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Reimagining Education through the Metaverse: Trends, Challenges, and Innovations on Emerging Trends and Future Directions

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ABSTRACT

The Metaverse, conceptualized as the convergence of digital virtuality and physical reality, is emerging as a powerful medium with the potential to transform education. Through immersive, multisensory, and interactive environments, it enables new forms of learner engagement that extend beyond traditional classroom boundaries. This systematic review synthesizes evidence from 98 peer-reviewed studies published between 2010 and 2023, retrieved from both international and domestic databases. Employing the PRISMA methodology, the review critically examines current applications of Metaverse technologies in education, their reported outcomes, and the challenges that hinder widespread implementation. Findings reveal that the Metaverse enhances remote and hybrid learning, supports personalized and experiential instruction, and expands access to non-formal and distance education. It further promotes collaboration, creativity, and situated learning experiences that align with twenty-first-century skill development. Nevertheless, significant barriers remain. These include the high cost of technological infrastructure, unresolved concerns about data security and ethical use, and limited teacher readiness to design and facilitate immersive environments. The review contributes to the literature by clarifying how the Metaverse is currently integrated into education, identifying critical obstacles to adoption, and highlighting gaps related to sustainability, accessibility, and long-term learning outcomes. These insights provide a foundation for informed policy development, curriculum innovation, and future research aimed at the responsible and equitable integration of Metaverse

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technologies into educational practice.

Keywords: Immersive Technology; Non-Formal Education; Metaverse; Systematic Review; Virtual Learning

1. Introduction

Education worldwide is undergoing rapid transformation, driven by technological advances that are reshaping how knowledge is transmitted, how classrooms are structured, and how learning experiences are delivered[1–3]. Among emerging technologies, the Metaverse has gained prominence as an immersive digital ecosystem that extends beyond traditional modes of virtual or augmented reality. Popularized by Stephenson's Snow Crash[4], the Metaverse is characterized by persistence, interoperability, decentralization, and shared social spaces[5, 6]. These features mark a paradigm shift in how learners and educators interact with content, peers, and institutions.

The COVID–19 pandemic accelerated global interest in immersive technologies, exposing limitations in conventional online platforms while amplifying the need for innovative solutions[7, 8]. The Metaverse offers unique opportunities to simulate classroom dynamics, foster collaboration, and support lifelong and remote learning. In this sense, it is increasingly discussed as a disruptive force in education, with the potential to democratize access while introducing new ethical and pedagogical challenges[9–11].

Despite the growing literature, questions remain about how the Metaverse is currently being applied in education, what benefits and barriers are most frequently reported, and what gaps still need to be addressed. Existing research has often focused on specific disciplines or technological affordances[12–17], but a comprehensive synthesis is lacking. Addressing this gap is essential for guiding educators, policymakers, and researchers in harnessing the Metaverse effectively and responsibly.

Research Question: This review addresses the following question: How is the Metaverse being integrated into education, and what are its key benefits, challenges, and future directions?

Organization of the Paper: The remainder of this article is structured as follows. Section 2 reviews the theoretical and empirical literature on the Metaverse in education. Section 3 explains the methodology, including database searches, inclusion and exclusion criteria, and PRISMA compliance[18]. Section 4 presents the results, organized around applications, benefits, and challenges. Section 5 provides a discussion of findings and highlights gaps in the literature. Section 6 concludes with implications for practice and directions for future research.

1.1. Research Question

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2. Literature Review

2.1. Theoretical Background and the Concept of the Metaverse

The integration of the Metaverse into educational settings draws upon a rich tapestry of theoretical frameworks that inform both its technological design and pedagogical implementation. One of the primary theoretical underpinnings is constructivist learning theory, which posits that learners construct knowledge actively through experience and social interaction[18]. In this context, the Metaverse provides a dynamic, interactive environment where learners can engage in experiential learning, simulations, and collaborative problem-solving. Additionally, situated learning theory offers a useful

lens for understanding how the Metaverse facilitates learning within authentic contexts[19, 20]. By immersing learners in scenarios that mirror real-life situations, such as virtual laboratories, historical reenactments, or workplace simulations, the Metaverse enhances the relevance and applicability of educational content.

The literature on the Metaverse in education has grown significantly in recent years, but remains fragmented. Early research emphasized virtual reality (VR) and augmented reality (AR) applications in higher education and training environments[21–25]. More recent studies extend these discussions to fully immersive Metaverse platforms that enable collaborative, interactive, and student-centered learning[26–30].

