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A systematic literature review on collaborative learning mediated by the metaverse: Trends, tools, and pedagogical implications for higher education

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ABSTRACT

Higher education has been affected by significant changes due to technological advances over the past decade. These advances have positively influenced various learning approaches, especially those related to collaborative learning. This article aims to analyze the impact of the metaverse on collaborative learning in higher education, based on a systematic review of the literature following the PRISMA methodology. During the search process, inclusion and exclusion criteria were established, considering the year of publication, language, databases (WoS and Scopus), study type, and thematic area of each document examined. As a result, 23 papers were deemed suitable for review. The findings indicated that the highest scientific output occurred between 2023 and 2024. The most frequently used database for publications on this topic was Scopus, accounting for 43.47% of the total documents examined. The predominant research methodology was quantitative, representing 52.17%. Additionally, four thematic areas related to the metaverse as a mediator of collaborative learning in higher education were identified. These categories include the educational process, technology, tools, and teaching methods influenced by virtual environments. It was concluded that collaborative learning benefits significantly from the metaverse, as the virtual reality it provides creates spaces for practice and reflection for university students, offering a more engaging and collaborative learning experience.

Contribution/Originality: This systematic review highlights the impact of the metaverse on collaborative learning in higher education. It demonstrates that virtual reality creates spaces allowing university students to experience practical and reflective learning environments with greater appeal and collaboration. Furthermore, this study is original, as it has not been presented elsewhere, and the authors have approved its submission.

1. INTRODUCTION

Over the last decade, people's lives have evolved at a dizzying pace, especially in terms of technological advances. Technology has gained a special place, as it is present in the environments that surround people when they communicate, play, get information, and, above all, in the way they learn. Thus, technological advances currently represent an important change in the educational environment, since they allow students to approach knowledge from different perspectives (Cordero, Herrera, & Pérez, 2022; Valero Franco & Berns, 2024).

This approach is produced through new teaching-learning models that were not present in the education of the past characterized by face-to-face teaching and in which the resources used in the educational process consisted of manuals and physical materials (books, notebooks, among others). With the emergence of COVID-19 and technological expansion, new teaching-learning models have been generated, among which blended learning, ubiquitous learning, electronic learning (e-learning), mobile learning (m-learning), and adaptive/personalized learning stand out. These technologies, in addition to allowing the generation of new teaching-learning environments, also favor interaction, collaborative work, and the promotion of learning (Valero Franco & Berns, 2024).

This new reality of online training through e-learning could lay the foundations for the Internet and how education evolves through metaverses (Onggirawan, Kho, Kartiwa, Anderies, & Gunawan, 2023). This is because metaverses facilitate teaching by influencing how students communicate with their peers and expand their knowledge. For (Mourtzis, Angelopoulos, & Panopoulos, 2023), the metaverse - a 3D digital space with virtual boundaries - has generated much interest as a result of advances in technological pillars, namely artificial intelligence (AI), digital twins, virtual reality (VR), augmented reality (AR), avatars, and blockchain, among others.

2. LITERATURE REVIEW

Much has been discussed about the change required by the pedagogical model perpetuated over time in higher education. This is because it is necessary to overcome that type of education that was centered on teaching and implement an education whose driving axis is learning (Pérez-García, Díaz-Calzada, Herrera-Miranda, Roig-Martínez, & Pérez-García, 2024; Reyes & Meneses, 2024). However, for this to happen, students need to achieve and make use of new interpersonal competencies that allow them to have a series of social interaction and cooperation strategies (Guerra, Rodríguez, & Artiles, 2019). Studies conducted in this regard show that collaborative learning represents the best alternative to achieving such competencies. This learning approach was developed by university teachers based on the theories of constructivism, whose main representatives were Piaget and Vygotsky and critical pedagogy by Freire, whose purpose was to change the authority structure in education.

Many definitions have been created around the term "collaborative learning"; however, the one proposed by Johnson and Johnson (1999) pointed out that it represents a system of interactions that allows the organization and promotion of reciprocal influence among the members of a team. Such a system is developed through a gradual process in which each individual or member feels committed to the learning of the rest of their peers, generating a positive interdependence (Vaillant & Manso, 2019). Carrying out collaborative learning usually involves designing open-ended tasks for students, i.e., working together to reach a consensus or teaching team-building skills (Yang, 2023).

However, the information revolution generated by the emergence of the internet allowed new and different knowledge societies or "network societies" to emerge, which highlighted the need to expand the training process regarding how education is understood and managed. In addition, it became necessary to emphasize the importance of collaborative work around the use of the network according to a given topic. This aspect is relevant because this collaborative work occurs in various groups, which are at the center of the production of information and knowledge in the knowledge society (Mosquera & Higuera, 2022).

