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Metaversity as the Learning Ecology in the Age of the Metaverse: A Systematic Review

Metaversidad como ecología de aprendizaje en la era del metaverso: Una revisión sistemática

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ABSTRACT

The recent pandemic forced the virtualization of educational processes around the world, which caused a series of problems in the quality of teaching due to the improvisation of its execution. The reappearance of the metaverse as a new social scenario has opened new possibilities to overcome the problems inherited by education during a pandemic. Therefore, the present study aims to review the literature on the emerging concept of "metaversity" through a systematic review. A methodology was developed following the PRISMA statement in the WoS, Scopus and Scielo databases. Twenty research studies were selected that were closest to the proposed concept of metaversity, where their main characteristics and scope are identified. The results show that, although there are no experiences that unify all possible areas to be developed in a virtualized university, there are fundamental advances in specific sectors. Educational benefits of the implementation of metaversity for students are identified, such as the improvement of cognitive skills and personalization of learning. The potential of metaversity to transform higher education is evidenced by offering not only the implementation of immersive learning but also a new center of virtual social interaction within the university campus.

RESUMEN

La reciente pandemia forzó la virtualización de los procesos educativos en todo el mundo, lo que provocó una serie de problemas en la calidad de la enseñanza debido a la improvisación de su ejecución. La reaparición del metaverso como nuevo escenario social ha abierto nuevas posibilidades para superar los problemas heredados por la educación durante una pandemia. Por lo anterior, el presente estudio tiene como objetivo revisar la literatura en torno al concepto emergente de la «metaversidad», a través de una revisión sistemática. Se desarrolló una metodología siguiendo la declaración PRISMA en las bases de datos WoS, Scopus y Scielo. Se seleccionaron 20 estudios de investigación que más se aproximaban al concepto propuesto de metaversidad, en donde se identifican sus características y alcances principales. Los resultados muestran que, aunque no existen experiencias que unifiquen todas las áreas posibles a desarrollar en una universidad virtualizada, sí existen avances fundamentales en sectores específicos. Se logra identificar beneficios educativos de la implementación de la metaversidad para el estudiantado como la mejora de habilidades cognitivas y personalización del aprendizaje. Se evidencia el potencial de la metaversidad de transformar la educación superior ofreciendo no solo la implementación del aprendizaje inmersivo sino un nuevo centro de interacción social virtual dentro del campus universitario.

KEYWORDS | PALABRAS CLAVE

Metaversity, Metaverse, ICT, Extended Reality, Higher Education, Systematic Review.
Metaversidad, Metaverso, TIC, Realidad Extendida, Educación Superior, Revisión Sistemática.

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1. Introduction

The pandemic, a product of the COVID-19 virus, has negatively affected the quality of education of nearly 90% of the world's student population (Monasterio & Briceño, 2020). This was mainly due to the decision of most educational institutions to suspend classroom attendance. This was the main strategy to reduce the spread of the virus, forcing the hasty adaptation and migration of the training process to "virtual environments", which in turn gave rise to the so-called Emergency Remote Education (ERE), whose implementation has been widely questioned due to its negative repercussions. ERE, coupled with the few digital competencies possessed by teachers and students (Alotaibi, 2022; Fardoun et al., 2020), the weak technological infrastructure of schools, and the lack of support processes for virtual education (Mad et al., 2020), have ramped up the complexity of the work of teachers. On the other hand, technology has also been a fundamental pillar in the process of overcoming all the negative effects left by ERE.

Positive aspects have also been derived from the implementation of ERE, such as the incorporation of disruptive technologies to the training process and pedagogical innovation, which have been accepted in post-pandemic education, given their proven potential and growing use, which has enabled great progress towards excellence in training. New technologies have facilitated the development of new experiences inside and outside the classroom, especially those associated with virtuality such as extended reality (virtual reality, augmented reality and mixed reality), which has laid the foundations for the birth of a new learning ecology in higher education.

The new global scenario has led to the need for universities to look to the future of the new educational model and all the activities that support it, incorporating the capabilities of the new type of student, known as the digital native. The virtuality implemented by ERE exposed the need to update many of the existing curricular and administrative processes, as well as the creation of new ones, in order to ensure the internal functioning of these education institutions and guarantee their operational continuity under the quality standards normally required. Universities have had to learn from the lessons left by ERE, enhancing new digital competencies of their actors, which are highly necessary in the hyperconnected context that the post-pandemic society lives, and where the so-called "Metaverse" seems to be the next evolutionary step of the educational environment, so it should be widely studied with objectivity and scientific rigor. For the reasons described above, the present research aims to compile and review the literature in relation to this emerging learning ecology in higher education.

