appropriated by scientific research, giving rise to converging but nuanced definitions according to the original disciplines (table 1).

Table 1:Definitions and characteristics of the metaverse according to the literature.

Author(s)	Definition	Features	Focus
(Y. Wang et al., 2022)	Digital environment integrating a distinct economic system and a unified value structure, connected to the physical world.	Virtual world generated; distinct economic system; connection to the physical world	Economic and physical integration
(H. Lin et al., 2022)	Virtual 3D world where people live their daily lives through avatars representing human characteristics.	Avatar; 3D virtual world; human representation	Human representation and socialization
(Hwang & Chien, 2022)	Created world in which individuals can "exist" according to rules defined by their creator.	Rules-based environment; created world	Virtual existence and the rules of the world
(Chen et al., 2023)	Bridge between the real and virtual world, promoting multisensory interaction and immersion through various immersive technologies.	Cyber-physical system; multisensory interaction; immersive technologies	Immersion and interaction
(Cheng et al., 2022)	Network of interconnected 3D virtual worlds, made possible by the Internet and immersive technologies; considered the next generation of the Internet.	Next-generation internet; 3D network of worlds; immersive technologies	Network and technological evolution

These definitions, although formulated from different perspectives (technological, sociological, cyber-physical), converge towards three common dimensions: (i) a persistent and immersive virtual world, (ii) an embodied representation of the user (avatar), and (iii) an interconnection, advanced according to the authors, with the physical world. For the purposes of this study, we adopt a synthetic operational definition: the educational metaverse refers to a persistent 3D digital environment accessible via immersive devices (VR headsets, AR interfaces or simple web browsers), in which avatars interact in real time around structured learning activities.

The history of the metaverse follows a technological path that stretches back over decades starting with the very first text-based virtual worlds, "serious games" of the 1990s–2000s, and arriving at today's devices that blend VR, AR, generative AI, and blockchain (Lee et al., 2022; Seebold & Nam, 2025). The democratization of consumer VR headsets, the growth of immersive social platforms and the incorporation of generative AI have opened the door to personalized virtual tutors and adaptive environments. Blockchain, however, is assuming a growing role in the certification of degrees, the tracking of learning pathways, and the safeguarding of data, thereby bolstering confidence in digital educational settings (Hajji et al., 2026; Maity & Deroy, 2024; Rawas et al., 2026).

Contributions to education and scientific applications

The educational metaverse is characterized by certain properties: persistence, multisensory immersion, avatar-based incarnation, interoperability, and a synchronous social dimension. These characteristics allow us to go beyond the limitations of traditional distance teaching, in particular the feeling of isolation and the difficulty of recreating practical situations (Zhang et al., 2022).

The literature identifies several major contributions:

• Personalized learning paths using adaptive systems with AI to adapt content, pace, feedback according to profiles and performance (Farhah et al., 2025; Xia et al., 2024).

• Acquiring practical skills by simulating risky or costly situations (virtual labs in physics, chemistry, technical gestures in health, and engineering simulations) (Chitra et al., 2024; Yang et al., 2024).

• Encouraging collaborative learning by having avatars co-exist in the same virtual space, promoting interaction, group problem solving, and social construction of knowledge (Noller, 2026; Yousefdeh & Oyelere, 2024).

• Enhancing access to educational resources for learners located far from the major down town by mitigating geographical barriers and varying the modes of interaction with content and peers (Onu et al., 2024; Román Medina et al., 2025).

A particularly active subfield is the learning of foreign languages. Immersive environments allow for the recreation of authentic communication situations, while conversational AI provides immediate corrective feedback (Yan et al., 2025; Yan & Lowell, 2025). This convergence is of particular interest to the Moroccan context, marked by structural plurilingualism (Arabic, Amazigh, French, English) and important language training needs.

International state of the art and sustainable development objectives

The research of the Edu-Metaverse involves many theoretical frameworks:

• Social constructivism, which stresses interaction and collaboration in the construction of knowledge and naturally lends itself to shared immersive spaces (Hernandez-Alvarado & al., 2026; L. H. Lin & al., 2025).

• Cognitive load theory questioning the risk of sensory overload in immersive environments and emphasizing the importance of careful educational design (task splitting, guidance, reduction of informational noise) (Oje & al., 2025).

• Technology Acceptance Model (TAM) to analyze factors of adoption differentiated by gender, professional experience, geographical location of teachers, and perceptions of usefulness and ease of use (Galimova et al., 2024; Scherer & Teo, 2019).

The educational metaverse is also mobilized as a lever at the service of Sustainable Development Goal 4 (SDG 4) which aims for quality and equitable education. It helps to reduce geographical disparities, to personalize pathways, and to strengthen collaborative learning, while raising the issue of the digital divide, inequalities of access to equipment, and connections (Nilashi & Abumalloh, 2023).

II. Methods

a. Study design and research strategy

This study is based on a bibliometric analysis, conducted in accordance with the PRISMA recommendations for transparency of the selection process. The bibliometric approach was chosen to produce a rigorous and reproducible mapping of the metaverse research field in an educational context, with a focus on Morocco. It allows a quantitative and qualitative analysis of publications based on structured metadata (keywords, citations, indexing, authors), offering an overview of scientific trends and thematic groupings.

