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Research Article

The Role of Metaverse Technology in Education: A Systematic Review of Opportunities, Challenges, and Educational Potential

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Abstract: This study investigates the application of the metaverse in educational settings, focusing on its development, implementation, and impact on learning outcomes. Employing a systematic literature review methodology, the research meticulously followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure a comprehensive and unbiased collection of data. Searches were conducted on major databases including Web of Science and Scopus, covering literature from January 2007 to June 2023. Consequently, a comprehensive bibliometric review was executed, harnessing the repositories of Web of Science (WoS) and Scopus. In pursuit of a comprehensive educational objective, the approach eschewed the imposition of restrictions pertaining to time frames, pedagogical stratification, or subject-specific criteria. Given the novelty of the metaverse topic and considering the inclusionary and exclusionary parameters, a compilation of 17 scholarly pieces was critically evaluated. The results elucidate the metaverse's intrinsic capacity to augment and revolutionize pedagogy, fostering elevated educational yields and bolstering student involvement and enthusiasm. The study categorizes the primary aims of metaverse applications in education, which include the development of virtual worlds, creation of specific educational tools such as avatars and virtual labs, and pedagogical innovations tailored for immersive environments. Key findings suggest that the educational metaverse fosters significant improvements in student engagement and collaboration, enhances digital proficiency, and supports diverse pedagogical approaches. Despite these advantages, challenges related to technological integration, accessibility, and the scalability of findings due to small sample sizes were identified. The study underscores the need for future research to expand on methodological diversity and larger participant groups to validate and generalize the results across different educational contexts. This research contributes to the academic discourse by providing a detailed overview of the current state of metaverse utilization in education, highlighting both its potential and limitations. The findings aim to guide future studies and inform educational practices and policy-making in integrating virtual reality technologies.

Keywords: Metaverse in Education, Systematic Literature Review, Virtual Learning Environments (VLES), Educational Technology Integration, Pedagogical Innovation

1. Introduction

The term "metaverse" is derived from the words "meta" (beyond) and "universe," and is defined as a virtual universe (Mystakidis, 2022). The metaverse extends beyond commerce and entertainment, facilitating the formation of virtual communities. It represents a next-generation internet, encompassing a three-dimensional virtual space where users interact through avatars, described as a significant digital explosion in cyberspace (Ko, Chung, Kim & Shin, 2021; Lee, 2021; Seok, 2021). Mark Zuckerberg, founder of Facebook, defines the metaverse not merely as a platform for viewing content, but as a tangible internet where we live our lives, aimed at enhancing the time spent on screens (Zuckerberg, 2021). According to Mystakidis (2022), the metaverse is described as a surreal universe that merges physical reality with digital virtuality, characterized by its continuity, permanence, and multi-user environment. Sriram (2022) views it as a transition from the real world to a virtual one. Zhao, Zhang, Zhu, Lan, and Hua (2022) describe it as a super virtual reality ecosystem based on the internet, composed of interdisciplinary technologies such as augmented reality, virtual reality, mixed reality, and artificial intelligence. The metaverse is known for utilizing augmented and virtual reality glasses in its application (Guo & Gao, 2022). It is recognized as an advanced stage of the virtual universe (Kye, Han, Kim, Park, Jo & Huh, 2021).

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The outbreak of the COVID-19 pandemic has profoundly impacted every facet of our daily lives. This circumstance underscored the importance of assimilating Information communication technologies (ICT) and digital tools into the educational realm (Daniel, 2020). Educational technology, encompassing the fusion of computerized assets and pedagogical principles to empower tech-enhanced learning, is witnessing increased prominence (Colomo-Magaña et al., 2021; Hew et al., 2019; Januszewski & Molenda, 2013). Furthermore, as today's learners navigate a globally diverse digital landscape with access to tailored, fluid information, their perceptions of efficacious learning and instructional necessities evolve (Anastasiadis et al., 2018). Hence, there's a burgeoning demand among students for richer, stimulating, and immersive learning journeys where they're proactive contributors, not just passive observers (López-Belmonte et al., 2021). This underscores the imperative of understanding how innovative, learner-centric tech-empowered learning avenues can reshape educational dynamics.