Likewise, the Internet allows the higher education system to use and take advantage of the benefits of VR, which has managed to transcend with time, becoming an everyday occurrence among students. Its use allows for maximizing teaching and learning because, with the arrival of the metaverse in the university, aspects such as collaborative learning, socialization, and communication are enhanced. This evidence demonstrates the relevance of the changes generated by immersive technologies in educational processes and the results achieved in university education (Center for Educational Studies of the Miguel de Cervantes University, 2022).

Now, it is necessary to establish to what extent university entities have used the different tools that the metaverse offers to promote collaborative learning, which is why it is necessary to review the existing literature on this topic. In this regard, it is important to gather the information that the scientific community has generated on the subject. Thus, the review will seek to identify the tools provided by the metaverse to promote meaningful learning and to see if these tools have been used by higher education.

The main objective of this review is to identify the scientific output that currently exists regarding the metaverse and its use in promoting collaborative learning in university education. It also aims to analyze the impact of metaverse tools on collaborative learning within higher education. This review seeks to contribute to the field of teaching by examining the use of collaborative learning mediated by the metaverse, especially for university students. The study attempts to answer two research questions: What is the scientific production on the use of the metaverse to promote collaborative learning in university education? And what impact do metaverse tools have on collaborative learning in university education?

3. METHOD

A systematic literature review (SLR) was conducted in accordance with the PRISMA protocol guidelines (Page et al., 2021). The SLR uses this methodology, which involves five phases in which the research questions, selected databases, eligibility criteria, quality standards, and selection criteria are established in order to analyze only the most important documents (De Felice, Petrillo, Iovine, Salzano, & Baffo, 2023).

3.1. The Search Protocol

The analysis followed the guidelines offered by the analytical model of studies, which provides greater scientific rigor to the work performed (Rodríguez-García, Moreno-Guerrero, & Lopez Belmonte, 2020; Soler-Costa, Lafarga-Ostáriz, Mauri-Medrano, & Moreno-Guerrero, 2021). We began by identifying the records through searching databases, including WoS and Scopus, as they are the world's leading databases, bringing together the largest number of high-impact publications of scientific importance (Aksnes & Sivertsen, 2019). Likewise, for the analysis of the established variables, some characteristics of the reported documents were taken into account, namely: title, authors, year of publication, objectives, methodology, sample, and the most relevant findings related to the use of the metaverse as a mediator of collaborative learning in higher education.

The search process focused on studies published in English and Spanish between 2014 and 2024. The inclusion criteria centered on empirical studies related to collaborative learning mediated by the metaverse. Thematic analysis enabled data extraction from each examined paper and the synthesis of key findings. Keywords, Boolean operators, and search filters were used to establish search strategies. The research began with the keywords "Collaborative learning AND Metaverse AND higher education," utilizing Boolean operators "AND" and "OR" (Table 1).

Table 1. Search strategy.

WoS	Scopus
158 results from all databases to analyze results: "collaborative learning" OR "metaverse" OR "higher education" (Title) AND "higher education" OR "collaborative learning" OR "virtual reality" OR "tools" OR "learning" (Abstract) AND Article (Document Types) English and Spanish (Languages)	396 document output (TITLE («Collaborative learning» OR «Metaverse» OR «higher education») AND TITLE-ABS-KEY («virtual reality» OR «Collaborative learning» OR «tools» OR «Metaverse» OR «learning»)) AND (LIMIT-TO (DOCTYPE, «ar»)) AND (LIMIT-TO (LANGUAGE, «Spanish» «English»))

3.2. Selection Criteria

To obtain the most recent scientific articles that respond to the research questions posed, some inclusion and exclusion criteria were established (Table 2). These criteria will make it possible to identify the documents that are most relevant to the stated objective, in addition to excluding those that are not relevant or are not related to the

topic developed. Likewise, the established criteria will facilitate a more structured and orderly handling of the information gathered.

Table 2. Inclusion and exclusion criteria.

Criteria	Inclusion	Exclusion
Time period	2014-2024	Before 2014
Type of document	Articles published in indexed journals	Papers resulting from conferences, theses, book chapters, and reviews.
Subject area	Papers on collaborative learning and the metaverse in education	Articles written outside the educational field
Type of study	Research articles, mixed, reviews	-
Language	Spanish or English	Journal articles published in a different language

A total of 554 articles were identified; in turn, 56 duplicate articles and 23 articles unrelated to collaborative learning and the metaverse were eliminated, resulting in 475 articles; these were reviewed by title and abstract. Next, 121 articles were eliminated because they were published in a language other than Spanish and English (23); in addition, they were published before 2014 (98). From this process, 354 articles were obtained that were considered relevant. Finally, 351 documents were excluded for not being related to education (109); for being conference papers, book chapters, theses/reviews (99); for not having access to the full text (58); and for being a different type of study than the one established (65). Figure 1 illustrates the search process carried out. The total number of documents resulting from this process was 23, which were reviewed because they met the eligibility criteria.