1.1. Literature Review

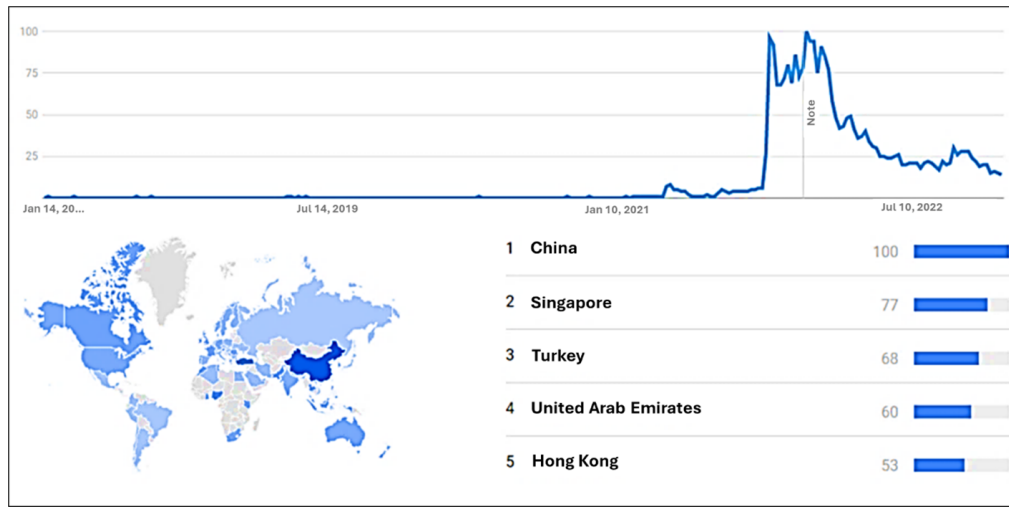
The word "metaverse" is an acronym composed of "meta", which comes from Greek and means "beyond", while "verse" refers to "universe", so the term alludes to a universe beyond the one currently known. The first recorded use of the term metaverse usually relates to the science fiction novel by Stephenson's (1992) called "Snowcrash," but as a concept, its use dates back much earlier, to the novel "Pygmalion's Spectacles" by Weinbaum (1935) in which the author narrates how one of the characters invents special glasses that allow seeing, hearing, tasting and touching things and people inside a virtual world. Recent literature defines the metaverse through different approaches and visions (Kountouridou, 2022; Park & Kim, 2022) but in general it is seen as the evolution of the internet (web 3.0), a unified network of virtual worlds in three dimensions, which is interoperable, massive in scale, operates in real time, and can be experienced by an unlimited number of users, where each one of them has a visual sense of presence and identity, and has the ability to be beyond the boundaries and controls of corporations and governments (Ball, 2020). Other characteristics of the metaverse proposed by Stephenson, also manage to remain in force today, as pointed out by Mystakidis (2022): 1) it is a metaphor for the real world, 2) the virtual avatars of users are customizable, facilitating telepresence, giving the ability of corporeality, 3) users are able to communicate with each other within the metaverse, and can interact with it, 4) it continues to function and develop despite the fact that some or all of its members are not connected to it.

Figure 1 shows the number of Google searches for the word "metaverse" in chronological order, where an exponential growth is evident, coinciding with the public announcement by Facebook CEO Mark Zuckerberg of the change of Facebook's company name to Meta in October 2021, and the information that this new company would focus on the creation of the metaverse (Muthuswamy & Al-ameryeen, 2022; Zuckerberg, 2021). Although the metaverse is not a new concept, this relaunch in the context of a pandemic, where people turned massively to the use of virtuality, has driven a renewed interest in the subject worldwide, generating abundant discussions

in the mainstream media and in various scientific and technology enthusiasts' forums (Novak, 2022).