Learning is most effective when it engages with student inquiry, enhances 21st-century competencies, addresses societal challenges, and integrates information and communication technology, as demonstrated by Barab and Dede (2007) and Zeidler et al. (2005). Learners, particularly those fluent with technology, are invigorated by digital assets, as discussed by Baynat and López (2020). The use of advanced technological pedagogies in learner-centered approaches can enrich the educational experience, according to Billingsley et al. (2019). The accelerated adoption of digital tools and the evolution of technologies within pedagogical frameworks, as detailed by Zawacki-Richter and Latchem (2018), are rendering traditional teaching methods obsolete, thereby facilitating the emergence of sophisticated educational strategies and innovative instructional methodologies, as identified by Hughes et al. (2006).

The educational sector exhibits growing enthusiasm for immersive virtual learning environments (VLEs) to craft tailored, captivating learning encounters (Reisoğlu et al., 2017). In such realms, accentuated by Extended Reality (XR) tech, learners can engage with virtual entities and glean practical insights (Lampropoulos et al., 2021). VLEs represent a synthesis of digital and tangible spaces, fostering educational exchanges through a blend of diverse technologies and pedagogical methods (Dillenbourg et al., 2002). They complement both online and conventional classrooms, empowering learners to actively co-create their educational journeys. VLEs also play a pivotal role in nurturing virtual educational communities, fostering camaraderie, enhancing learners' analytical skills, and facilitating access to interactive resources (Pan et al., 2006). In this VLE milieu, the metaverse's adoption is rising, heralded for its potential dividends. It's a digital, three-dimensional universe facilitating real-time interactions among users and between users and digital entities, blurring the boundaries of time and space. Within the metaverse, tangible and virtual realities converge, with user interactions mediated by virtual avatars, underscoring the confluence of online and offline identities (Park & Kim, 2021; Sparkes, 2021). The metaverse offers a lifelike, immersive digital milieu anchored in principles of persistence, interactivity, and embodiment, promoting social interactions and cultural exchanges (Falchuk et al., 2018; Park et al., 2021). Given its intrinsic features, the metaverse's integration in educational contexts is gaining traction. In these immersive domains, gamified elements augment learning experiences, boosting creativity, collective intelligence, and memory retention (Díaz et al., 2020; Márquez, 2010). The metaverse, when approached with a student-centric lens, can enhance analytical abilities, amplify academic achievements, and facilitate in-depth subject comprehension, culminating in superior learning environments (Tarouco et al., 2013).

1.1. Justification and research objective

The transition towards technologically enhanced education has been significantly expedited by the disruptions caused by the COVID-19 pandemic. This shift has underscored the importance of digital platforms like the metaverse—an interactive, three-dimensional digital universe that supports real-time interactions among users and between users and digital entities. The metaverse blurs the

boundaries between virtual and physical realities, offering a novel context for redefining educational strategies (Moreno-Guerrero et al., 2021; Pozo-Sánchez et al., 2021).

The potential of the metaverse to provide immersive, gamified, and highly interactive learning experiences positions it at the forefront of educational technology research. With its unique capabilities to simulate real-world interactions in a controlled, virtual setting, the metaverse holds promise for transforming educational practices, enhancing learner engagement, and facilitating deeper understanding of complex subjects (Lee, 2021; López-Belmonte et al., 2022).

Given these dynamics, this study aims to conduct a comprehensive bibliometric analysis of the literature on the educational use of the metaverse. By categorizing existing studies, identifying dominant themes, and pinpointing gaps, this research will not only provide a clear snapshot of the current landscape but also set the stage for future investigations that can build on these findings. This approach will help establish a theoretical framework for the application of the metaverse in educational contexts, aiming to contribute substantially to the field by informing both academic research and practical application (Zhao et al., 2021).

The primary goal of this study is to conduct a comprehensive analysis of existing research on the educational metaverse, establishing its theoretical foundations and delineating its current relevance and implications for the academic community. This exploration aims to pave the way for future research, building upon well-established findings. To guide our inquiry and ensure it aligns with the overarching objectives, we have formulated several specific research questions. Each question is designed to uncover distinct aspects of the educational metaverse that are critical for understanding its development and impact. These questions are developed based on a review of the literature and consultations with subject matter experts (Tlili et al., 2022):

RQ1: Which countries have led the way in generating content on the educational metaverse? This question aims to identify geographical leaders in metaverse content creation, providing insights into regional advancements and potential biases in technology deployment.

RQ2: What stand out as the primary objectives in literature concerning the educational metaverse? Exploring the primary objectives highlighted in the literature will help clarify the main aims pursued by researchers and educators, aligning future studies with these goals.