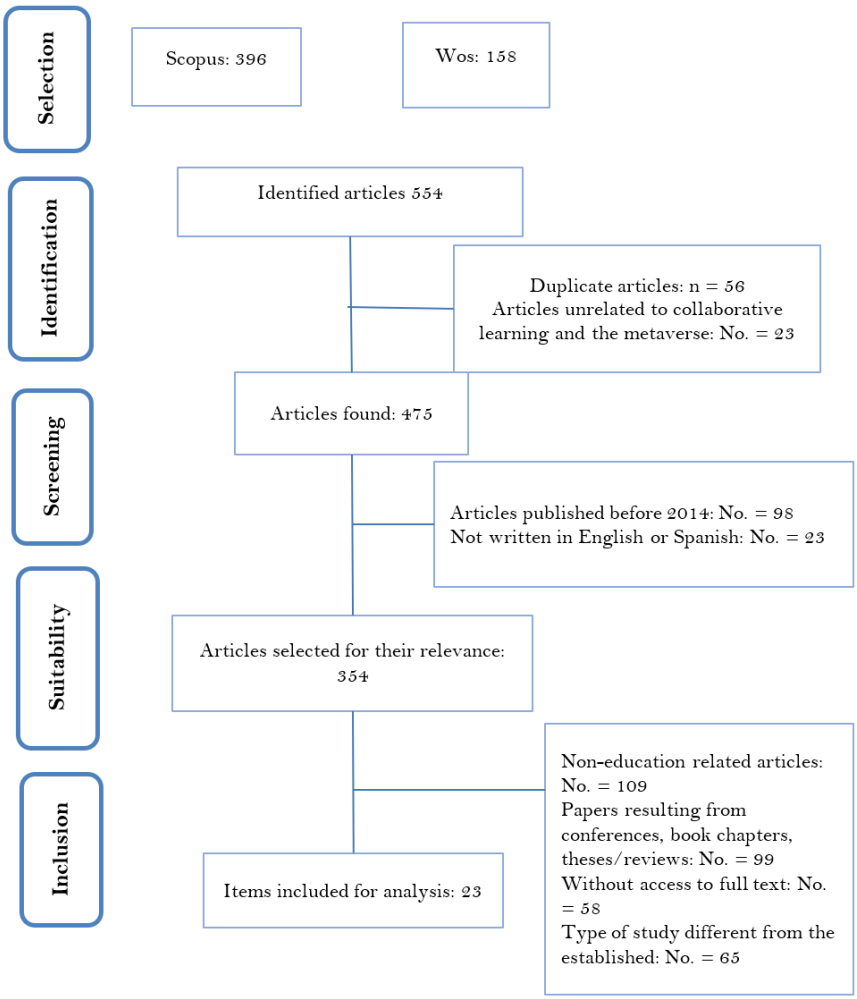

Figure 1. Prisma Flowchart.

4. FINDINGS

The results obtained in the search of the selected databases are presented below, taking into account the contextual information of each one. The first aspect considered in the systematic review was the information extracted from the databases consulted concerning the articles reviewed and which allowed us to answer the first question defined. Table 3 presents the most salient characteristics of the publications reviewed, such as title, authors, type of study, language, journal, and year of publication, considering each database and its relation to the number of documents found.

Likewise, the most outstanding bibliometric data of the publications reviewed from the WoS and Scopus databases are included. Additionally, the results obtained from reviewing the 23 articles selected according to the inclusion criteria will be presented through a thematic analysis to facilitate their identification and evaluation. This analysis was conducted using the bibliometric map created with VOSviewer software. This bibliometric technique of co-occurrence enables the analysis of the coincidence and the strength of association between the terms "collaborative learning," "metaverse," and "higher education," as well as the construction of thematic groups.

Table 3. Characteristics of the articles submitted for review.