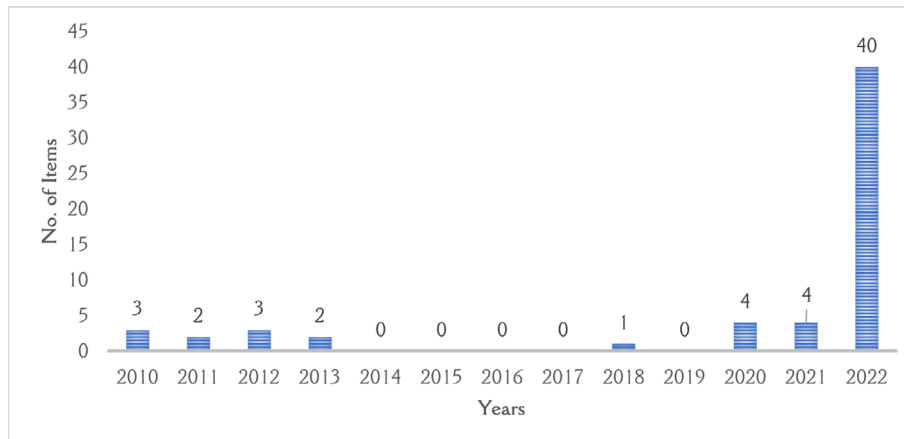
Since then, Meta has devoted its efforts to the creation and acquisition of immersive technology hardware and software in the areas of video games, fitness, social networks, entertainment and productivity, while leaving aside specific applications for education. Other companies have also been developing immersive technologies, but with a focus on their use in virtual worlds aimed at imparting knowledge, for example, platforms like TimeRide (2018) which allows immersive technologies to be used to experience everyday life in other centuries. In addition, companies such as ClassVR (Kurniawati, Kusumaningsih, & Hasan, 2019), NearpodVR (Wang & Chia, 2022) or MergeEdu (David Blas et al., 2022) have already developed hundreds of individual learning scenarios, so the possibility of a new learning ecology based on the metaverse remains within the reach of universities.

Figure 1: Trends of Interest in the Metaverse in Google Trends.



A brief search in the Scopus database for the keywords «Metaverse» and «University», shows the boost in scientific production in the months following Zuckerberg's announcement, as can be seen in Figure 2. This scientific production is summarized in the literature reviews included in the quick search results sheet showing its main objectives (https://doi.org/10.6084/m9.figshare.23203004.v1), which serves as a first approach to the state of the art on the subject.

Figure 2: Chronological Distribution of Scientific Production in Relation to the Metaverse.



1.2. Metaversity as a New Ecology of Learning

Currently, the concept of "metaversity" involves the metaverse and the university, but goes beyond the use of immersive technologies within the learning process to encompass the entire learning ecology in higher education (Sutikno & Aisyahrani, 2023; Zheng, Huang, & Zhou, 2024). It is easy to deduce that the word metaversity comes from the fusion of the words metaverse and university, but its concept exceeds the implementation of immersive learning in classrooms, as it involves the creation of a virtual meeting point that puts all the actors within a higher education center in contact, such as teachers, students, researchers, administrative staff, and other stakeholders. In metaversity, all of these roles and functions are fully exercised, and the physical infrastructure and pedagogical resources are represented or reproduced through digital twins (Lee et al., 2024).

Metaversity could be experienced at its own pace, where typical administrative processes such as student enrollment, tuition payment, consultations with directors, professors, or pedagogical processes such as teaching undergraduate and graduate students, as well as research and social interaction, and even recreational or recreational activities would take place. All these instances would be enhanced by the advantages of virtuality and new immersive technologies, such as the use of learning objects modeled in three dimensions (human organs, historical artifacts, molecules, mechanical structures, etc.). In metaversity, traditional classrooms can be replaced by specialized learning rooms focused on the particular subject matter, such as a spaceship, a dinosaur island, an art history museum or even a nuclear power plant, where the student can interact in a safe and controlled way with the added virtual elements, visualizing physical phenomena that resemble the real ones. Classes taught live by the teacher can be recorded and stored in a content repository so that they could be accessed and consulted by the students whenever they consider it necessary (bin Ahmad Al, 2024; Laurens-Arredondo & Laurens, 2023).

Metaversity and the platforms that support it have the ability to work with technological tools other than immersive ones, such as Big Data for data collection, artificial intelligence for data analysis and real-time decision making, the Internet of Things for anytime, anywhere connectivity, and blockchain for user identification and e-commerce. Another important feature of metaversity is that it would have the ability to be geographically agnostic, i.e., its users can interact, even if they are physically hundreds of kilometers apart.