RQ3: Which methodologies dominate the research landscape of the educational metaverse? Identifying dominant methodologies will inform us about the robustness and diversity of research approaches, guiding methodological choices in subsequent studies.

RQ4: What participant demographics are commonly represented in educational metaverse studies? Understanding who is being studied will reveal inclusivity and the scope of the research, ensuring that future initiatives can address any demographic gaps.

RQ5: What are the recurrent variables under scrutiny in educational metaverse research? This question seeks to catalog the variables frequently analyzed, helping to establish a core set of factors for ongoing and future investigations.

RQ6: What tools or instruments have been prominently employed in the study of the educational metaverse? Detailing the tools and instruments used allows for an assessment of the technological and methodological standards in the field, facilitating the adoption of effective practices.

RQ7: What insights or conclusions frequently emerge from research on the educational metaverse? This question will compile prevalent findings and conclusions, contributing to a cumulative knowledge base that supports evidence-based decision-making in educational technology.

2. Method

2.1. Research design

To achieve our objectives and address the research questions outlined, we conducted a systematic literature review guided by the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) standards (Page et al., 2021). Additionally, we implemented an "analytical framework," which is a structured set of criteria used to assess and interpret the impact of studies systematically. This framework, based on methodologies described by Rodríguez-García et al. (2020) and Soler-Costa et al. (2021), helps us categorize and analyze findings from the literature in a methodical way, enhancing the rigor and reliability of our conclusions.

For our literary exploration, we tapped into the Web of Science (WoS) and Scopus databases, both globally recognized for their repository of impactful and scientifically significant publications (Aksnes & Sivertsen, 2019). Our choice also aligns with expert recommendations who have underscored the significance of WoS and Scopus for such studies (Zhao et al., 2021). A critical factor influencing our database selection is their widespread acknowledgment for aggregating impactful works in the realm of educational technology (Lampropoulos et al., 2022; Mystakidis et al., 2022), directly mirroring our study's focal point.

In our investigation, the core variables we deemed essential for document analysis include: country of origin, underlying objectives, employed methodology, research sample, variables chosen by the investigators, utilized instruments, and salient findings related to the educational metaverse.

2.2. Procedure

Our investigative journey started in January 2022, aiming to encompass all preceding scholarly works. Our inaugural step was crafting a precise search equation, tailoring it to the contemporary state of the art. With a well-defined scope, the singular term "metaverse" sufficed as our search criterion in the TOPIC metadata, namely title, abstract, and keywords. We confined our search to WoS's educational domains, such as Education, Educational Research, and Education Scientific Disciplines, and also to Scopus's social sciences sphere. The objective was a comprehensive view of the metaverse's role in education, embracing every educational phase and all knowledge domains interlinked with education.

The data collection phase for our study was executed by scanning the Web of Science (WoS) and SCOPUS international databases on June 30, 2023, encompassing publications from January 2007 to June 2023. The choice of these databases stems from their widespread recognition and usage within the international scientific community, as well as their relevance for academic promotions. We selected the period starting from 2007 because it marks significant developments in digital and virtual technologies that underpin the evolution of the Metaverse. Notably, this timeframe includes critical advancements in Internet speed, graphics technology, and the launch of influential platforms that have shaped the trajectory of Metaverse technologies. The search criteria for the included studies were established following the PRISMA (2020) guidelines, focusing on titles and abstracts containing various combinations of "metaverse" and "education" in the advanced search settings. Only documents classified as "articles" were considered. We have detailed the criteria for document inclusion and exclusion in Table 1.

Table 1

Inclusion and Exclusion Parameters

Inclusion Criteria	Exclusion Criteria
Documents spotlighting metaverse in education.	Inaccessible documents. Improperly indexed documents. Redundant documents. Documents lacking a majority of the variables examined in this study.