Author(s)	Type of study	Language	Database	Journal
Jia et al. (2024)	Quantitative/24 participants	English	Scopus	IEEE Transactions on Learning Technologies
Mitchell (2024)	Quantitative-exploratory/12 participants	English	WoS/Scopus	International Journal of Information Systems and Project Management
Lewis, Popov, and Fatima (2024)	Review	English	WoS/Scopus	Annals of Medicine
Pyae et al. (2023)	Mixed/21 students	English	WoS/Scopus	Electronics
Kee, Kuys, and King (2024)	Quantitative/75 students	English	Scopus	International Journal of Technology and Design Education
Yahaya, Bakar, Jabar, Abdullah, and Segaran (2024)	Qualitative	English	Scopus	International Journal of Sustainable Development and Planning
Zhou, Suraworachet, and Cukurova (2024)	Quantitative/34 students	English	Scopus	Education and Information Technologies
Damaševičius and Sidekerskienė (2024)	Narrative Review	English	WoS/Scopus	Sustainability
Said (2023)	Qualitative/10 participants	English	WoS/Scopus	Electronics
Joshi and Pramod (2023)	Systematic Review.	English	WoS/Scopus	Heliyon
Di Natale et al. (2024)	Quantitative/359 students	English	WoS/Scopus	Cyberpsychology, Behavior, and Social Networking
Shu and Gu (2023)	Mixed/60 students	English	WoS/Scopus	Systems
Rudolphi-Solero, Lorenzo-Álvarez, Domínguez-Pinos, Ruiz-Gómez, and Sendra-Portero (2024)	Mixed/300 students	English	Scopus	Journal of the American College of Radiology
Sinlapaninman, Yonwilad, and Pattanachai (2023)	Quantitative/78 students	English	Scopus	International Journal of Interactive Mobile Technologies (Jim)
Agustini, Putrama, Wahyuni, and Mertayasa (2023)	Mixed/20 students	English	Scopus	International Journal of Information and Education Technology
Valdés and Ángel (2023)	Quantitative/9 students	Spanish	WoS/Scopus	Revista de Educación a Distancia (RED)
Ruiz-Campo, De Matías-Batalla, Boronat-Clavijo, and	Qualitative/47 teachers	Spanish	WoS	Revista Latinoamericana de Tecnología Educativa

Author(s)	Type of study	Language	Database	Journal
Acevedo-Duque (2023)				
Márquez-Díaz and Morales-Espinosa (2020)	Mixed/60 students	Spanish	WoS	Educación en Ingeniería
Hernández-Sellés (2021)	Qualitative/106 students	Spanish	WoS	Educatio Siglo XXI
Mapile and Lapinid (2023)	Quantitative/20 students	English	Scopus	Mathematics Teaching Research Journal
Thohir, Ahdhianto, Mas'ula, April Yanti, and Sukarelawan (2023)	Quantitative/406 students	English	WoS/Scopus	Contemporary Educational Technology
Karami, Nurhayati, and Arif (2024)	Quantitative/40 students	English	Scopus	International Journal of Information and Education Technology
Shwedeh (2024)	Quantitative/129 students	English	Scopus	International Journal of Data and Network Science

Regarding to literature referred to the use of metaverses as enhancers of collaborative learning at the higher level, it was established that, during the period between 2014 and 2024, 23 documents were published in the Scopus and WoS databases, of which 4 (17.39 %) were published in Spanish and the vast majority (19) were in English, representing 82.60 % of the total number of articles reviewed.

In addition, Figure 2 shows that, between 2020 and 2022, the scientific production of manuscripts showed little growth and was fairly uniform, i.e., only 3 articles were published during this period, one per year. However, between 2023 and 2024, a fairly prolific production was evidenced; thus, for the year 2023, 9 studies were published, representing 39.16% of the total number of documents reviewed. On the other hand, the year 2024 presents the highest production with 11 scientific articles, representing 47.82 % of the total reviewed.

According to these percentages, it was possible to establish that annual scientific output, starting in 2023, exceeds the average. In this sense, it is important to point out that such results are related to the appearance of the COVID-19 pandemic, because from that moment on, the implementation of virtual classes was almost mandatory, which discovered, from that moment on, the benefits of metaverse platforms and tools as enhancers of collaborative learning. This was mainly because technological advances made classes more immersive, and AI tools such as metaverses began to be implemented. This allowed higher education students to navigate and manage virtual learning environments, which facilitated teamwork and the use of different tools.