Recent advancements include applications in engineering education that demonstrate improved visualization, engagement, and problem-solving skills[31, 32]. Other research emphasizes the importance of low-cost, accessible tools for integrating immersive environments into university teaching, highlighting the ongoing challenge of equity in technology adoption. These findings resonate with calls for designing Metaverse ecosystems that support inclusivity and reduce digital divides[33], showing how learners from diverse socioeconomic and cultural backgrounds can be accommodated. From a pedagogical perspective, Hou[34], stresses that Metaverse-based experiences must be integrated into curriculum design through sustainable teaching strategies, while Charles[31], and Hasani et al.[35], argue that teacher readiness and local educational contexts must be carefully considered in order to ensure meaningful adoption. Together, these findings underscore both the transformative potential and the barriers to widespread implementation.

Key gaps remain: 1) limited longitudinal evidence of learning outcomes in Metaverse-based environments, 2) insufficient exploration of accessibility and inclusivity, especially for learners with disabilities or limited resources, and 3) a lack of pedagogical frameworks that align immersive technologies with curriculum standards. Tlili et al.[23], similarly identify sustainability and equity gaps in Metaverse adoption, underscoring the importance of addressing these dimensions in future research. These gaps highlight the need for systematic review and synthesis, which this study addresses.

The concept of the Metaverse itself originates from science fiction but has evolved into a multi-layered digital space characterized by immersion, interactivity, and continuity. As defined by Dionisio et al.[6], the Metaverse is a persistent, shared, and embodied digital environment that integrates physical and virtual experiences[12–14]. In educational discourse, this concept is often aligned with emerging notions of extended reality (XR), which encompasses virtual reality (VR), augmented reality (AR), and mixed reality (MR).

At its core, the Metaverse combines three defining features: persistence (the environment continues to exist and evolve even when users log off), shared spatial presence (multiple users interact in the same virtual space), and interoperability (systems and content are seamlessly integrated across platforms). These features support a learner-centered approach, promoting autonomy, social presence, and deeper cognitive engagement. As the Metaverse continues to mature, its alignment with connectivism theory becomes increasingly apparent. This theory emphasizes learning as a process of building networks and accessing knowledge across digital platforms[14], mirroring the distributed, networked nature of the Metaverse.

In sum, the Metaverse is not only a technological innovation but also a conceptual extension of well-established educational theories. Understanding its theoretical foundations is essential for designing effective, equitable, and meaningful learning experiences in virtual environments.

2.2. Related Studies

The literature on the Metaverse in education has expanded significantly in the last five years, driven by global interest in immersive learning environments, AI integration, and the post-pandemic shift to hybrid and remote education. Studies vary in focus, ranging from technological affordances and learner experiences to institutional challenges and instructional design.

Early conceptualizations of the Metaverse emphasized its distinction from conventional virtual or augmented reality by highlighting three core attributes: shared environments, persistence, and decentralization[36]. These characteristics create immersive, interactive experiences that replicate and often enhance real-world interactions. In educational contexts, the Metaverse facilitates spatial and emotional presence, enabling learners to participate in simulations, collaborative tasks, and role-playing exercises that transcend traditional classroom limitations.

Several key studies have explored how the Metaverse can enhance domain-specific training. Siyaev and Jo [16], for example, introduced a neuro-symbolic speech executor within an aircraft maintenance simulation, showcasing the Metaverse's capacity to merge technical instruction with experiential learning. This stands in contrast with Lee and Hwang [17], who emphasize the importance of preparing teachers through VR-enhanced textbooks that connect immersive technologies with sustainability-oriented pedagogy. Charles [31], extended this discussion by exploring how immersive technologies can reshape broader educational civilizations, while Hasani et al. [35], grounded these insights in the lived experiences of Iranian teachers, highlighting the significance of local context and teacher readiness for successful integration. Collectively, these studies show how Metaverse adoption requires both technical innovation and thoughtful pedagogical alignment.

Suh and Ahn [21] provided insight into student attitudes toward Metaverse-based learning, reporting that over 96% of elementary learners found it relevant to their daily lives. Other scholars [18, 19], have highlighted cross-sector applications, from healthcare to engineering, underscoring the versatility of the Metaverse as a pedagogical tool. Importantly, Wang et al. [7] situate these developments in the post-pandemic era by proposing a blueprint for blended classrooms that integrate virtual and physical spaces. Their study illustrates how the Metaverse can extend beyond isolated experiments to reshape systemic instructional models, particularly in contexts where hybrid learning has become a necessity.