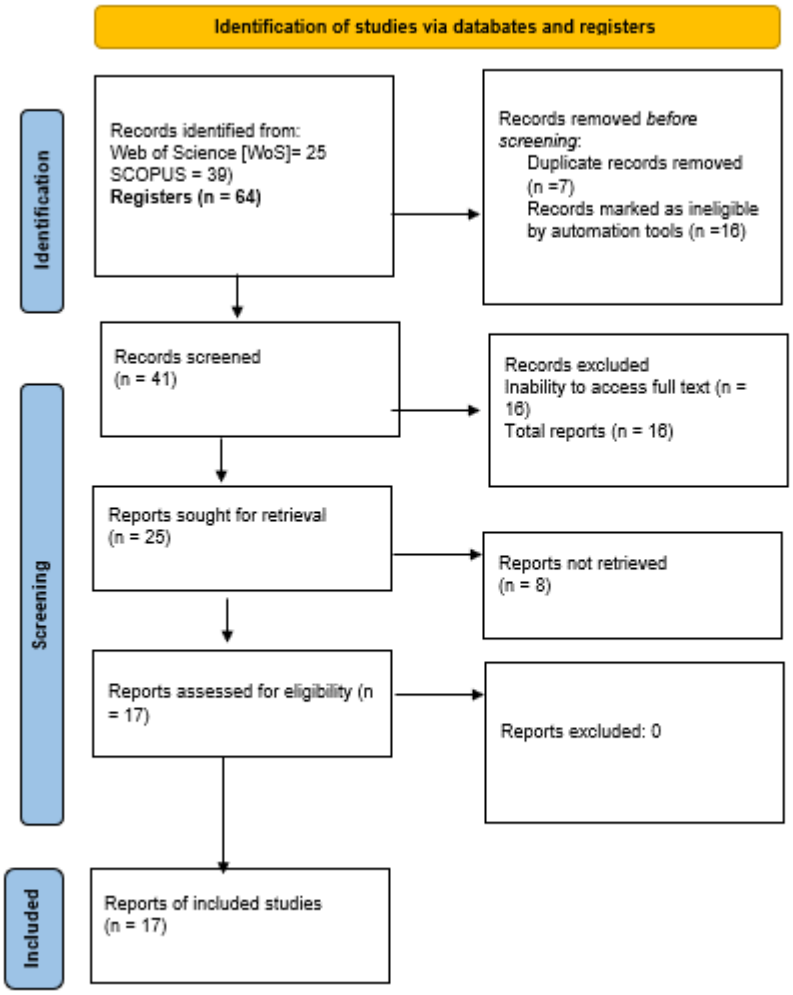
Our initial search on the Web of Science (WoS) and Scopus databases yielded 64 scholarly articles, comprising 25 from WoS and 39 from Scopus. The search was meticulously designed using combinations of the terms "metaverse" and "education." These included phrases like "metaverse AND education," "educational metaverse," and "metaverse in learning environments," searched within the titles and abstracts to ensure relevance and specificity.

Following the PRISMA systematic review protocol, we refined our collection based on predefined inclusion and exclusion criteria. Articles that were inaccessible, improperly indexed, redundant, or lacked significant research variables were excluded. This refinement process resulted in 22 articles from WoS and 35 from Scopus being initially considered. After further exclusions for suboptimal indexing, duplicates, and lack of necessary variables, our final analytical base consisted of 17 well-indexed and pertinent publications.

For transparency and further details, the complete dataset including the search terms, strategies, and selected studies can be accessed via this hypothetical link: View Dataset ((https://docs.google.com/spreadsheets/d/1VHuW5jySFnKmeib8x4ZCdT0f9wb4TlDAEI5v0ev3Rgg/edit?usp=sharing).

Figure 1

A Schematic Representation Based on the PRISMA Protocol



Upon reviewing these articles, we applied our inclusion and exclusion criteria as follows:

1. Accessibility Check: Articles that were not accessible were excluded, resulting in the exclusion of 3 articles from WoS and 4 from Scopus.
2. Indexing Check: We removed articles with improper indexing or those not appearing prominently in the databases, which accounted for the exclusion of 5 from WoS and 11 from Scopus.
3. Redundancy Check: We identified and removed 11 duplicate articles between the databases.
4. Variable Relevance Check: Articles lacking in a majority of the specified research variables were also excluded, amounting to 7 from WoS and 12 from Scopus.

After these exclusions, we were left with a distilled group of 17 well-indexed and relevant publications which form the analytical base for our study.

3. Results

The findings from the study's variable analysis are segmented into different subsections to ensure clarity and ease of interpretation.