Scopus (Elsevier) and Web of Science (WoS) databases have been mobilized for their international coverage and relevance in education, immersive technologies, and engineering sciences. The research strategy combined, via Boolean operators, terms related to the metaverse and immersive technologies ("metaverse") with terms related to the educational context ("education"), in a second time, to the Moroccan context ("Morocco"). Title, summary and keywords were searched without initial period or language restrictions.

Were included: (i) articles from scientific journals indexed in Scopus and WoS; (ii) dealing with the metaverse or related immersive technologies (VR, AR, virtual worlds) related to education; (iii) involving at least one author affiliated with a Moroccan institution or explicitly dealing with the Moroccan educational context. Excluded were: (i) book chapters, conference proceedings, and other documents not indexed as journal articles; (ii) publications unrelated to education; (iii) documents for which the full text was not accessible and whose metadata was insufficient for analysis. The filter criteria (language, document type, period, access to full text) were applied during the screening and eligibility stages. The exact research equations are presented in an appendix.

b. Selection process (PRISMA)

Initial research identified 2,696 publications in Web of Science and 2,751 in Scopus on the topic "metaverse in education". Among these, 9 (WoS) and 21 (Scopus) had a link with Morocco (affiliation of authors or mention of the Moroccan context). After deduplication (3 duplicates) and application of the eligibility criteria, a corpus of 4 articles was selected for in-depth analysis. The PRISMA diagram summarizing these steps (identification, screening, eligibility, inclusion) is presented in Figure 1.

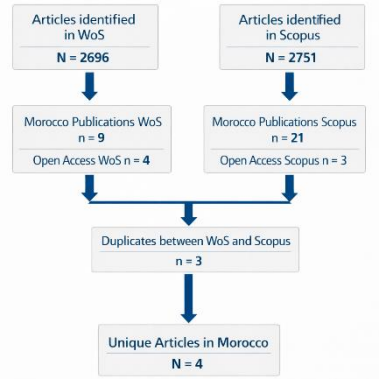

Figure 1:PRISMA diagram of the selection process for publications on the metaverse in education in Morocco.

The final corpus includes 4 articles, detailed in table 2. Two of them deal explicitly with the metaverse in an educational context with authors affiliated to Morocco (El Hajji & al., 2025; Illi & Elhassouny, 2025). The other two addresses related themes (multidisciplinary metaverse, smart factory in VR) and include co-authors affiliated with Morocco, without specifically focusing on Moroccan education (Alpala & al., 2022; Dwivedi & al., 2022).

Table 2:Corpus of selected articles on the metaverse in education in Morocco.

Article	Title	Year	Author(s)	Indexing
A1	Metaverse beyond the hype: Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy	2022	Y.K. Dwivedi et al. (Incl. Ikram Jebabli, Université Internationale de Rabat)	Scopus, WoS
A2	Smart Factory Using Virtual Reality and Online Multi-User: Towards a Metaverse for Experimental Frameworks	2022	L.O. Alpala, D.J. Quiroga-Parra, J.C. Torres, D.H. Peluffo-Ordóñez (UM6P, Maroc)	WoS
A3	Edu-Metaverse: A Comprehensive Review of Virtual Learning Environments	2025	C. Illi, A. Elhassouny (ENSIAS, Université Mohammed V, Rabat)	Scopus, WoS
A4	An Architecture for Intelligent Tutoring in Virtual Reality: Integrating LLMs and Multimodal Interaction for Immersive Learning	2025	M. El Hajji, T. Ait Baha, A. Berka, H. Ait Nacer, H. El Aouifi, Y. Es-Saady (Université Ibnou Zohr, Agadir)	Scopus, WoS

c. Data extraction, coding and analysis

For each publication, the following metadata was extracted: author(s), year, document type, source, authors and indexed keywords, main topic, and search method. This data was coded and imported into VOSviewer for the analysis of the co-occurrence of keywords. The analysis parameters (minimum occurrence threshold, normalization method, clustering resolution) are detailed in the appendix. As an exploratory step, this step identified thematic groupings (clusters) and semantic proximity links between the most frequently associated concepts.

The VOSviewer analysis highlighted four main thematic clusters: immersive learning and technological advances, virtual reality and e-learning, collaborative and active learning, and a marginal cluster around lifelogging. These clusters reflect, in an exploratory way, the diversity of themes addressed in the four selected studies.

III. Results and discussion

The final showcase includes four singular articles, two of which focus specifically on the Moroccan educational context (El Hajji & al., 2025; Illi & Elhassouny, 2025), while the other two present Moroccan affiliations and related themes (Alpala & al., 2022; Dwivedi & al., 2022).

Table 3:Summary of selected articles on the metaverse in education in Morocco.