Despite its potential, the literature also reveals persistent gaps. Tlili et al. [23], conducted a content and bibliometric analysis, identifying a lack of attention to sustainability, equity, and ethical design in Metaverse-based education. Moreover, generational factors influence adoption and engagement, with Generation Z showing a greater affinity for blended and micro-learning formats compared to older cohorts. Inclusivity research further emphasizes that equitable Metaverse ecosystems can foster participation among marginalized learners [36, 37], though achieving this requires systemic attention to design and access.

Recent reviews [21, 22], highlight technological, ethical, and cultural barriers that must be addressed to ensure scalable and inclusive educational models. When read together, these studies suggest that while engineering-focused applications [32], pedagogical frameworks [16, 32, 33], inclusivity efforts [38, 39], and blended learning models [40] each contribute to advancing the field, a critical synthesis of these perspectives is necessary to build robust, equitable, and pedagogically sound Metaverse ecosystems.

In sum, the related literature demonstrates four interdependent strands: technical innovation in engineering education [13], curriculum and teacher-centered pedagogy [18, 19, 31], equitable and inclusive access [41–46], and systemic rethinking of post-pandemic hybrid models [47, 48]. Each strand highlights both opportunities and challenges, but only by integrating them can the field move toward holistic frameworks that align immersive technologies with sustainable, inclusive, and scalable educational practices. This synthesis provides the foundation for the present study, which seeks to bridge these fragmented approaches into a more comprehensive understanding of Metaverse-based education. The convergence of these four strands is illustrated in **Figure 1**, which maps their contributions to the evolving discourse on immersive learning.

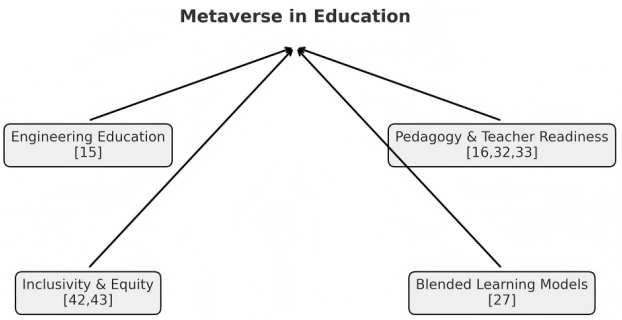

Figure 1. The Key Strands of Metaverse Research in Education.

3. Materials and Methods

This review followed PRISMA guidelines to ensure transparency and rigor. Although the protocol was not registered in PROSPERO, this is acknowledged as a limitation. Searches were conducted across Scopus, Web of Science, ERIC, and national databases, covering publications between 2010 and 2023.

Inclusion criteria: (1) peer-reviewed articles, (2) explicit focus on the Metaverse, VR, or AR in education, (3) English or Persian language, (4) publication years 2010–2023. Exclusion criteria: non-academic reports, duplicate publications, and articles unrelated to education.

Two reviewers independently screened titles, abstracts, and full texts. Disagreements were resolved through discussion. A bias assessment checklist adapted from PRISMA was applied.

3.1. The Research Design

This study employed a qualitative synthesis approach through a systematic review methodology to explore the integration and impact of the Metaverse in educational contexts. This method was chosen to comprehensively capture and analyze trends, findings, and theoretical perspectives across a diverse and evolving body of literature. The review was conducted by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [24], which provide a standardized framework to enhance the transparency, rigor, and replicability of literature reviews. The process was carried out in three main stages: identification, screening, and eligibility.

In the identification stage, academic databases such as Scopus, Web of Science, ERIC, and Google Scholar were searched using keywords including "Metaverse," "virtual reality," "immersive learning," "extended reality," and "education." The screening stage involved the removal of duplicates and a preliminary review of titles and abstracts to assess relevance. During the eligibility stage, full-text articles were assessed based on predefined inclusion and exclusion criteria, such as peer-reviewed status, focus on educational applications of the Metaverse, and publication within the last five years (2019–2024).

A total of 98 studies were included in the final synthesis. The selected articles were thematically analyzed to extract key patterns, challenges, and pedagogical implications related to Metaverse-based education. This approach enabled a nuanced understanding of both the affordances and limitations of the Metaverse across various educational levels and disciplines.

3.2. Data Collection

The data collection process for this study followed a systematic approach, ensuring a comprehensive and methodical review of relevant articles. The systematic review was conducted by examining both domestic and international databases to provide a balanced and extensive view of the literature. To ensure inclusivity, various domestic databases were utilized, including Civilica, Magiran, the Scientific Database of Jihad University, the Noor Specialized Journals Database, the Comprehensive Portal of Humanities, and the Ganj Scientific Database of Iran. Additionally, international databases such as Google Scholar, Elsevier, and Springer were employed to access a wider range of global research on the subject. The review encompassed publications from 2010 to 2023, capturing the most recent trends and developments in the field.