3.1. Country

When examining the primary contributors to the realm of educational metaverse research (RQ1), both Brazil and Spain emerge prominently, accounting for 29.4% each. Brazil's pioneering efforts are showcased through five distinct contributions (Arcila, 2014; Díaz et al., 2020; García, 2011a; Reyes, 2020; Tarouco et al., 2013). Spain's involvement is equally robust with five studies (Baynat & López, 2020; Díaz et al., 2020; Garrido-Íñigo & Rodríguez-Moreno, 2013; Hadjistassou, 2016; Reyes, 2020). After these frontrunners, Mexico (Nurhidayah et al., 2020; Park et al., 2021) and Colombia (García, 2011b; Vaca Barahona et al., 2016) are both represented with two scholarly pieces each.

Table 2 presents the primary countries contributing to educational metaverse research, along with the number of contributions from each country.

Table 2

Contributions to Educational Metaverse Research by Country

Country	Number of Contributions	Contributing Studies
Brazil	5	Arcila (2014); Díaz et al. (2020); García (2011a); Reyes (2020); Tarouco et al. (2013)
Spain	5	Baynat & López (2020); Díaz et al. (2020); Garrido-Íñigo & Rodríguez-Moreno (2013); Hadjistassou (2016); Reyes (2020)
Mexico	2	Nurhidayah et al. (2020); Park et al. (2021)
Colombia	2	García (2011b); Vaca Barahona et al. (2016)

Table 2 highlights that Brazil and Spain are the leading contributors to educational metaverse research, each accounting for 29.4% of the total contributions. These countries are followed by Mexico and Colombia, each with two scholarly contributions.

3.2. Aims

In addressing the primary objectives observed in metaverse education-related documents (RQ2), there's a notable diversity in focus. Some studies dive into the intricacies, potential pitfalls, and challenges encountered during the creation, deployment, and operational phases of virtual educational spaces (Díaz et al., 2020). In contrast, others pivot towards constructing specific tools and assets within the virtual realm. This includes the formulation of avatars (Schlemmer et al., 2009), creation of virtual labs (Clark, 2012; Schaf et al., 2012; Tarouco et al., 2013), development of unique platforms (García, 2011b), 3D environment prototypes (Arcila, 2014), and pedagogical techniques tailored for the metaverse (Díaz et al., 2020).

As illustrated in Table 3, a summary is provided of the number of scholarly articles focusing on various research objectives within the domain of metaverse education. The table categorizes these articles by their primary focus, which spans from the development and implementation of virtual worlds in educational environments to the impact of the metaverse on students. This distribution offers insights into the focal points and prevailing trends in metaverse-related educational research.

Table 3

Distribution of Research Objectives in Metaverse Education Studies

Research Objectives	Number of Papers
Developing and implementing virtual worlds in educational environments	7
Development of concrete and specific resources, such as avatars	6
Virtual laboratories	5
Prototypes of 3D environments	4
Platforms	3
Pedagogical methods	2
Impact of the metaverse on students	1

Table 3 presents a quantitative overview of scholarly articles classified by their research objectives within the field of metaverse education. The table enumerates articles that range in focus from the development and implementation of virtual worlds within educational settings to the examination of the metaverse's impact on students. The numbers indicate the quantity of articles dedicated to each specific objective, offering an insight into the areas that are currently receiving the most attention in academic research. It is a representation of the relative emphasis placed on each area within the corpus of collected literature.

3.3. Research approach

When assessing the research methodologies used in the educational metaverse studies (RQ3), it emerges that case studies dominate. The research techniques have been either quantitative (Arcila, 2014), qualitative (Vaca Barahona et al., 2016), or mixed-methods (Díaz et al., 2020). An extensive list of the methodologies is presented in this paper's appendix.

Table 4 presents an overview of the research methodologies used in educational metaverse studies, highlighting the dominance of case studies and the diversity of research techniques employed.

Table 4

Research Methodologies in Educational Metaverse Studies

Methodology	Study	Type of Research
Case Study	Arcila (2014)	Quantitative
Case Study	Vaca Barahona et al. (2016)	Qualitative
Case Study	Díaz et al. (2020)	Mixed-Methods

Table 4 shows the prevalence of case studies in educational metaverse research. The methodologies encompass quantitative, qualitative, and mixed-methods approaches.

3.4. Study participants

In examining the sample size in the educational metaverse research (RQ4), most studies involved less than 100 participants, accounting for 41.1% of the 17 reviewed studies. A mere 11.7% of the studies had samples greater than 100 students, and in 29.4%, the sample size wasn't specified (Table 5).