Given the novelty of this concept of metaversity, this research aims to map the available literature on the subject, bringing together the various advances made through a state-of-the-art approach, in order to provide an overview of the existing scientific evidence with the objective of detecting gaps and challenges in its implementation.

To achieve the above, this study defined five guiding research questions, posed as follows:

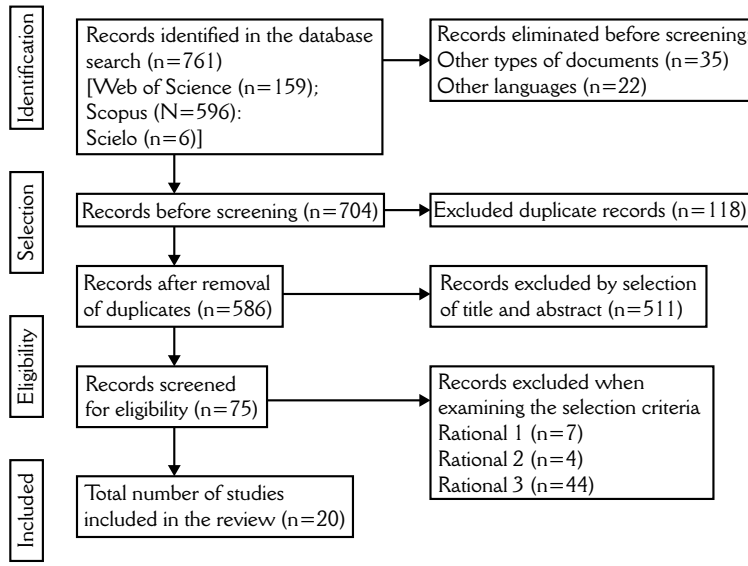
- -RQ1: What is the state of research on the concept of metaversity?
- -RQ2: What are the characteristics of the studies included in this review?
- RQ3: What are the main countries represented in the items gathered?
- RQ4: What are the research scopes of the collected articles?
- RQ5: What are the gaps in the state of the art?

2. Method

Given that the review of previous studies revealed only a few investigations related to the use of the metaversity concept described above, the present research aims to obtain a general understanding of the trends, areas of application, target audience, and main experiences of its implementation. To achieve the above, a systematic search of the scientific literature was conducted following the guidelines of "Preferred Reporting Items for Systematic Reviews and Meta-Analyses - PRISMA" (Page et al., 2021), which is summarized in Figure 3.

In this systematic literature review, English and Spanish language publications of peer-reviewed journal articles, books/conference proceedings and systematic literature reviews were considered, with the aim of achieving credible results and solid scientific references. To provide a comprehensive search, the Web of Science, Scopus and Scielo databases were selected, since they are highly reliable databases, and are commonly consulted in the scientific world. The search was restricted to publications published between 1996 and 2023 (January 1).

Figure 3: Article Selection Process for Review (adapted from PRISMA flowchart).



2.2. Search String

A first approximation through an initial non-systematic search yielded approximately 59 articles, which served as a basis for determining the main terms used in titles, keywords and abstracts.

The following terms were selected: "metaversity", "metauniversity", "university", "higher education", "metaverse", "metaverses", "immersive experience", "extended reality", "web 3.0", "digital twin". The above terms were connected with Boolean operators ("OR" and "AND"), depending on whether the words describe similar or different ideas. Other operators were used to search for phrases, and for the right truncation of a word in order to find all its forms, obtaining the following search equations, for each of the databases:

- WoS: TS=(metaversity OR metauniversity OR university OR "higher education") AND TS=(metavers* OR "digital twin" OR "web 3.0" OR "immersive experience" OR "extended reality")
- Scopus: TITLE-ABS-KEY (metaversity OR metauniversity OR university OR "higher education") AND TITLE-ABS-KEY (metavers* OR "digital twin" OR "web 3.0" OR "immersive experience" OR "extended reality")
- Scielo: TS=(metaversity OR metauniversity OR university OR "higher education") AND TS=(metavers* OR "digital twin" OR "web 3.0" OR "immersive experience" OR "extended reality")

In this systematic review, the search strings were designed to search the title, keywords, and abstract of the article.