The search strategy involved using the term "metaverse in education" in Persian for domestic databases and the corresponding English term for international databases. Initially, 772 articles were retrieved from both sets of databases. After a rigorous screening process, irrelevant articles were excluded, resulting in the selection of 98 papers for final analysis. This refined dataset served as the foundation for understanding the metaverse's role in education, specifically in enabling learners to engage in accessible remote virtual classrooms that simulate aspects of traditional classroom settings.

Education, being a cornerstone of both economic and social development, is an area of immense interest and potential for technological advancements. Despite ongoing innovations, fundamental changes are needed to transform traditional methods of content delivery, classroom settings, and textbooks. The metaverse, with its immersive digital environments, presents an opportunity to rethink how education is delivered and experienced. As the metaverse continues to evolve, there is considerable competition to establish the infrastructure, standards, and protocols that will guide its integration into educational systems.

Following the methodology outlined by Moher et al. (2015), the study was structured in three distinct stages: identification, screening, and eligibility (see **Figure 1**). The first stage involved retrieving articles from the aforementioned databases using pre-defined keywords. The frequency of records identified through the database search is summarized in **Table 1**.

In the second stage, the retrieved articles were examined for duplication. A total of 73 articles were identified as duplicates across the datasets and subsequently removed. The remaining articles were subjected to further screening, focusing on relevance. This step involved reviewing the titles and abstracts of the identified records. The results of this stage are shown in **Table 2**, where the final set of articles was divided into two categories: (a) unrelated sources, and (b) related sources.

Table 1. Frequency of Records Identified through Database Search.

Keywords	Database Search	Frequency
Metaverse and Education (English)	International	552
Metaverse and Education (Persian)	Domestic	220

Table 2. Frequency of Screened Articles for Final Analysis.

Keywords	Database	Year of Publication	Frequency of Articles	Databases
Metaverse and Education	Domestic	2022	7 (7.3%)	Scientific Database of Jihad University
		2021–2023	24 (24.2%)	Civilica
		2021–2023	4 (4.2%)	Normagz
Metaverse and Education	International	2010–2023	34 (34.7%)	Google Scholar
		2010–2023	29 (29.4%)	Science Direct

Table 2 summarizes the main applications of the Metaverse across different educational contexts. As shown, immersive environments have been implemented in higher education, vocational training, and K-12 settings. The most prominent applications include virtual classrooms, skill-based simulations, and collaborative laboratories. These applications demonstrate the versatility of the Metaverse in supporting experiential learning, remote participation, and subject-specific visualization. Importantly, the findings emphasize that successful integration depends not only on technological infrastructure but also on alignment with pedagogical goals.

As the final step, 601 irrelevant findings were excluded after a careful evaluation of the titles and abstracts, leaving 98 articles deemed relevant for in-depth analysis. This systematic review process ensured that only the most pertinent and reliable sources were included in the study. The following figure **(Figure 2**) visually summarizes the various stages of the systematic review process, highlighting the classification of records and the steps taken to refine the final dataset.

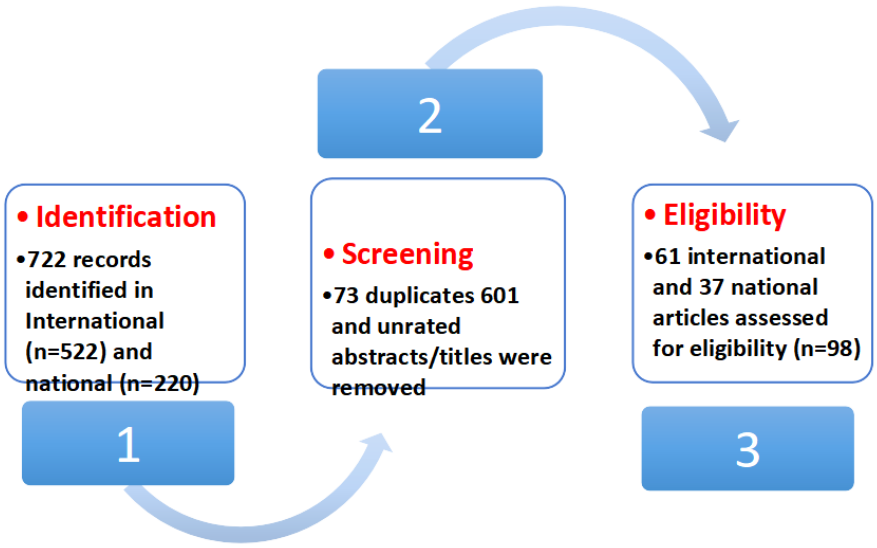

Figure 2. The steps of systematic review for national and internal databases.