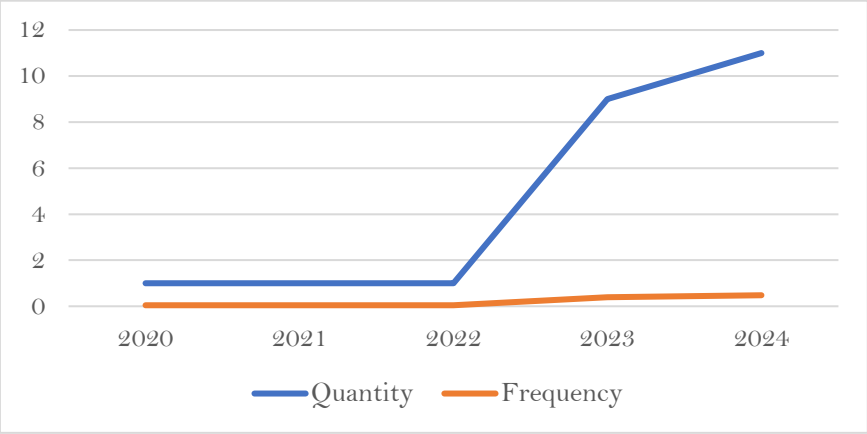

Figure 2. Scientific production per year.

On the other hand, the database most used to publish the studies reviewed is Scopus, with 10 scientific articles, representing 43.47% of the total number of documents examined; while only 3 documents (13.05%) were found in WoS. It should be noted that, in the review carried out, 10 (43.47%) articles were published in journals with double

indexing, i.e., in WoS and Scopus (Figure 3). Similarly, the review showed that the methodology most used in the documents examined was quantitative, with 12 articles, representing 52.17% of the total; 5 (21.73%) were mixed, 3 (13.04%) were qualitative, and 3 (13.04%) were systematic reviews.

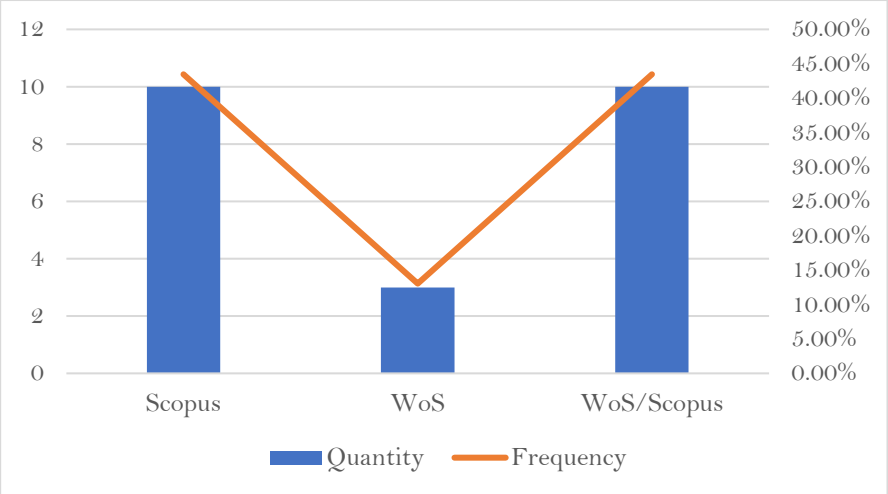

Figure 3. Most used database for publications.

However, the clustering and mapping technique offered by VOSviewer facilitated the validation of the defined research questions, since it is possible to construct networks of scientific journals, keywords, or terms through methods such as bibliographic linkage, co-authorship, co-occurrence, citation, or co-citation links (Kirby, 2023; McAllister, Lennertz, & Atencio Mojica, 2022). In the review, the co-occurrence of keywords in the search results was analyzed (Figure 4). This process consists of the joint occurrence of two terms in a text to establish the conceptual and thematic structure of a specific topic or study.

After that, the network map generated from the co-occurrence of the most frequent and important keywords linked to collaborative learning and the metaverse, located in Scopus scientific publications, is shown. The term metaverse stands out in comparison with the others, revealing that it is a more general and main term that encompasses the rest of the keywords. It is observed that it presents a larger size and the most intense color (blue); this aspect suggests a high frequency and importance. The other terms are grouped and connected by lines, representing different categories or topics within the scope of the metaverse. On the other hand, the red color refers to the technological aspects linked to learning; while the green color represents the different types or worlds that the metaverse offers to the educational field; finally, the yellow color revolves around virtual reality.

The most prominent keywords are "collaborative learning," "higher education," "students," and "immersive learning." The fact that these terms revolve around the largest clusters reflects the impact of the metaverse on education, especially collaborative learning, through its various tools, namely immersive learning, learning systems, VR (virtual worlds, augmented reality), and interactive computer graphics, among others. Similarly, the map shows the relationships and distances between terms, indicating the degree of association or similarity between them. For example, "metaverse" is closer and more connected to "virtual reality," "higher education," and "e-learning" than to "collaborative learning"; this contradicts the stated objective; however, this is not the case, since one of the clusters closest to the main cluster is "e-learning," within which "collaborative learning" is found. In addition, the multiplicity of the metaverse in different areas of social work, especially in education, is evident.

