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The Metaverse in University Education during COVID-19: A Systematic Review of Success Factors

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Abstract. The experiences that the COVID-19 pandemic brought led educational institutions to use disruptive technologies that guaranteed continuity of learning in the face of any adverse scenario, ranging from the conceptual to the experiential. This article aims to describe how the metaverse contributed to university education, and through these factors the success of its application was evidenced. For which a systematic review of the literature was developed. The research is exploratory-descriptive level. A total of 738 documents from the Scopus, ERIC, Taylor & Francis, and Google Scholar databases were reviewed, from which 16 articles were finally extracted. The content analysis technique was used through the Atlas Ti software. With this, it was obtained as a result that the type of metaverse used to a greater extent was virtual reality. Likewise, the areas of study in which they were applied to a greater extent are in education: medicine, engineering and administration. In addition, the factors that evidenced the improvement in university education as an effect of the application of the metaverse are academic performance and interaction between students. It is concluded that, given the pandemic scenario and the need to continue the teaching-learning process considering the limitations offered by the virtual modality in which experiential learning is not developed, it led to the development of learning scenarios through the metaverse. However, it will be necessary to reduce the gaps in terms of teaching skills, create teaching scenarios in the virtual world, use and evaluate them permanently.

Keywords: metaverse; virtual reality; augmented reality; university education; COVID-19

1. Introduction

The scenario of the COVID-19 pandemic made us rethink the work that had been carried out in higher education (Acevedo-Duque et al., 2021; Chura, 2022). Given technological tools were hardly used in education before the pandemic, social isolation required teachers and students to adapt to their use (Delgado et al., 2021; Díaz et al., 2021). This new context triggered an acceleration in the adoption of innovative and disruptive technologies in different fields (Cruz et al., 2022; George-Reyes et al., 2023; Sánchez et al., 2022). Higher education is a sector in which its immersed processes are constantly changing, which makes it a favorable field for the application of disruptive technologies (Zuñiga et al., 2021); the same ones that contribute to the refinement and improvement of study plans and strategies and set challenges for teachers and students (Arceo & Tirado, 2022). That is why new active methodologies in virtual pedagogy must be innovated and implemented, inserting disruptive technologies with collaborative platforms into online education (Romero & Hormaza, 2022).

Virtual education admits a permanent update as technological advances are developed and new forms and learning environments are created (Martínez et al., 2019); although in recent years innovation in educational technologies has been extensive, there are still problems in the communication processes that lead to the appropriation of knowledge (Castro et al., 2021). The world of digital transformation has given rise to an accentuated management of technologies

with the assertion of optimizing the teaching and learning process, particularly that corresponding to the creation of immersive, multisensory 3D or metaverse ecosystems (Barráez-Herrera, 2022; González & Manjón, 2022; Reyes, 2022). These scenarios offer a repertoire on a three-dimensional contour in the opportunity and possibility in which it is afforded to reproduce an unknown and unique ecosystem, wherein learning emerges (Briceño, 2022; Luna, 2022).

The creation of a virtual learning environment mediated by a metaverse allows the student to be motivated and familiar with the way characters are created and presented (Moreno & Raúl, 2016; Pérez & Crespo, 2022). The metaverse is conceptualized as fictional constructions in which the participants interact through avatars, trying to reproduce real life in a virtual metaphor environment, without space-time limitations (Felip, 2023; González et al., 2022; Hurtado-Chong et al., 2022; Vidal, 2022). The metaverse is a record of the life of its users, where they interact in a mirror world with augmented reality and virtual reality; this space is oriented toward reality, but focused more on the virtual (Quiroz, 2022). In addition, the metaverse supposes the development of a network of virtual environments in which users can carry out different activities in an immersive way (Arias & Alexandra, 2016; Buitrago & Yesid, 2016; Herrero, 2023; Ramallal et al., 2022). Immersion refers to the subjective reaction users experience when immersed in a virtual environment, such that the brain behaves in a similar way as when it is in the real world (Celis & Maria, 2016; Ortega-Rodríguez, 2022). Another feature of the metaverse is linked to the persistence or ability of the metaverse to allow users to stay in it for a longer time (Li, 2022). Since the meaning of the metaverse goes far beyond the association with three-dimensional virtual worlds, certain categories or types of metaverses found in the network are developed (Florido & Oswaldo, 2016; Pelaez, 2014). It is possible to identify at least four different types: augmented reality, virtual reality, lifelogging and mirror world (Mendiola, 2022; Sánchez et al., 2022).