Table 5

Distribution of Sample Sizes in Educational Metaverse Research

Sample Size	Percentage of Studies	Number of Studies
Less than 100 participants	41.1%	7
Greater than 100 participants	11.7%	2
Not specified	29.4%	5

Table 5 summarizes the distribution of sample sizes in educational metaverse research studies, highlighting the prevalence of smaller sample sizes and the instances where sample sizes were not specified.

3.5. Key Variables

In answering which main variables are prevalent in educational metaverse studies (RQ5), many studies exhibit similar focuses. The majority center on learning outcomes derived from the metaverse's application. Emphasis is given to the ideas of presence and telepresence in virtual domains (Shlemmer et al., 2009), student performance outcomes (Nurhidayah et al., 2020), challenges in metaverse integration (Arcila, 2014), time allocations in metaverse activities (Clark, 2012), acceptance levels (Díaz et al., 2020), motivation (Park et al., 2021), and interactivity in the educational arena (Vaca Barahona et al., 2016) (Table 6).

Table 6

Key Variables in Educational Metaverse Studies

Key Variable	Study
Presence and Telepresence	Shlemmer et al. (2009)
Student Performance Outcomes	Nurhidayah et al. (2020)
Challenges in Integration	Arcila (2014)
Time Allocations	Clark (2012)
Acceptance Levels	Díaz et al. (2020)
Motivation	Park et al. (2021)
Interactivity	Vaca Barahona et al. (2016)

Table 6 identifies the key variables studied in educational metaverse research, highlighting the recurring themes and focuses of various studies.

3.6. Measurement instruments

In examining the kinds of instruments applied within the realm of the educational metaverse, ad hoc surveys stand out as the primary data collection tool (Arcila, 2014; Clark, 2012; Díaz et al., 2020, and others). Additionally, participant observations during different task applications within varied

experiments also play a critical role (García, 2011a; Garrido-Iñigo & Rodríguez-Moreno, 2013; Jaffurs, 2011) (Table 7).

Table 7

Measurement Instruments in Educational Metaverse Studies

Measurement Instrument	Study
Ad Hoc Surveys	Arcila (2014); Clark (2012); Díaz et al. (2020)
Participant Observations	García (2011a); Garrido-Iñigo & Rodríguez-Moreno (2013); Jaffurs (2011)

Table 7 summarizes the primary measurement instruments used in educational metaverse research, emphasizing the prominence of ad hoc surveys and participant observations.

3.7. Key outcomes

Delving into the significant discoveries in educational metaverse research, findings from multiple studies present some variations. While an appendix detailing these findings is included, a common thread in the studies is the examination of metaverse applications within educational processes. For instance, Abeles (2007) observed that integrating metaverse within educational approaches will foster innovation in both traditional and e-learning modalities. Further, multiple researchers, including Arcila (2014) and Schaf et al. (2012), found that the virtual space enhances active engagement, collaborative learning, and digital proficiency. Meanwhile, other studies noted benefits such as improved learning outcomes and enhanced subject comprehension (Table 8).

Table 8

Key Outcomes in Educational Metaverse Studies

Key Outcome	Study
Innovation in Educational Approaches	Abeles (2007)
Enhanced Active Engagement	Arcila (2014); Schaf et al. (2012)
Improved Collaborative Learning	Arcila (2014); Schaf et al. (2012)
Increased Digital Proficiency	Arcila (2014); Schaf et al. (2012)

Table 8 outlines the key outcomes observed in educational metaverse research, reflecting the positive impact of metaverse applications on educational processes and learning outcomes.

4. Discussion and Conclusions

Our examination of the academic literature confirms significant shifts in the educational landscape in recent times, as emphasized by sources like Jackman et al. (2021) and Moreno-Guerrero et al. (2021). Such shifts have been intensified due to the ramifications of the Covid-19 pandemic, leading to a transformation in traditional learning spaces (Daniel, 2020; Ratten & Jones, 2021). Contemporary learning environments, deeply rooted in virtual platforms and digital methodologies, have been crafted to ensure that pedagogical processes adhere to the principles of ubiquity (Schneider & Council, 2021). Within this digital and virtual shift, the concept of the metaverse gains distinct prominence (Díaz, 2020; Lee, 2021; Rospigliosi, 2022). The onset of these metaverse-driven digital realities, and their prospective integration into education, accentuates the importance of dissecting existing scholarly works in this domain.