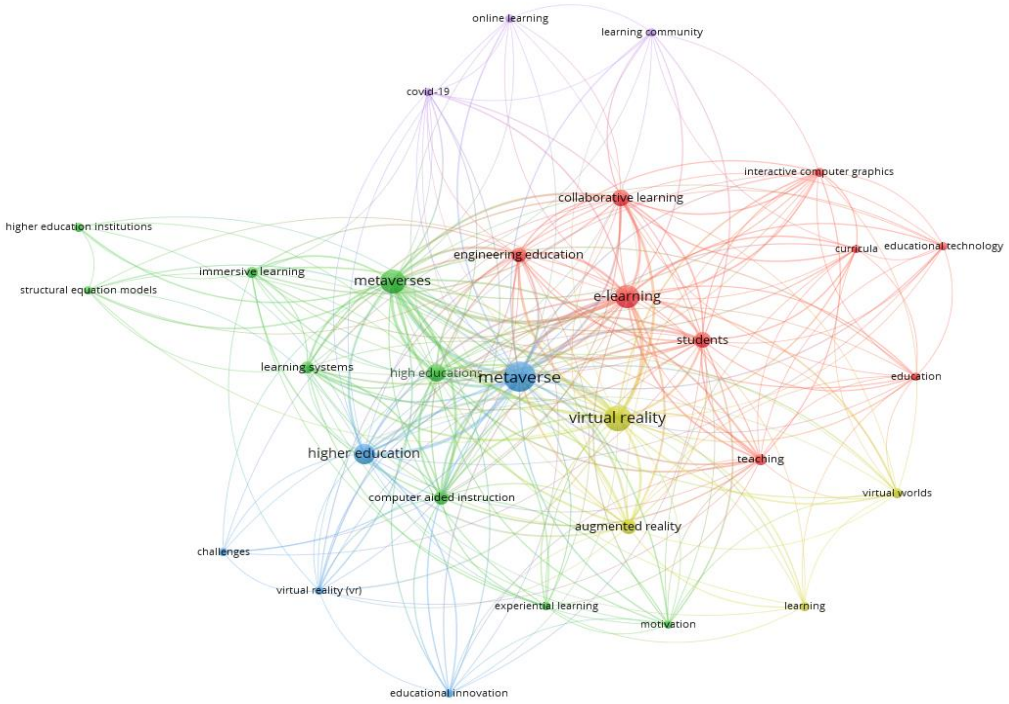

Figure 4. Network map of keyword co-occurrence on scientific production in Scopus metaverse and collaborative learning.

5. DISCUSSION

5.1. Thematic Groups Identified

A series of foundational concepts were found that allow a holistic understanding of how collaborative learning in university education is enhanced using the metaverse. This approach is based on the premise that knowledge is socially constructed, that is, through interaction between people. In education, it represents certain activities that allow students to develop knowledge through collaboration and interaction among themselves (Jia et al., 2024).

The review made it possible to identify four categories that make it possible to organize the information generated around the metaverse as a mediator of collaborative learning in higher education. Such categories pertain to the educational process, technology, tools, and teaching methods around which virtual environments exert some kind of influence. The following sections provide quite characteristic details about the established categories, linking each of them to the reviewed studies.

5.2. Metaverse in Education

The metaverse is a shared, interconnected virtual space that includes mixed reality (MR), VR, and AR. All of this promotes the development of training based on collaborative learning, simulation, and the acquisition of experiential skills for the development of competencies (Lewis et al., 2024). Agustini et al. (2023) state that it is a 3D and online concept that combines multiple and different virtual spaces; this characteristic gives the metaverse the ability to revolutionize education. That is, it is a very appropriate platform to provide access to the student to a learning experience based on inventive thinking, quality, and more efficient retrieval (Said, 2023).

When metaverses are incorporated into education, they provide virtual resources to create new learning models, among which collaborative and immersive learning models stand out. Currently, teachers feel prepared to use them as teaching strategies; however, certain technical impediments are evident, since, although there is a high level of digital literacy among teaching staff, interaction and behavioral dynamics require constant updating of learning (Ruiz-Campo et al., 2023). This aspect is little considered in some educational institutions since it has not been given the importance it has in the teaching-learning process.