Augmented reality superimposes images, 3D models, or other computationally generated information onto a real image (Cabero-Almenara et al., 2021; Carrillo & Vera, 2022; Pérez et al., 2021); it is capable of complementing perception and interaction by providing the user with a real scenario augmented with additional computer-generated information (Barrera, 2021;Muñoz -Hernandez et al., 2020). While "lifelogging" or life record, consists of capturing data on human activity in real time (Rincón et al., 2019), recording behavioral information and storing it for knowledge extraction in a later state or context (Climent-Pérez et al., 2020). So we also have the type of metaverse called mirror world that makes it possible to access the reflected real world through the provision and integration of information taken from the external environment (Mujica-Sequera, 2022); it can be recognized through virtual map applications and modeling using GPS technology, such as Google Earth, Google Maps, Naver Maps, and Airbnb (Gómez et al., 2022). Finally, virtual reality is about immersive technology that seeks to create the complete immersion of the user in a totally virtual world, simulated and alien to their real or physical environment (Mariscal et al., 2020; Portela, 2022). These alternative realities make it possible to leave the classroom

and learn from what is seen, that is, it is discovery-based learning (Alvarado et al., 2019; Tzancoff et al., 2019). However, one of its limitations is related to the digital divide, because its use requires mid-range mobile devices and internet connectivity in educational institutions, and there is a lack of digital literacy among teachers and students (Reyes, 2020).

Taking the above as a reference, this article shows the findings and results of the systematic review of the literature, which seeks to explore the contributions of the metaverse to university education, in the context of COVID-19. For which the PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses) methodology was used, which led to the identification, projection, choice and inclusion of scientific articles for the systematic review. Based on the above, the following research questions were defined:

- RQ1: What types of metaverse were used to a greater extent in university education, in the context of COVID-19?
- RQ2: In what areas and fields of study of university education was the metaverse used to a greater extent, in the context of COVID-19?
- RQ3: What factors evidenced the success of the application of the metaverse in university education, in the context of COVID-19?

2. Literature Review

Considering the metaverse and higher education as study variables, it is significant to refer to some studies that define the current context in which both variables are linked. Gonzales et al. (2022), in their research work on the metaverse in higher education, point out that the metaverse is a fictitious construction in which the participants interact through avatars created by themselves trying to reproduce participation or real life. In the same line of opinion, Ruiz-Campo (2022) establishes that the main characteristic of the metaverse is that the creation of images is required, combining fantasy and multimedia technology with extensions of the real world. Thus, when linking it with higher education, Barraéz-Herrera (2022), in his study on the metaverse in virtual education, affirms that metaverses are by themselves simulated immersive 3D media in real time, whose ecosystem is adequately adapted to host audiovisual notifications, which result in imposing configurations in training or pedagogical places. In this regard, Anacona et al. (2019) point out that higher education is looking for strategies to use the metaverse in order to achieve greater interaction between students and learning resources, in such a way that the contexts managed in the past are able to evolve.

3. Methodology

The research level is exploratory-descriptive. It is exploratory because it is intended to obtain or acquire information from examining findings or results of scientific publications related to the contribution of the metaverse in university education in the context of COVID-19. An exploratory type of research is when it is intended to acquire a first approach to the situation that arises as a problem, supported by documentary type analysis (Contreras, 2021; Munguía et al., 2019). It is also descriptive because it is intended to characterize aspects obtained in response to how the metaverse contributed to university education in the

context of COVID-19. Descriptive research is used to expose aspects or characteristics of a particular subject, which contributes to achieving the researcher's study objectives (Tarodo et al., 2020). Likewise, the type of research is theoretical since it is intended to contribute to existing knowledge about how the metaverse contributed to university education, in a defined context or period. Theoretical research has the purpose of supporting and collaborating in future studies, generating knowledge (Bardales, 2021), regarding the application of the metaverse in post-pandemic or hybrid teaching scenarios.

3.1 Study objectives

In accordance with the research questions, and considering the methodological aspects indicated in the previous section, the objectives of the study to be achieved in this systematic literature review are:

- Objective 1: Determine the types of metaverses that were used to a greater extent in university education, in the context of COVID-19.
- Objective 2: Determine the areas and fields of study of university education in which the metaverse was used to a greater extent, in the context of COVID-19.
- Objective 3: Determine the factors that evidenced the success of the application of the metaverse in university education, in the context of COVID-19.