4. Results

Recent educational trends, shaped by creative convergence within the Fourth Industrial Revolution, have led to new educational models aimed at fostering learners' critical and creative meaning-making processes [25]. In the metaverse, students can participate in various activities and events such as educational clubs, competitions, and sports. These experiences create a sense of physical presence in the school environment, promoting active participation. Role-playing games, set in fantastical worlds, allow learners to select characters from various classes to develop unique powers or

skills, ultimately completing missions. The metaverse thus mirrors the real world, offering diverse experiences without completely replacing real-life interactions. The primary aim of education, however, remains to humanize individuals rather than virtualize them. **Table 3** presents a summary of articles reviewed to examine the metaverse methodology.

Table 3. A Review of Articles on the Metaverse Methodology.

No.	Study (Author, Year)	Design	Objective	Key Findings
1	Siyaev and Jo (2021)	Neuro-Symbolic Speech Executor	To explore the use of the metaverse in the maintenance and repair training of Boeing 737 aircraft.	The neuro-symbolic speech operator enhances technical guidance, improving practical aircraft maintenance education.
2	Thomason (2021)	Blockchain and Irreplaceable Tokens	Investigates how the metaverse can transform healthcare.	Metaverse opens new economic and revenue opportunities by recognizing the value of patients, experts, and communities.
3	Zhong and Zheng (2022)	Comparative Study	Compares the edu-metaverse concepts and their application in education.	The study identifies challenges in developing the edu-metaverse, including public opinion, technology concerns, and ethical issues.
4	Suh and Ahn (2022)	Library and Field Study	Analyzes perceptions of the metaverse from a learner-centered approach using constructivism.	96.8% of primary school students engage with the metaverse, with 96.4% seeing its relevance to their everyday lives.
5	Lee and Hwang (2022)	Virtual Reality Education	Investigates teacher preparation in designing learning environments with advanced technology.	Highlights the need for hands-on learning to help educators effectively use emerging technologies for sustainable education.
6	Almarzouqi et al. (2022)	Acceptance Constructs	Evaluates metaverse use in medical education in the UAE.	The study contributes to understanding how users accept and utilize metaverse technology in educational contexts.
7	Cai et al. (2022)	Library and Field Study	Examines challenges and applications of the educational metaverse.	Provides suggestions for the early development of educational metaverse mechanisms, technology, and pedagogy.
8	Yu (2022)	Library and Field Study	Investigates the role of the metaverse in physical education.	Expands future research scope in physical education within metaverse contexts.
9	Rospigliosi (2022)	Self-learning Algorithms	Investigates metaverse adoption for educational contexts.	Explores ethical concerns and the role of deep learning in enhancing interactive metaverse experiences.
10	Golzari Zamir and Bayat (2022)	Gamification	Investigates the social effects and challenges of metaverse use.	Focuses on the communication and business opportunities for game managers in the metaverse.
11	Labibzadeh (2022)	Normative Future Research	Examines the role of the metaverse in architectural education.	Discusses how the metaverse creates realistic educational experiences in architecture.
12	Sheikhi and Zarei (2022)	Library Study	Investigate metaverse applications and their educational potential.	Provides a clear vision of the metaverse's use in educational environments.
13	Moradian et al. (2022)	Designing Learning Environments	Explores the impact of the metaverse and virtual reality on teaching methods.	Enhances teacher confidence and promotes consistent, sustainable learning programs.
14	Hasani et al. (2022)	Field Study	Examines the role of the metaverse in higher education.	Highlights the need for universities to establish a compelling presence within the metaverse.
15	Hassanzadeh (2022)	Normative Future Research	Investigate how the metaverse can enhance architectural education.	Discusses the role of the metaverse in creating more immersive learning experiences.
16	Arpaci and Bahari (2023)	Hybrid Method (ANN & CB-SEM)	Studies psychological needs in forecasting education sustainability.	Provides insights for metaverse developers and educational administrators to implement effective environments.

Table 3 highlights the reported benefits of integrating the Metaverse in education. Common themes include enhanced student motivation, improved engagement, and opportunities for personalized learning. Several studies also report gains in critical thinking, problem-solving, and teamwork skills. These benefits reinforce the argument that immersive platforms can offer educational experiences that surpass the capabilities of traditional classrooms. However,

the literature also shows that benefits are maximized when Metaverse-based tools are accompanied by structured instructional design and teacher support.