Article	Context and objective	Main inputs	Related Cluster
A1	Conceptual and multidisciplinary approach of the metaverse, including education.	Analysis of trust, data protection and equity of access issues; proposal for a global framework for immersive innovation.	Innovation and educational immersion
A2	Experimental study on VR and multi-user environments applied to industrial training.	Highlighting the potential of VR for collaboration and remote simulation; application to industry 4.0 and technical education.	Virtual reality and distance teaching
A3	Systematic review of the concept of Edu Metaverse in the Moroccan context.	Proposal for a taxonomy and an educational ecosystem model integrating AI, digital twins, and blockchain.	Innovation and educational immersion
A4	Design of an intelligent tutoring system in an immersive environment.	Integration of language models (LLMs) and multimodal interactions (voice, gesture, gaze) for personalized and collaborative learning.	Active and collaborative learning

Analytical comment two articles belong to the Innovation and Educational Immersion cluster (Dwivedi et al., 2022; Illi & Elhassouny, 2025), one to the Virtual Reality and Distance Teaching cluster (Alpala & al., 2022), and one to the Active and Collaborative Learning cluster (El Hajji & al., 2025). This distribution shows that Moroccan research covers three of the four clusters identified by the bibliometric analysis but remains limited on emerging themes.

The co-occurrence map of keywords (Figure 2), constructed from the author and indexed keywords of the four articles, reveals a structure in four clusters: a central core around metaverse, education, avatars, representing innovation, and educational immersion (Dwivedi & al., 2022; Illi & Elhassouny, 2025). A cluster related to augmented reality and economic dimensions (augmented reality, economics, 2nd life), illustrated by Alpala & al., (2022); a cluster dedicated to active and collaborative learning, with recent terms such as AI augmented learning and collaborative learning, in connection with El Hajji & al., (2025); finally, a more diffuse cluster grouping emerging technologies (blockchains, animation, computer-aided instruction). The temporal coloration (purple in 2022, yellow in 2025) shows a recent intensification of research, notably around AI and blockchain.

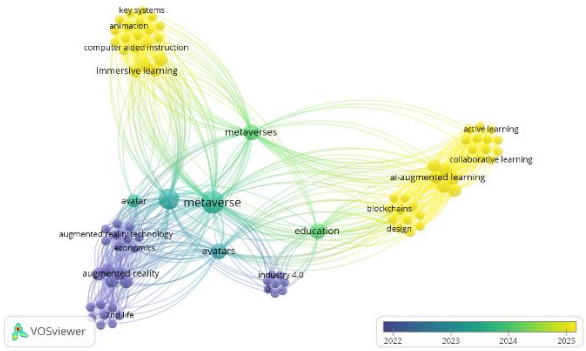

Figure 2: Co-occurrence map of keywords in the corpus on the educational metaverse in Morocco (VOSviewer).

This structure confirms that Moroccan research on the educational metaverse is in an emerging phase, while joining international trends that emphasize immersion, collaboration and ethical issues.

The results show that Moroccan research covers three of the four clusters identified by bibliometric analysis: immersive innovation, VR and distance teaching, and collaborative learning. Emerging themes remain little explored, confirming the still programmatic nature of the field.

This configuration is in line with the findings of the international literature on the metaverse in education. Several systematic reviews and bibliometric analyses report rapid growth in publications since 2022, with a strong focus on East Asia and North America, and a marked interest in immersive, collaborative, and AI-driven uses (Bizel, 2023). This work

highlights both the pedagogical potential (motivation, engagement, simulation learning) and the challenges related to infrastructure, teacher training and ethical issues.

In this landscape, Morocco appears, in this landscape, as a context that is still little documented. The few available contributions (especially those studied in this corpus) suggest a growing interest for immersive environments, but embryonic research, scattered and mostly conceptual or experimental on a small scale. This asymmetry fully justifies the bibliometric mapping approach adopted in this article, which aims to draw up a structured inventory and to identify avenues for future more systematic research.

IV. Conclusion

This bibliometric study proposes a structured mapping of scientific research on the educational metaverse in Morocco. From a corpus of four indexed articles, the analysis revealed a thematic structure in four clusters: innovation and educational immersion, virtual reality and distance teaching, active and collaborative learning, and emerging themes. Two of these works are specifically Moroccan (El Hajji & al., 2025; Illi & Elhassouny, 2025), reflecting a still limited national dynamic but in the development phase.

Compared to the international literature, Moroccan production is distinguished by a particular attention paid to inequalities of access (gender, geographical location, professional experience). Global studies indicate educational effectiveness, social collaboration (Kye & al., 2021; Mystakidis, 2022), The Moroccan corpus underscores digital divide and infrastructural limitations. This specificity confirms that the integration of the metaverse in Moroccan education can not be thought without a reflection on ethical issues and material conditions of deployment (Dwivedi & al., 2022; Metwally & al., 2026).

In the end, the present research is a useful reference for educational policies and academic actions in Morocco. It paves the way for future work to enlarge the corpus, to look at regional and institutional bases, and to compare the Moroccan case with international experiences in a more systematic way (Selwyn, 2022). The challenge is to build an inclusive, responsible and sustainable Edu Metaverse, able to improve the equity and quality of education in a context of accelerated digital transformation.

Declaration of Conflicting Interests

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