3.2 Data collection instrument

The instrument used for data collection, due to the nature of the article, was scientific documents that demonstrate coherence and agreement with the subject of study, and was structured based on the criteria established in the PRISMA declaration, through which the identification and selection of scientific articles eligible for the phase of analysis and synthesis of findings was achieved. The PRISMA declaration contributes to the selection of data or bibliographic references linked to the research questions, for which it is necessary to define a search strategy, as well as the inclusion and exclusion criteria of the study (Yepes-Nuñez et al., 2021). It should be noted that a systematic review is a form of research that compiles and provides a summary on a specific topic aimed at answering one or a set of research questions that must be developed according to a pre-established design (Eguía, 2014). Unlike narrative or bibliographic reviews, it is not necessary to establish a rigorous protocol; it is mainly used to determine the background and theoretical foundation of what has been done or not in a certain investigation (Grijalva et al., 2019).

3.3 Data collection procedure

The scientific articles selected for analysis in this systematic review were extracted from the Scopus, ERIC, Taylor & Francis, and Google Scholar databases. The selection criteria for the databases were , first of all those that contain documentation related to the subject of study, in this case on the metaverse in higher education. It should be noted that there are many databases that only contain scientific documentation of a specific area of knowledge such as medicine, social sciences or engineering. The second criterion was that the databases provide open access to scientific documentation. Also here it is

specified that not all databases provide this privilege to their readers. This is how the databases were chosen, and, taking into account the research questions, it was possible to extract the keywords with which the search for bibliographical references was generated through the search equations. Table 1 shows the search equations for each database, always considering the keywords. Once the keywords and the possible relationships between them have been determined using the "AND" and "OR" Boolean operators, the search equations will be structured (Chamorro-Atalaya et al., 2023;Gelvis-Salamanca et al., 2021). In addition, these search equations optimize the selection process of articles, which will require inclusion and exclusion criteria to establish if they are eligible for the systematic review process (Castellanos-Domínguez et al., 2020).

Table 1: Search equation

Database	Search equation
SCOPUS	(((TITLE-ABS-KEY (metaverse) OR TITLE-ABS-KEY (metaverso))) AND ((TITLE-ABS-KEY(tipo) OR TITLE-ABS-KEY (type) OR TITLE-ABS-KEY (herramienta) OR TITLE-ABS-KEY (tool) OR TITLE-ABS-KEY (componentes) OR TITLE-ABS-KEY (components)))) AND ((TITLE-ABS-KEY (educación) OR TITLE-ABS-KEY (education))
ERIC	((((metaverse) OR (metaverso))) AND (((tipo) OR (type) OR (herramienta) OR (tool) OR (componentes) OR (components)))) AND (((educación) OR (education)))
Taylor & Francis	[[All: "metaverse"] OR [All: "metaverso"]] AND [[All: "tipo"] OR [All: "type"] OR [All: "herramienta"] OR [All: "tool"] OR [All: "componentes"] OR [All: "components"]] AND [[All: "educación"] OR [All: "education"]]
Google Scholar	((((("metaverse") OR ("metaverso"))) AND ((("tipo") OR ("type") OR ("herramienta") OR ("tool") OR ("componentes") OR ("components")))) AND ((("educación universitaria") OR ("University education")))

Table 2 shows the inclusion (IC) and exclusion (EC) criteria that were applied to the bibliographic references obtained from the search equation, with which it was possible to reduce bias and suppress irrelevant and low-quality studies. These criteria are defined with the purpose of delimiting the search for bibliographic references and that, through their processing, it will be able to answer the research questions (Chamorro-Atalaya et al., 2023; Serhan & Yahaya, 2022).

Table 2: Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
IC1: Publications made in the university field	EC1: Publications made in the field of primary and secondary education
IC2: Peer-reviewed scientific journal publications	EC2: Publication of theses, conference articles, gray literature

IC3: Open access publication	EC3: Articles that only show the summary or require a payment for full download
IC4: Articles published between the years 2020 to 2023	EC4: Articles published before the year 2020

3.4 Critical review and data extraction

Figure 1 shows the process followed as part of the critical review and data extraction, which included four stages: identification, screening, eligibility, and inclusion of the scientific articles to be considered as part of the systematic review process. The identification stage covered the bibliographic references obtained from the use of the search equations in the aforementioned databases. The selection stage included a review of the titles and abstracts of the identified bibliographic references. The eligibility stage included the application of inclusion and exclusion criteria to the bibliographic references that passed the selection stage. Finally, in the inclusion stage, an exhaustive review of each and every one of the scientific articles that passed the eligibility test was carried out, thus establishing that there are 16 scientific articles to be analyzed and a synthesis of their findings.