The metaverse is positioned as a promising platform for learning. Beyond simply displaying educational content, it provides interactive experiences that facilitate personalized learning[21]. This enables learners to engage in rich, immersive environments that prepare them for future work. The metaverse's ability to blend the virtual and physical worlds enhances learning outcomes and fosters new opportunities for lifelong education. **Table 4** provides a summary of the role of the metaverse in remote education.

Table 4. The Role of the Metaverse in Remote Education.

No.	Reference/Year	Definition of Metaverse in Remote Education
1	Ganapathy (2022)	The metaverse combines virtual and physical spaces, enabling immersive interactions that translate into real-world experiences.
2	Wang et al. (2022)	Metaverse overcomes limitations of video-conferencing platforms by offering blended physical and digital experiences.
3	Stanoevska-Slabeva (2022)	Metaverse is a stable, multi-user context blending digital virtuality with physical reality, forming a third space.
4	Chen and Zhang (2022)	The health metaverse integrates multimodal medical data and supports telemedicine and medical AI applications.
5	Lee et al. (2022)	Metaverse generates socio-economic activities that mimic real-world dynamics, providing new educational possibilities.
6	Mourtzis and Mystakidis (2022)	Successful online learning engages learners through collaborative and individual activities, forming active learning communities.
7	Barry et al. (2015)	Teachers use the metaverse to teach math problems online, measuring student engagement through blink count data.
8	Wu et al. (2022)	The metaverse, supported by augmented reality, offers new opportunities for various educational fields.
9	Zhai et al. (2022)	Metaverse enhances collaboration and communication but poses challenges for promoting educational equality.
10	Alam and Mohanty (2022)	Metaverse enables technical training in virtual environments, fostering organizational growth and skill development.

Table 4 presents the challenges and limitations identified in the reviewed studies. The most frequently reported barriers include high financial costs, technical difficulties, and lack of faculty readiness. Ethical concerns, particularly related to data privacy and student well-being, were also highlighted. Importantly, several studies note that inequities in access to high-speed internet and advanced hardware risk deepening the digital divide. Addressing these challenges requires coordinated efforts by policymakers, institutions, and educators to ensure equitable and sustainable implementation of Metaverse technologies in education. As illustrated in **Table 4**, the metaverse's immersive qualities engage learners in innovative ways, potentially improving educational outcomes. It empowers teachers to explore new pedagogical techniques and technologies.

Challenges and Approaches

The Metaverse faces several technological challenges, particularly with virtual reality (VR) and augmented reality (AR). These technologies significantly impact users' emotions, cognition, and behaviors[31]. Key barriers include the high cost of equipment—expected to decline over time—and information overload, which can lead to psychological stress. Ethical concerns, such as the unauthorized reinforcement of biased perspectives, also pose risks. Data privacy issues and cybersecurity threats related to the additional layer of virtual data further complicate adoption.

Moreover, the perception of time and space in the Metaverse differs from the real world. Full immersion can distort users' sense of time, potentially leading them to spend excessive time in virtual spaces. Therefore, establishing mechanisms to connect users to the real world is essential. The Metaverse's vast virtual environment may also overwhelm users, making it difficult to navigate the volume and diversity of information. To mitigate this, guidance during initial immersion is necessary to help users feel comfortable and aware in the virtual context[32].

For teachers, the challenges include acquiring the necessary technological and pedagogical skills to teach effectively in the Metaverse. Monitoring and controlling the virtual classroom environment also remains a significant concern [33]. **Table 5** categorizes some of the challenges and solutions associated with the metaverse based on prior research.

Table 5. Challenges and Solutions Related to the Metaverse.

No.	Reference/Year	Challenge	Solution
1	Njoku et al. (2023)	Diverse metaverse applications in business, education, and healthcare.	The article explores innovative uses of data in the metaverse for intelligent transportation systems.
2	Lee and Kundu (2022)	Development of an industrial metaverse for intelligent production systems.	Provides a foundation for enhancing industrial metaverse applications in production.
3	Troja et al. (2023)	Challenges of teaching cybersecurity during the pandemic.	Explores gamified learning in the metaverse to transform traditional cybersecurity education.
4	Ullah et al. (2023)	Finding cost-effective solutions for medical services.	Focuses on improving healthcare management with metaverse applications.
5	Shen et al. (2023)	Cyber-physical-social intelligence in education.	Develops a centralized education system considering social factors and teacher roles.
6	Hou (2023)	Learning computer games in the metaverse.	Proposes strategies to enhance motivation and performance in educational games.
7	Lin et al. (2022)	Challenges of integrating the metaverse in education.	Discusses strengths and weaknesses of personalized learning in virtual environments.
8	Román-Belmonte et al. (2022)	Inefficiencies in health education within the metaverse.	Recommends gamification to optimize healthcare and organizational procedures.