2.3. Eligibility Criteria

Articles had to meet the following criteria to be included in this review: 1) all types of studies on implementations of the metaverse or immersive technologies within the university context that are covered by the scope of the metaversity concept proposed in the present study. 2) Manuscripts included are original, as well as conference proceedings. 3) All papers are peer-reviewed and published in English and Spanish, regardless of the country of origin. Studies published in other languages without available translation are excluded. Also, letters to the editor, editorials, and abstracts were excluded from the study, as well as any type of research that was limited only to immersive learning experiences at the university. Studies of immersive experiences outside the university context were also excluded. The type of participants in the included studies were university students, faculty, and other staff at institutions of higher education. Primary, secondary, and other participants outside the university context were excluded. After selecting

the related studies, data extraction was performed in a data extraction table designed in MS Excel. Data were analyzed through the content analysis method, and the results were summarized and reported in related tables and figures. The program Rstudio version 2022.12.0 and the Bibliometrix and Biblioshiny libraries were used as they are quantitative tools commonly used in bibliometrics for this type of studies.

2.4. Selection Process

A total of 761 publications were obtained, of which 159 belong to the Web of Science database, 596 to the Scopus database, and 6 to the Scielo database. The overall database obtained can be viewed at https://doi.org/10.6084/m9.figshare.23198942. A total of 175 studies were excluded before the initial analysis (duplicates = 118; other reasons = 57) and were subsequently removed from the registry. A screening and filtering process was then performed according to the PRISMA guidelines (Moher et al., 2009) as shown in Figure 5, which resulted in 55 ineligible articles considering the established criteria. As a final result of this process, 20 publications were relevant for this systematic literature review after selection by eligibility criteria, which formed the database used for the analysis and can be seen in the table of characteristics of studies included in https://doi.org/10.6084/m9.figshare.23203415.v1.

2.5. Quality Assessment

After identification of eligible articles, the procedure by Tang et al. (2022) was used, which consists of determining a scoring system to judge the quality of each article analyzed, in which two experts external to the research scored the articles according to a series of previously established qualification criteria. The score for each criterion ranged from 1 to 5 (1= poor quality; 3= average quality; and 5= excellent). Discrepancies in the opinions or evaluations of the experts were resolved by the rating assigned by the author of this paper. The criteria used were derived from those of Feng et al. (2018), and consist of the following questions:

1. Are the research objectives clearly identified?
2. Is the context or discipline of the study adequately specified?
3. How appropriate is the study to answer the research questions of this study?

Final scores were averaged, and papers with scores equal to or lower than 3 were excluded from further analysis (average quality score = 4.2). The risk of bias assessment matrix was performed using the Cochrane tool, since it provides a structured and transparent assessment of the quality of the included studies.

3. Results

This section presents the key findings of the systematic review conducted in the study, in relation to the research questions posed.

3.1. RQ1 - What is the State of Research on the Concept of Metaversity?

The results obtained show the incipient degree of research on the use of virtual platforms and immersive technologies in the university context, especially those that go beyond the implementation of immersive learning, as evidenced in the table of characteristics of studies included in the systematic literature review (https://doi.org/10.6084/m9.figshare.23203415.v1). At the date of completion of this study, there are no documents that show the formal implementation of the concept of metaversity in the databases consulted, but approaches that are close to a greater or lesser extent were identified. Among the closest are some that are more theoretical, such as the discussions raised by Figueiredo (2022) through his proposal for a speculative and pragmatic reinvention of rhetorical pedagogy for the metaverse, or the proposal by Shen et al. (2021) of reconstructing the learning area and fostering the educational revolution through a new learning community supported by the use of digital twin technology. Other studies are more practical, such as the uses of digital twins of university campuses conducted by Yali and Huijie (2020), Mohammadi et al. (2021), and Ukko et al. (2022) where different daily activities of university life are represented, developed and optimized.