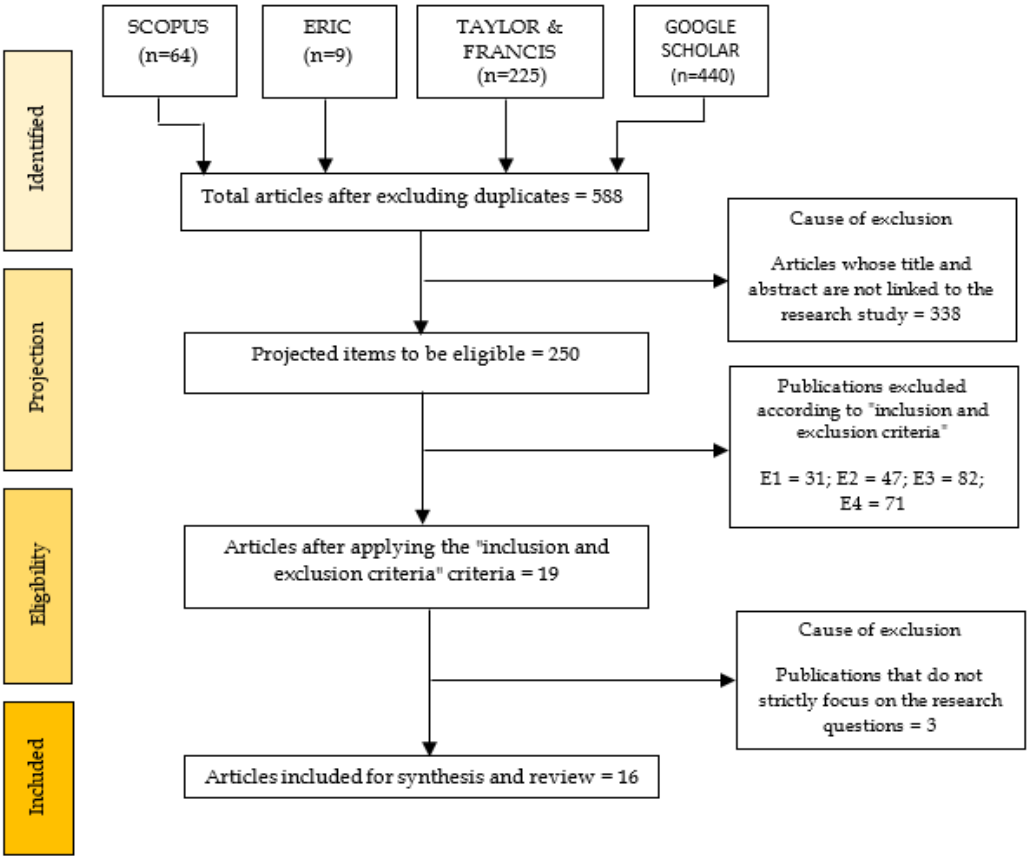

Figure 1: Extraction process of scientific articles according to the PRISMA declaration

3.5 Study sample

After making use of the guidelines established in the PRISMA declaration, as well as after applying the inclusion and exclusion criteria with the purpose of reducing any possibility of bias in the selection of the

bibliographic references to be reviewed, the sample study is made up of 16 scientific articles. En la Tabla 3 se muestran los artículos que forman parte de la muestra de estudio, detallando el título, así como el país en que se realizó la investigación.

Table 3. Scientific articles considered for the systematic review

Reference	Title of the scientific article	Country where the study was carried out
Yong et al. (2022)	A study on the possibility of a change in culture and arts education curriculum by shooting 'Metaclassroom' in the COVID-19 pandemic era.	Republic of Korea
Chen et al. (2022)	On application of metaverse in medical education via platform of medical electronic journals: a case study of Journal of Trauma and Emergency Electronic Version.	China
Pezzutti et al. (2020)	Virtual worlds and immersive learning in higher education	Peru
Teng et al. (2022)	Factors affecting learners' adoption of an educational metaverse platform: an empirical study based on an extended UTAUT model.	China
Rivadeneira and Toledo (2020)	Non-immersive 3d learning environment to support the computer component.	Colombia
Almarzouqi et al. (2022)	Prediction of user's intention to use metaverse system in medical education: a hybrid SEM-ML learning approach.	United Arab Emirates
Jovanović and Milosavljević (2022)	Vortex metaverse platform for gamified collaborative learning	Serbian
Pregowska et al. (2022)	Information and communication technologies combined with mixed reality as supporting tools in medical education.	Poland
Díaz et al. (2020)	Virtual world as a resource for hybrid education.	Colombia
Lee and Hwang (2022)	Technology-enhanced education through VR-making and metaverse-linking to foster teacher readiness and sustainable learning	Republic of Korea
Lozano-Durán et al. (2023)	Training scientific communication skills on medical imaging within the virtual world second life: perception of biomedical engineering students.	Spain
Lee et al. (2023)	Comparative case study of teamwork on Zoom and Gather Town.	Republic of Korea