From an institutional perspective, Shwedeh (2024) argues that rather than guaranteeing students access to the metaverse, it is necessary to provide interfaces with user-friendly systems that can be easily integrated into the academic context. Similarly, collaboration is needed to achieve subsidized access and digital literacy initiatives for both students and teachers, as well as care in generating rapid technological adaptation. This aspect is fundamental and requires not only a gradual implementation approach but also comprehensive training. Educational leaders should bear in mind that interdisciplinary work can generate better knowledge, while monitoring and evaluation help ensure that the inclusion of the metaverse can be linked to institutional objectives. By addressing suggestions such as these, universities will be able to navigate the complex landscape of metaverse technology adoption, thereby promoting its seamless integration. When suggestions such as these are taken into account, universities will be better able to manage the complicated reality of adopting metaverse technology, thereby promoting a more seamless integration (Shwedeh, 2024).

5.3. Most Representative Technologies of the Metaverse

The metaverse requires adequate infrastructure and technology to be executed. These have undergone constant and accelerated development in the last decade, especially after the COVID-19 pandemic. Some of these technologies are detailed below.

- Blockchain: It is a technology that surrounds cryptocurrencies such as Bitcoin, Ethereum, and others. In addition, as an accounting technology, it allows digital transactions to be securely and immutably recorded. Currently, it is used for data storage, automated smart contracts, and easier transfer of value. Blockchain technology is based on a blockchain containing a set of transactions carried out securely. This blockchain is stored in a distributed network, which allows data to be stored and shared online in the network (Mourtzis et al., 2023).
- AR and VR: These are technologies used in metaverses. AR is used to superimpose virtual information on the real world, while VR creates an entirely new virtual world. Both shape the metaverse, facilitating immersive and logical interaction and augmenting physical reality regardless of the location of each user (Agustini et al., 2023; Di Natale et al., 2024; Karami et al., 2024; Kee et al., 2024; Lewis et al., 2024; Márquez-Díaz & Morales-Espinosa, 2020; Thohir et al., 2023).
- Artificial Intelligence (AI): Machines can self-learn with algorithms. This intelligence is based on processing huge amounts of data through algorithms that can identify patterns and create links using analytical data mining and text mining. At the educational level, AI has some disciplines that act as assistants to educational systems; among them are machine learning and deep learning. Thus, online learning systems offered or supported by AI allow students different forms of analysis, which promote personalized and collaborative learning (Pyae et al., 2023).
- 5G (6G): Generations of mobile communications systems are characterized by the acronyms 2G, 3G, 4G, and 5G, which provide the bandwidth capacity and low-latency transmissions required by connected devices to process data, including VR devices or AI-based bots (Yahaya et al., 2024). In education, 5G technology drives innovation, as the 5G network has a platform that promotes the development and adoption of innovative educational technologies. It provides an ultra-fast connection, low latency, and greater device connectivity, allowing you to make learning more interactive and dynamic (Damaševičius & Sidekerskienė, 2024; Kee et al., 2024).
- Devices: The metaverse consists of interaction within a virtual universe parallel to the physical world. To enter this universe, it is necessary to have a series of AR and VR devices, for example, sensors and lenses with which it is possible to register physical movements using an avatar, whose function is to simulate the presence of a person within the metaverse (Hernández-Sellés, 2021). In this way, these physical persons manage to establish some kind of relationship inside that parallel world, achieving, in addition, that the

metaverse is immersive (Damaševičius & Sidekerskienė, 2024; Kee et al., 2024; Ruiz-Campo et al., 2023; Valdés & Ángel, 2023). With each passing day, these devices are better developed and constantly evolving; some of them are Oculus Quest 2, Apple Vision Pro, and gloves and suits with haptic feedback.

5.4. Virtual Reality (VR)

VR allows the user to be immersed in a completely new digital environment, creating a different interactive experience in which headphones or glasses can be used (Di Natale et al., 2024). In the educational field, teaching and learning experiences are enriched by the use of immersive digital environments and simulations. The VR environment is completely artificial, and each participant becomes an immersive or non-immersive member of the simulated world. As a result, the student is able to manipulate and interact with objects generated by the computer; this occurs through haptic interfaces present in the virtual environment. A clear example of this is a series of investigations in which undergraduate chemistry students were considered using AR/VR environments to develop carbon bonding models, resulting in students showing a positive attitude towards AR/VR due to its experiential learning approach (learning by doing), which helps to adequately understand and retain complex concepts compared to traditional teaching methods (AlGerafi, Zhou, Oubibi, & Wijaya, 2023).