Despite not having found a full and intentional development of metaversity experiences at present, the findings show important advances in different aspects that are within the scope of this concept, and can be grouped into different categories:

- *Virtual campus services:* such as those developed by Sebastien, Sebastien and Conruyt (2018), Suen,

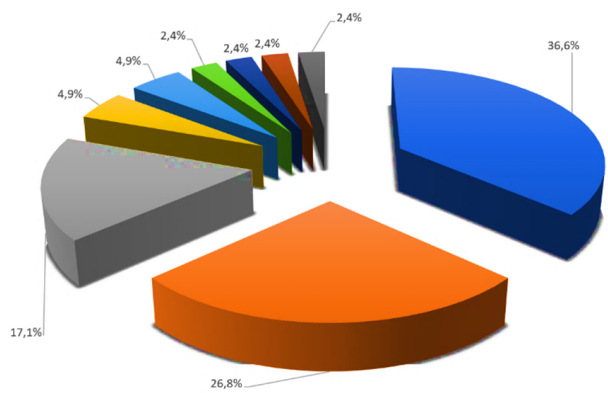
Chiu and Tang (2020) or Ellern and Cruz (2021) who show experiences of providing services in real-time virtual mirror worlds, exploring educational applications and other utilities.

- *Formative processes in the metaverse:* one of the areas where most progress has been made is directly related to formative processes, such as those presented by Jeong, Choi and Ryu (2022) o Pigultong (2022) who manage to design and implement a metaverse integrated to a learning management system. On the other hand, Yin et al. (2020) show how immersive technologies framed in a formative metaverse can improve the academic performance of its users. Taiwo (2022) exposes the use of the metaverse in the university to help students think in more present, relational, and multidimensional ways.
- *Experimental technological implementation:* other researchers have addressed the technical feasibility of the implementation of immersive technologies, such as that developed by Braud, Fernández and Hui (2022), who experiment with the use of augmented reality on a large scale and shared among visitors to a university campus, or that developed by Córdova-Solís (2020), who tests the potential of virtual reality to provide an immersive space that replicates a university campus for student-teacher and student-student interaction, as well as the work of Frania et al. (2022), who also address these interpersonal relationships in the web 3.0 era, and the work of Staroverova, Urintsov and Sviridova (2021) who develop a methodology for the creation of a digital teacher profile in the metaverse.
- *Virtual social integration:* such as the experiences carried out by Rapanotti and Hall (2010), Hadzi (2021) o Han et al. (2022), who successfully combine metaverse technologies with a university campus, and elements of social, cultural and artistic expression sciences. Bucea-Manea-Ţoniş et al. (2020) show how work-life balance is positively influenced by the inclusion of extended reality in the e-learning process.

3.2. RQ2 - What are the Characteristics of the Studies Included in this Review?

Figure 4 presents the distribution of research in different fields or subject areas. The findings show that 36% of the selected studies were used in computer science, followed by social sciences (26%) and engineering (17%), which accounted for 80% of the publications. The motivation for using immersive technologies in the context of metaversity by the computer sciences is due to their innovative nature, and their relationship with the state-of-the-art technological resources usually used in this discipline. The use of this technology by the social sciences can be explained by its direct involvement in the educational sector, which is one of the scenarios where the greatest number of experiences have been carried out, as well as the possibility of new developments in learning methodologies, and its proximity to digital natives, who make up the new generation of university students. In specific disciplines such as engineering, its use is explained by the ability to provide technical support for the development of immersive experiences, and the proximity of this discipline to 3D modeling of three-dimensional virtual elements through specialized software.

Figure 4: Distribution of Articles by Discipline or Area of Study.



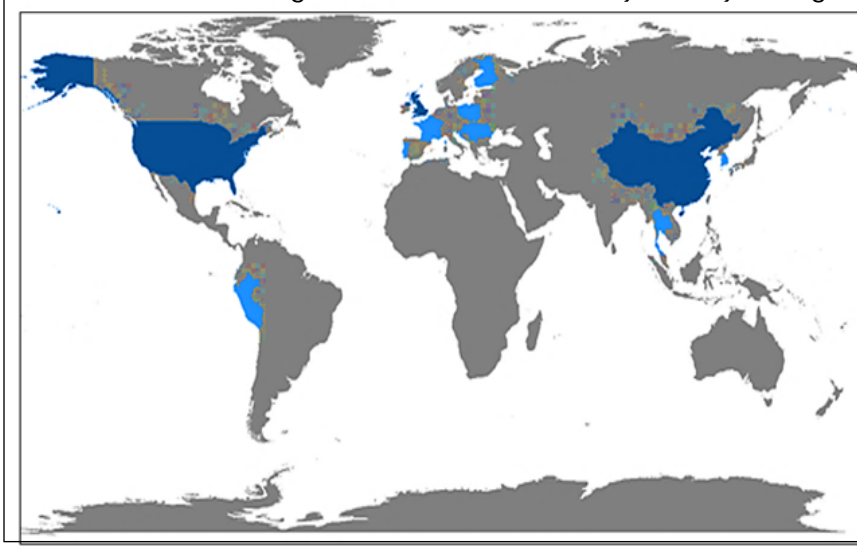
Subject Area	No. Studies
Computer Science	15
Social Sciences	11
Engineering	7
Arts and Humanities	2
Decision Sciences	2
Energy	1
Environmental Science	1
Mathematics	1
Physics and Astronomy	1