Sunardi et al. (2022)	Acceptance of augmented reality in video conference based learning during COVID-19 pandemic in higher education.	Indonesia
Ramesh et al. (2022)	Holographic elysium of a 4D ophthalmic anatomical and pathological metaverse with extended reality/mixed reality.	India
Díaz (2020)	Virtual world as a complement to hybrid and mobile learning.	Colombia
Agustini et al. (2023)	Applying gamification technique and virtual reality for prehistoric learning toward the metaverse.	Indonesia

4. Results

In an initial analysis of the articles included for the data processing phase of the systematic review, Figure 2 shows the percentage distribution of scientific articles by year of publication, in which, out of a total of 16 bibliographic references, 25.0% were published in 2020, 56.25% in 2022 and 18.75% in 2023.

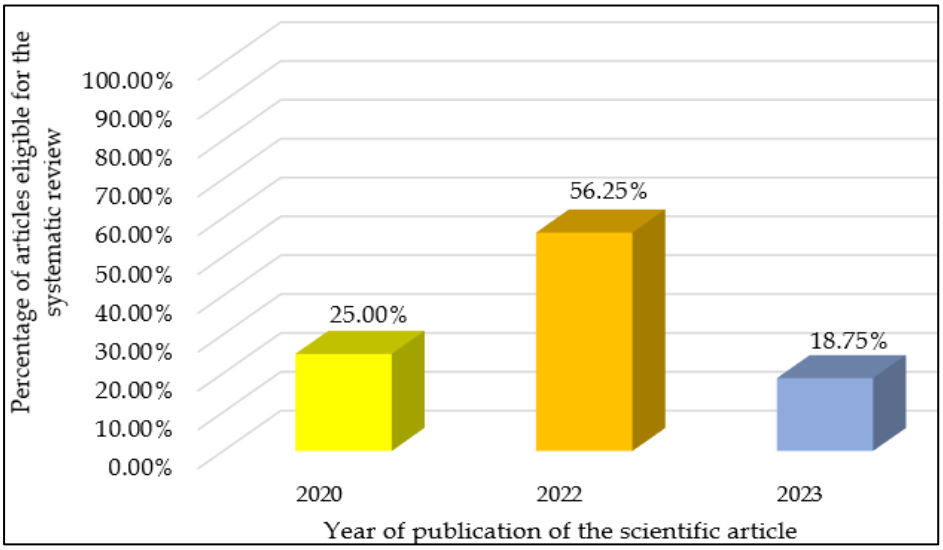

Figure 2: Percentage distribution of articles included in the systematic review by year of publication

The results obtained from the systematic review of the literature are presented below, in accordance with the three research questions defined in the introduction section.

4.1 Types of metaverses used in university education, in the context of COVID-19

In order to categorize the results found in the scientific articles included for the systematic review, regarding the types of metaverses that were used in university education, this study followed González et al. (2022) who defined four types of metaverses: augmented reality, lifelogging, mirror world and virtual reality. Based on Figure 3, it is shown that of the total articles reviewed,

68.75% used "virtual reality," 25.0% used "augmented reality," and 6.25% used the "lifelogging" metaverse.