Our assessment, rooted in articles from the WoS and Scopus databases and following the PRISMA protocol, unveiled several observations. Notably, there's a concentration of research emerging from Brazil and Spanish-speaking nations like Spain, Mexico, and Colombia. This reveals an evident gap in contributions from English-speaking and Asian countries, which historically dominate pioneering educational research. Such findings gain significance when juxtaposed against research indicating the United States' dominant role in the field (Abbate et al., 2022; Tas & Bolat, 2022; Tlili et al., 2022).

The studies in question predominantly utilize case study methods, with a minority employing quantitative, qualitative, or mixed methodologies. Most of these early endeavors draw from modest sample sizes and target university demographics. Tlili et al.'s (2022) insights align with our observations, suggesting the metaverse's novelty in academic circles. Instruments like tailored questionnaires (Arcila, 2014; Clark, 2012) and direct experiential observation (García, 2011a; Nurhidayah et al., 2020) form the core data collection tools.

Differing objectives emerge from our analysis. While some studies delve into the educational impacts of the metaverse (Abeles, 2007; Baynat & López, 2020), others are tailored towards metaverse-specific platforms and tools (Arcila, 2014; García, 2011b). This delineation showcases the broad potential for research, emphasizing a holistic and comprehensive examination of educational contexts.

In summing up, the metaverse's integration into education is in its nascent phase. While digital ecosystems and techno-pedagogical tools are becoming pervasive, there's a paucity of significant metaverse-centric educational endeavors. Hence, more expansive research, encompassing diverse methodologies and broader demographics, is imperative. However, one must approach these findings with circumspection due to the inherent constraints of systematic reviews. The subject is evolving, and research trends may shift in the upcoming years. Yet, the importance of a foundational review in a promising arena cannot be understated. Establishing a solid theoretical framework is essential for facilitating the metaverse's practical integration into educational settings.

The investigation into the educational metaverse has unveiled several core areas of focus that span across different countries and educational methodologies, revealing the depth and diversity of metaverse applications in education. The significant representation of countries like Brazil and Spain highlights a regional enthusiasm and commitment to exploring the potential of virtual environments in enhancing educational outcomes. These findings suggest a growing global interest in the metaverse as a transformative tool for educational practices.

Our analysis reveals a rich variety of aims within metaverse education research, ranging from the development of virtual tools and environments to pedagogical innovations tailored for digital realms. The diversity in objectives underscores the metaverse's capacity to support a wide array of educational activities, including the creation of immersive, interactive learning experiences that can cater to different educational needs and learning styles.

Despite the innovative approaches uncovered, the research methodologies predominantly employed were case studies, which, while insightful, limit the generalizability of the findings. The dominance of small sample sizes in these studies further restricts the ability to broadly apply these insights across diverse educational settings. Therefore, future research should consider incorporating larger, more diverse participant groups to enhance the validity and applicability of the results.

In terms of outcomes, the metaverse has demonstrated potential to significantly influence educational practices by fostering engagement, collaboration, and digital proficiency among students. These outcomes align with the emerging demands of modern education systems which seek to integrate technology more deeply into the learning process. However, the challenges of metaverse integration, such as technological accessibility, user adaptation, and the need for robust digital infrastructure, must be addressed to realize its full potential.

The discussion section has also highlighted a gap in the literature, particularly in the systematic review of existing studies. A more meticulous and comprehensive literature search and review would enrich the discussion by providing a more solid foundation for understanding the metaverse's current impact and future potential in education. This approach would also help in identifying and addressing any existing gaps in the research, thereby supporting more targeted and effective future studies.

In conclusion, while the metaverse holds promising prospects for revolutionizing educational methods and outcomes, a concerted effort to understand and mitigate its challenges is essential. The future of metaverse research in education should focus on expanding the scope of studies to include more diverse methodologies and larger participant samples, enhancing the literature base with comprehensive reviews, and developing frameworks that address both the opportunities and obstacles presented by such advanced digital environments.

This study aims to enlighten the academic and educational sectors about the metaverse's emergent role in learning. With some educational scenarios already leveraging the metaverse's potential, there's ample scope for broadening the research horizon. Exploring the metaverse's implications across various educational levels, from primary to tertiary, becomes vital. Additionally, the metaverse's immersive attributes present transformative opportunities for students with developmental challenges, enabling the transcendence of disability-induced barriers. As such, research into the metaverse's applications for students with unique learning requisites becomes paramount.

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