Most of the papers found were conference proceedings (50%), followed by journal articles (45%) and finally systematic reviews (5%). The interest in conference papers can be explained by the faster publication processes of proceedings and the effort of academia to quickly understand the promises and potential of the technologies associated with the metaverse. The scarcity of systematic reviews is due to the emerging nature of the subject under study.

3.3. RQ3 - What are the Main Countries Represented in the Articles Included?

The scientific publications found for all databases involved authors and organizations from 18 countries of origin, as can be seen in Figure 5, where the country of affiliation of the first author was considered to present the distribution of research. The results show that only three countries published three or more papers. The countries with the most publications were the United States (12%), United Kingdom (12%), China (12%), and Hong Kong (8%). The geographical distribution was mainly concentrated in the American, European and Asian continents with just under half of the publications (43%). None of the publications came from Africa or Oceania, which could be explained by the limited infrastructure in most of these countries or the lack of interest in the implementation of immersive technologies.

Figure 5: Distribution of Items by Country of Origin.



Country	No. Studies
China	3
United Kingdom	3
United States	3
Hong Kong	2
Croatia	1
Finland	1
France	1
Hungary	1
Malta	1
Peru	1
Poland	1
Portugal	1
Romania	1
Russian Federation	1
Serbia	1
Singapore	1
South Korea	1
Thailand	1

3.4. RQ4 - What are the Research Scopes of the Collected Articles?

The scopes of the research included in the present study, for the selected databases, are shown in the characteristics of the studies included in the systematic literature review (https://doi.org/10.6084/m9.figshare.23203415.v1).

3.5. RQ5: What are the Gaps in the State of the Art?

The emergent character in the application of metaversity detected in the present document opens the door to many questions that still do not have a firm answer. All of these coincide with the six fundamental pillars for the creation of the new learning ecology based on the metaverse proposed by Lee et al. (2021) and are described below:

- «Avatars». Although existing technology can capture the characteristics of our physical appearance and automatically generate their movements, mobile sensors are not fully developed, which may limit the ubiquitous nature of metaversity, and its real-time use. Additional efforts are required to improve micro-expression, the non-verbal expression of avatars, and their interaction with current smart devices.

- «Content creation». The creation of virtual models in three dimensions is currently restricted to design professionals, which goes against the universality of metaversity. The research and development of platforms can bring all stakeholders closer to the overall design of this digital universe.
- «Virtual economy». Advances in the adoption of cryptocurrency as a digital transaction element have been successfully developed, but few experiences have been developed that address the transition between the traditional and virtual economy.
- «Social acceptance». Collective judgments and opinions of relevant actors are aspects that are necessary for the establishment of metaversity, but they haven't been significantly addressed by researchers on the subject.
- «Security and privacy». The design of strategies and technologies to fight cybercrime is an aspect of utmost importance for the correct operation of the metaversity. The protection of digital assets is vital to ensure the future viability of the metaverse. Experiences with the use of blockchain have been a first step, but the means of identification, its interconnection with the internet of things, or the "wearables" have not yet been developed.
- «Trust and Accountability». Current research has not been able to define a framework based on ethical principles that can define and regulate the privacy of personal or biometric data at the same pace at which technological innovations develop. Future studies should address issues such as minority rights, vulnerable communities, or socially sensitive issues as the new metaverse-based learning ecology evolves.