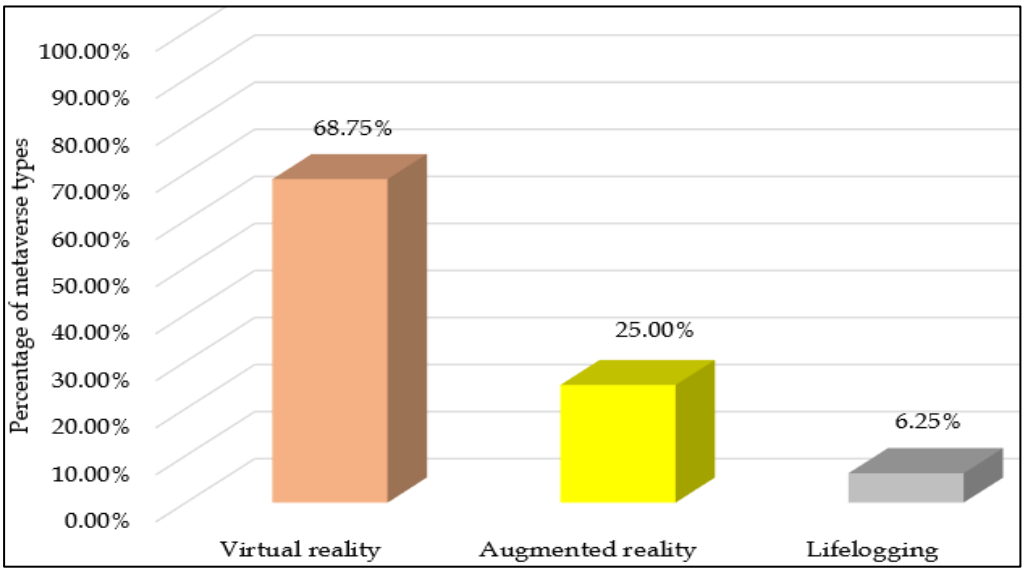

Figure 3: Percentage distribution by type of metaverse used in university education

Likewise, in order to extract more information and knowledge of the types of metaverses used in university education, Table 4 specifies which tools were used for the application of each of the different types of metaverse; managing to identify that, of the total articles reviewed, 68.75% used "computers" as a tool, 25.0% used extended reality "glasses" and 6.25% used "Smartphone.

Table 4: Types of metaverses used in university education

Metaverse type	Tool	Reference
Virtual reality	Computer	Rivadeneira and Toledo (2019), Díaz et al. (2020), Díaz (2020), Pezzutti et al. (2020), Lee and Hwang (2022), Teng et al. (2022), Yong et al. (2022), Agustini et al. (2023), Lozano-Durán et al. (2023),
	Glasses	Chen et al. (2022), Jovanović and Milosavljević (2022)
Augmented reality	Smartphone	Almarzouqi et al. (2022)
	Computer	Sunardi et al. (2022)
	Glasses	Pregowska et al. (2022), Ramesh et al. (2022)
Lifelogging	Computer	Lee et al. (2023)

Based on what was stated in the previous paragraph, Table 5 was obtained, which represents the results obtained from the cross-table analysis between the type of metaverse and the tools that were used in the field of university education in the context of the COVID-19. As such, it was possible to identify that research with metaverse of the "virtual reality" type was developed to a greater extent, representing 68.75% of the total articles reviewed, of which 56.25% used computers as a tool to apply the metaverse in university education, while 12.50% used extended reality glasses. It was also possible to identify that, of the 25.0% who used the "augmented reality" metaverse, they to a greater extent used glasses; the same percentage used computers and smartphones, both representing 6.25% of the total results published in the context of COVID-19.

Table 5: Cross-table analysis between the type of metaverse and the tool used

Tool	Metaverse type			Total
	Augmented Reality	Lifelogging	Virtual Reality	
Computer	6.25%	6.25%	56.25%	68.75%
Glasses	12.50%	0.0%	12.50%	25.0%
Smartphone	6.25%	0.0%	0.0%	6.25%
Total	25.0%	6.25%	68.75%	100.0%

4.2 Areas and fields of study of university education in which the metaverse was used, in the context of COVID-19

In Figure 4 it can be seen that 31.25% of the reviewed articles focused their research on the "Medicine" area, 18.75% on "Engineering," the same percentage on the "Administration" area, 12.5% on the area of "Art and communication," 6.25% in the area of "Language and culture," 6.25% in the area of "Education" and the same percentage in the area of "History." It is important to point out that some publications show that their study was not only applied to a specific area, but rather that they cover two areas of knowledge.

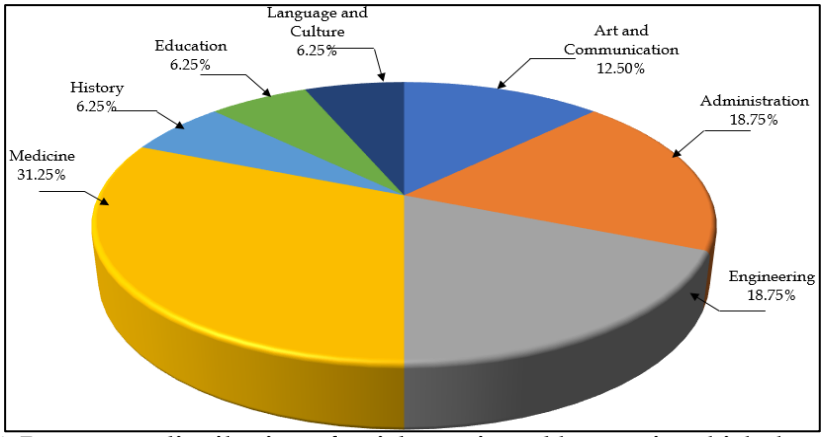

Figure 4: Percentage distribution of articles reviewed by area in which the research was carried out