5. Discussion

As global education landscapes continue to evolve, the integration of innovative technologies like the metaverse presents new opportunities and challenges in shaping the future of learning. The importance of expanding educational paradigms to embrace digital realms and virtual spaces has become increasingly evident in response to the changing needs of learners in today's rapidly transforming world. This study aimed to shed light on the emerging role of the metaverse in non-formal education and online distance learning, using a comprehensive review of recent literature and studies. The findings provide insights into the metaverse's applications, its potential for enhancing distance education, and the associated challenges and solutions, as detailed in **Tables 3–5**.

The metaverse, with its rich virtual ecosystem, offers distinct advantages over traditional educational methods, particularly in fostering engagement and immersion. Blending the virtual and physical worlds allows learners to interact within three-dimensional spaces, participate in hands-on activities, and engage in experiential learning. As emphasized by other researchers [5–9, 24, 30, 40], this convergence provides learners with the ability to experience real-world situations in a safe, risk-free environment. Whether participating in scientific experiments, sports events, or educational workshops, learners can engage more deeply in the material, which leads to a better understanding of concepts and a greater retention of knowledge. Additionally, the metaverse offers learners the autonomy to control their pace, encouraging personalized and adaptable learning experiences.

The synthesis highlights both opportunities and challenges in adopting the Metaverse for education. Benefits include immersive experiential learning, enhanced collaboration, and expanded access for remote learners. However, barriers such as high implementation costs, ethical concerns about data privacy, and inadequate teacher training persist.

Significant gaps remain: 1) few studies evaluate long-term educational outcomes; 2) limited research explores integration into formal curricula; 3) cost-effective strategies for developing and maintaining immersive platforms are underexplored. Recent work in engineering education [32] and the development of low-cost educational tools [15] highlights promising directions, emphasizing affordability, accessibility, and sustainability as key priorities for future research.

Moreover, the metaverse facilitates inclusivity by overcoming the physical and geographical barriers that typically hinder traditional learning environments. Students can connect and collaborate from diverse locations, fostering a sense of community despite physical distance. As supported by

the works of Arpaci and Bahari [48], Zhai et al. [29], and Masferrer et al. [12], this technology provides opportunities for marginalized and underserved populations to access educational resources and experiences that might otherwise be unavailable. Additionally, the virtual nature of the metaverse offers significant benefits in vocational and practical training, where students can gain hands-on experience without the high costs and risks typically associated with real-world learning environments. This holds particularly true for industries such as healthcare, engineering, and aviation, where training in real-world environments may be cost-prohibitive or risky for beginners, as previously mentioned by Zhai et al. [29], and Arpaci and Bahari [48].

However, despite the promise of the metaverse in education, there are significant challenges that must be addressed to ensure its effective and equitable integration into educational systems. One of the most pressing issues is the accessibility of the necessary technological tools. The cost of devices such as VR headsets, motion capture gloves, and the computational power required for running metaverse applications can be prohibitive, particularly in low-income or under-resourced settings. As noted by Haddad Iraqi [44], Barjesteh and Isaee [2], and Farshbaf Khalili [42], this presents a significant barrier to widespread adoption, potentially exacerbating existing educational inequalities. Moreover, the infrastructure required to support these technologies, including high-speed internet and advanced computing systems, remains limited in certain regions, hindering the full potential of the metaverse as a transformative educational tool.

Another critical challenge highlighted in the literature concerns the ethical implications of using the metaverse in education. As virtual spaces become more integrated into our daily lives, issues such as data privacy, cybersecurity, and digital identity protection will need to be addressed with the utmost care. As Cai et al. [19], discuss, the risks of data breaches, fake identities, and malicious activities within virtual environments pose significant threats to the safety and integrity of the educational experience. Furthermore, the management of user-generated content, intellectual property, and digital rights in the metaverse must be carefully considered to prevent exploitation and misuse.