4. Discussion and Conclusions

More than a few authors predict the success of the metaverse in economic, social and educational terms, and its positive impact on people's daily lives (Dwivedi et al., 2022; Jagatheesaperumal et al., 2022). The current literature shows different proposals and successful experiences in areas such as: health (Abdelwahed, Al Doghan, & Soomro, 2022; Skalidis, Muller, & Fournier, 2023), manufacturing (Hernández-Ascencio & Angel-Alvarado, 2022; Yao et al., 2024), maintenance (Lee, Woo, & Yu, 2022), smart cities (Allam et al., 2022), gaming (Chia, 2022), entertainment (Niu & Feng, 2022), commerce (Popescu, Valaskova, & Horak, 2022), human resources (Choi, 2022), real estate (Hutson et al., 2023), financial services (Seth & Seth, 2022), utilities (Yfantis & Ntalianis, 2023), transportation (Njoku et al., 2023), tourism (Buhalis, 2020), and vocational training (Hurtado et al., 2022), which seem to evidence the above.

The implementation of the metaverse offers many opportunities, particularly in universities, given the significant impact on students' cognitive development as evidenced by recent studies. Metaversity, by combining the use of immersive technologies with the teaching process, promotes greater retention of information and meaningful learning (Ariani, Sumardjo, & Marzuki, 2022; Pigultong, 2022). These technologies allow students to experience and explore complex concepts in a tangible and visual way, which enhances understanding and facilitates active learning, fostering higher cognitive skills such as critical thinking and problem solving (Bhattacharjee et al., 2018). In addition, the ability to personalize and adapt environments to individual needs contributes to a more learner-centered approach to learning, enhancing learner autonomy and intrinsic motivation (Jeong et al., 2022).

Metaversity not only represents a technological evolution in education, but also a powerful tool for the cognitive development of students; however, it also generates many questions and issues still under development, which is why this research delves into a new concept of metaversity, where we try to group the applications of metaversity around higher education, going beyond immersive learning in the formative process of students. The construction of the state of the art of this novel definition was approached through five research questions to answer the general objective. The findings show the emerging stage of the concept of metaversity, since there are no experiences that cover its implementation, but development exists on very close approximations and innovative experiences in several of its main aspects.

This incipient state in the level of research is to be expected, given that the technologies necessary for its full implementation are in full development, which makes all those studies of previous decades mere projections of the near future (RQ1).

The results also show that most of the documents found correspond to the areas of computer science, social sciences and engineering. The largest number of publications were conference proceedings, followed by articles and systematic reviews. There was evidence of a substantial increase in the number of publications

from the year 2020, following a trend line that predicts a continuous increase in the coming years (RQ2).

The United States was the country with the most associated publications, followed by the United Kingdom, China and Hong Kong, which suggests the origin of the organizations with the greatest advances in this regard. There are still many academics and institutions from Africa and Oceania with no scientific publications on metaversity, and very few from countries in the Americas and Europe, which represents an opportunity to expand research globally (RQ3).

The studies addressed have explored a variety of applications and possible benefits of the concept of metaversity, such as the improvement of students' cognitive skills through the use of immersive technologies, the increase in students' motivation and autonomy given the possibility of personalized learning environments, the development of digital twins and the provision of educational services in virtual environments, and the application in interdisciplinary areas (RQ4).

Despite the benefits and advances identified, there are still gaps and challenges with the implementation of metaversity, such as ownership, accessibility, interoperability, security, social acceptance or trust of people in the use of this type of platforms and technologies, especially in the educational field. In addition, the interdisciplinary nature of metaversity brings to the fore many other points, which also represent a great opportunity for researchers, such as assessing the implications of the prolonged use of this type of technology for people's mental and physical health (RQ5).

The present systematic review had the intention of analyzing the characteristics of research related to the concept of metaversity, where its great potential and benefits for higher education were evidenced, but also shone light on its incipient character. The replacement of the real world by metaversity does not seem to be as close as the enthusiasts of this technology would like, despite the fact that the level of its current development gives the ability to virtualize in real time those details that give the perception of reality (facial expressions of people, their gestures, eye contact and even physical contact).

The present study had several limitations. The first is that it is limited to only three databases (WoS, Scopus, Scielo), which, although they are mainly used in the scientific world, there are several others that can also be consulted by researchers. Second, the type of document consulted was restricted to scientific articles, conference proceedings and systematic reviews, leaving aside other types. Third, only documents in English and Spanish were included. Fourth, the country of affiliation of the first author was used to determine scientific production. For future analyses, books, book chapters, letters to the editor and other high quality scientific publications in languages such as Portuguese could also be included.

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