Thus, the results were also categorized in relation to the teaching modality, since, although the study focused on the context of COVID-19, not all the investigations focused on a specific teaching modality, for which it was found that 62.5% of the reviewed scientific articles used the metaverse as an application for teaching in its virtual modality and 37.5% used the metaverse as an application for teaching in its face-to-face modality. Table 6 details the result of categorizing the scientific articles reviewed by teaching modality, area and specialty in which the metaverse was applied.

Table 6: Cross table analysis between the type of metaverse and the tool used

Teaching modality	Study area	Field of study	Reference
Virtual	Art and Communication	Performing arts	Yong et al. (2022)
		Communication	Pezzutti et al. (2020)
	Administration	Marketing	Teng et al. (2022)
		Accounting	Rivadeneira and Toledo (2019), Sunardi et al. (2022)
	Engineering	Industrial	Sunardi et al. (2022)
		Computing	
		Computer science	
		Systems	Diaz et al. (2020), Díaz (2020)
	Medicine	Biomedical	Lozano-Durán et al. (2023)
	History	History	Agustini et al. (2022)
	Education	Education	Lee et al. (2023)
Face-to-Face	Engineering	Software	Jovanović and Milosavljević, 2022
		Telecommunications	
		Electronics	
	Medicine	General medicine	Almarzouqi et al. (2022), Chen et al. (2022), Pregowska et al. (2022)
		Pharmacy	Pregowska et al. (2022)
		Ophthalmology	Ramesh et al. (2022)
	Language and culture	English	Lee and Hwang (2022)

Referring to the categorization seen in Table 6, it is evident that of the total scientific articles reviewed, in the "face-to-face teaching modality" the area with the highest percentage of research publications that have used the metaverse in the context of COVID-19 is "Medicine" and whose fields of study on which the publications focused were Medicine in general, Pharmacy and Ophthalmology. In the "virtual teaching modality," the study area with the highest percentage of research publications that have used the metaverse in the context of COVID-19 is "Administration" with the study areas of Marketing and Accounting.

4.3 Factors that evidenced improvement in university education as an effect of the application of the metaverse, in the context of COVID-19

Regarding the factors that evidenced on improvement or contribution in university education as an effect of the application of the metaverse in the context of COVID-19, three categories were identified: academic performance, interaction between students, and student satisfaction. However, to a greater extent, the scientific articles reviewed showed that they focused their studies on the academic performance factor when using the metaverse, representing 62.5%, while those that focused their studies on the interaction factor and improvement of communication skills between students through the application of the metaverse represent 37.5%. Table 7 shows the categorization of the reviewed articles by factor showing the improvement when applying the metaverse.

Table 7: Factors that show the contribution of the metaverse in university education

Factor that shows improvement	Result achieved	Reference
Academic performance	They obtained a positive impact on teaching and learning by implementing a meta-classroom in a new educational curriculum in the field of culture and art.	Yong et al. (2022)
	They managed to improve the learning of medical students using 3D glasses for complete immersion and thus innovating traditional medicine.	Chen et al. (2022)
	They had a positive impact on student teaching, thanks to immersive learning.	Pezzutti et al. (2020)
	They had a positive impact on the teaching and learning of students.	Teng et al. (2022)
	Achieved a positive impact on student academic performance.	Rivadeneira and Toledo (2020)
	They determined that the use of the metaverse greatly influences student learning.	Almarzouqi et al. (2022)
	They determined that the use of the metaverse significantly influences student learning.	Jovanović and Milosavljević (2022)
	They determined that the use of the metaverse influences the performance and understanding of student learning.	Pregowska et al. (2022)
	They determined that the use of the metaverse has a positive impact on student learning and is a great complement to traditional teaching.	Díaz et al. (2020)
	They had a positive impact on teaching students.	Lee and Hwang (2022)
Interaction between students and communication improvement	They obtained a positive impact on communication skills and scientific information which was attractive and appropriate for students.	Lozano-Durán et al. (2023)
	They had a positive impact on student-to-	Lee et al. (2023)

	student interaction by using the metaverse as a tool.	
	Made a significant impact on student performance, habits, and interactions.	Sunardi et al. (2022)
	They determined that the use of the metaverse has a positive impact in an immersive environment through 3D glasses.	Ramesh et al. (2022)
	They obtained a significant impact on the learning interaction with the students.	Díaz (2020)
	They obtained a positive impact on the interaction of students in the investing world.	Agustini et al. (2022)