In addition to these technological and ethical concerns, the very nature of the metaverse requires educators to adopt new pedagogical strategies that may require a steep learning curve. Teachers must develop proficiency in using these virtual environments and adjust their teaching methods to accommodate the interactive, immersive nature of metaverse-based learning. This shift represents a departure from traditional, instructor-centered models of education toward more learner-centered, collaborative, and experiential forms of learning [31]. Consequently, educator training and professional development in the use of emerging technologies will be crucial in ensuring that teachers are well-prepared to navigate the complexities of teaching in virtual spaces.

Lastly, the impact of the metaverse on social equity and educational justice cannot be overstated. The metaverse has the potential to democratize access to education, but only if it is made available to all learners. Ensuring equitable access to virtual learning tools, minimizing barriers to entry, and fostering inclusive educational environments will be essential to achieving this goal. Moreover, considerations around the digital divide and the varying levels of technological literacy among different populations must be taken into account to avoid reinforcing existing disparities.

6. Conclusions

This review demonstrates the Metaverse's transformative potential for education, offering immersive and collaborative environments that can enhance learning outcomes. At the same time, implementation faces technological, financial, and ethical challenges. Future research should focus on developing cost-effective adoption models, designing teacher training frameworks, and conducting longitudinal studies that assess the long-term effectiveness of Metaverse-based interventions. By addressing these gaps, the Metaverse can evolve into a powerful, equitable, and sustainable educational tool.

In conclusion, this study highlights the transformative potential of technology-based education, which is increasingly shaping the future of learning in the modern era. The rapid advancements in educational technologies, particularly the concept of intelligent classrooms (self-guided, adaptive, motivational, resource-independent, and embedded with advanced technologies), have already significantly reshaped the landscape of learning. Digital resources, with their interactive capabilities and portability, have opened up new dimensions in educational access and engagement. Yet, we

are still at the threshold of a new frontier: the metaverse. If harnessed effectively, the metaverse holds the promise of providing a rich, immersive learning environment, but only if its implementation is carefully managed to overcome the challenges it presents.

The metaverse offers unprecedented opportunities to create accessible and immersive educational spaces, but it should not replace the natural world. Instead, it should be viewed as an enhancement—a complementary space where users can interact, learn, and grow while engaging in activities that were once confined to traditional physical settings. By creating a virtual world that mirrors real-life scenarios and interactions, learners can engage in personalized learning experiences that are both innovative and engaging. The metaverse's interactive features have the potential to revolutionize how education is delivered, allowing students to participate in dynamic and immersive environments tailored to their unique needs and preferences.

However, the integration of the metaverse into educational systems requires careful consideration. Educational authorities and policymakers must ensure a comprehensive understanding of the metaverse's potential and challenges before introducing it to students. This includes evaluating its strengths and weaknesses, defining appropriate levels of accessibility based on age, foundational knowledge, and individual learning needs, and addressing any ethical or safety concerns. In light of the nascent nature of metaverse technology, it is important to establish clear guidelines and regulations that govern its use in education. Researchers should explore the socio-cultural, ethical, and psychological implications of metaverse-based learning, ensuring that its advancement does not undermine human values or disrupt established social and interactional patterns.

Ultimately, the metaverse offers a promising new dimension to education, but its successful integration will depend on strategic planning, regulation, and thoughtful implementation. By prioritizing equity, accessibility, and pedagogical effectiveness, the metaverse can become a powerful tool for enhancing educational experiences, providing learners with new ways to explore, engage, and succeed in their educational journeys.

Future Research Directions

Building on the findings of this review, several avenues for future research are recommended. First, longitudinal studies are needed to assess the sustained impact of Metaverse-based interventions on student achievement, motivation, and equity. Second, more research should focus on cost-effective and scalable models that can be adopted by resource-constrained institutions. Third, teacher training and professional development frameworks must be developed and evaluated to ensure effective pedagogical integration of immersive technologies. Finally, ethical concerns—particularly regarding data privacy, accessibility for learners with disabilities, and the potential for widening the digital divide—should be central to future investigations. Addressing these issues will help guide the responsible and sustainable adoption of Metaverse technologies in education.

Author Contributions

Conceptualization, H.I. and H.B.; methodology, M.M.; software, H.I.; validation, S.S. (Sharareh Shirzadi) and S.S. (Shaghayegh Shirzad),; formal analysis, H.I.; investigation, H.I.; resources, H.B.; data curation, H.I.; writing—original draft preparation, H.B.; writing—review and editing, M.M.; visualization, M.M.; supervision, H.B.; project administration, H.I. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement

The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board (or Ethics Committee) of Ayatollah Amoli Branch of Islamic Azad University, Amol, Iran.

Informed Consent Statement

Not applicable.

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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Conflicts of Interest

The authors declare no conflict of interest.

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