5. Discussion

In relation to the types of metaverses used in university education, it was identified that, to a greater extent, in the context of COVID-19, the research focused on the use of virtual reality, compared to other types of metaverses such as augmented reality and lifelogging. In this regard, Lepez (2022) points out that the metaverse can provide a more immersive and enriching learning experience for students through virtual reality. Likewise, González et al. (2022), affirm in their article on the metaverse in higher education that, without a doubt, the new educational models that include the metaverse as a learning tool are focused on virtual reality devices, the same ones that provide immersive experiences of time and space, a very particular characteristic of this type of metaverse.

In relation to the areas and fields of study of university education in which the metaverse was used, it was identified that, to a greater extent, the investigations were carried out in the study area of "Medicine," "Engineering" and "Administration." However, when categorizing the studies in the face-to-face and virtual teaching modality, it was obtained that, in the context of COVID-19, the applications of the metaverse in the virtual teaching modality focused to a greater extent on the "Administration" area where in the fields of study were Marketing and Accounting. In this regard, George-Reyes et al. (2023) point out in their study on the metaverse in education 4.0, that the area showing an increase in studies in which the metaverse is used is Economics and Marketing, since it contributes in generating a vehicle for new ways of making a product or service known. Likewise, in the same line, Alfaisal et al. (2022), obtained that, although the metaverse could be applied to any area of study, they specified that, of the articles reviewed as part of their systematic review, the metaverse was used to a greater extent in medical education, aviation training and tourism education.

Regarding the factors that showed a positive impact on university education as an effect of the application of the metaverse, three categories could be identified: academic performance, interaction between students and student satisfaction. However, to a greater extent, the scientific articles reviewed showed that, in the context of COVID-19, they focused their studies on the "academic performance" factor when using the metaverse. In this regard, López-Belmonte et al. (2023) developed a systematic review on the metaverse in education, in the context of

the pandemic, in which they were able to determine that the factors on which the different studies focus are the impact on the improvement of learning and the "interaction, communication and student motivation for the use of the metaverse." In the same line, as part of a systematic review of the literature on the use of metaverses in distance learning due to the health emergency caused by COVID-19, Onggirawan et al. (2023) concluded that the various applications in general contribute to an improvement in student learning, improving in their abilities to address real-world problems. his further supports what was determined in this systematic review, George-Reyes et al. (2023) conclude that the metaverse has contributed to education by improving the interaction between students, leading to instances that go beyond communication processes, transforming digital spaces into almost real scenarios from permanent interaction and immersion.

6. Conclusion

From the results obtained, regarding the type of metaverse that was used in university education in the context of COVID-19, it is concluded that, to a greater extent, the investigations made use of virtual reality; this due to its high degree of capacity immersion in time and space. Likewise, the areas of study where research related to metaverse applications in university education was carried out were identified to be very diverse. There were no restrictions on its use due to any specialty; however, if we focus on the context of COVID-19, the systematic review found that, to a greater extent, the research was carried out in the areas of medical education, engineering and administration, developing both in the face-to-face and virtual teaching modality. Finally, it is concluded that the factor that showed an improvement in university education as an effect of the application of the metaverse was, to a greater extent, academic performance, while to a lesser extent it was the interaction between students and their communication, as well as student satisfaction with respect to learning using the metaverse. As a final implication of the study, it is concluded that the scenario of the COVID-19 pandemic and the need to continue the teaching-learning process under the limitations offered by the traditional virtual modality, in which experiential learning is not developed, led to the development of learning scenarios through the metaverse; however, it will be necessary to reduce the gaps regarding teachers' competencies, to create teaching scenarios in the virtual world, use it and evaluate it permanently.

7. Limitation of the Study

This study was limited to giving an approach from a more academic than technological perspective, so it is considered that its limitations were not addressing the types of platforms and their characteristics that support the development of the metaverse, such as Second Life, Roblox or Zepeto among others. This implies that future investigations focus their studies on addressing the implications of implementing the metaverse in the teaching-learning process.

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