In graduate students, the technology offered by VR acts as an inhibitor and facilitator, providing social and temporal freedom in the field activities performed. This aspect generates greater curiosity in the student for what he/she is doing and is an effective spatial stimulus mechanism. Concerning the training of student teachers, the work carried out by Ruiz-Campo et al. (2023) demonstrated, through the intervention carried out, that the teachers being trained believe that metaverses represent a very useful tool for facilitating a type of remote teaching. The sample used by these authors in their study experimented with a virtual platform that presented two dimensions, which generated greater interest in the students for the experience, expressing their willingness to continue their training to incorporate this methodology into their teaching.

Researchers such as Joshi and Pramod (2023), in a study conducted in some Indian universities, found that the collaborative metaverse-based A La Carte framework for higher education (CO-MATE) is a comprehensive, cost-effective, anytime-anywhere ecosystem that represents the future of higher education. Its architecture includes four layers: the first refers to the virtual academic infrastructure, the second is the base layer, the third is called the service layer, and the fourth refers to the channel through which the user interacts. All of these layers are used according to the established educational requirements. CO-MATE opens the door to a complete virtual learning system, offering diverse immersive learning experiences in which it is possible to find advanced digital characters, educational technology resources, autonomous and collaborative learning models, and supervised study spaces (Joshi & Pramod, 2023).

5.5. Impact of the Metaverse on Collaborative Learning

Collaborative learning is an active learning approach in which students work in small teams and solve problems using productive discussions and peer feedback. An example is project management students, who can work and collaborate in a metaverse environment with the sole goal of reaching group consensus on a task. Another benefit is being able to reflect on the experience and connect it to the information received in the course (Mitchell, 2024).

Similarly, the virtual worlds (simulation world, role-playing world, adventure world, creative world, and collaborative world) offered by the metaverse to education demonstrate significant potential to enhance individual student experiences and learning outcomes; this is achieved through immersive and interactive environments, whose educational purpose is to promote creativity, critical thinking, collaborative skills, and communication. (Damaševičius & Sidekerskienė, 2024). In this sense, Said (2023) points out that the metaverse is capable of revolutionizing education, since it represents a very suitable platform for providing access to a learning experience based on innovative thinking, high quality, and improved recovery. In the university setting, different learning

options based on games and collaborative reality stand out for creating knowledge, especially in practical learning and training situations (engineering, design, and medicine, among others).

In the case of an architecture class, whose teacher makes use of the metaverse, students can digitally explore unique architectural structures in real-time. Such exploration through a realistic simulation provides them with an excellent educational experience, as they can analyze and discuss designs in a shared virtual environment. Similarly, the digital interaction occurring in the metaverse, based on three-dimensional social networks such as Meta, favors greater collaboration between students and teachers, generating immersive simulated scenarios for teaching (Said, 2023; Shu & Gu, 2023).

Collaborative work and learning are also achieved when a collaborative research project is developed, in which students from different countries worldwide manage to meet in a virtual space to share resources, discuss ideas, and work together in real time. This interconnection allows the way of accessing information to be redefined, enabling interaction in an academic environment, and providing a more global and collaborative learning experience (Mapile & Lapinid, 2023; Rudolphi-Solero et al., 2024). Therefore, the climate generated in the participation of each member of the group in aspects such as decision-making, selection, or proposal of topics and the method to be used in collaborative activities is decisive.

Collaborative learning in an online environment has been shown to foster better interaction between students, as well as a sense of social presence. This is because, as a tool, it facilitates teamwork, encouraging reflection and interaction among students to achieve the planned objectives through motivation, participation, and active collaboration. All of this provides improved learning and the ability to adapt to different teaching methods, in addition to individual satisfaction and motivation.

6. CONCLUSION

The interest in virtual worlds that has emerged in higher education has led to some significant findings; one of them relates to the way these environments offer extraordinary opportunities for generating truly immersive and interactive learning experiences. University students who engage in academic activities involving virtual worlds can interact with such content in diverse and creative ways, differentiating them from the traditional educational process, so that he or she can participate in realistic simulations and engage in collaborative projects.

According to the review conducted, it was observed that different virtual worlds significantly improve learning experiences and outcomes; these virtual worlds provide interactive and immersive platforms that favor that the content taught is better understood. In addition, they help to improve problem-solving skills and memory retention. This type of reach that the metaverse platforms possess favors an integral development of skills and prepares the student for better performance when training in a specific career, in their personal life, and, above all, in their future work life.

There is no doubt that digital environments and the use of technological resources have represented a new educational phenomenon in recent years. Digital environments allow teachers to offer students an immersive reality in which learning is supported by platforms that also foster interaction between teachers and their students. However, although studies reveal the importance of digital learning environments and the search for immersive experiences, this does not reflect in practice the existence of numerous such experiences using the metaverse. In view of this apparent contradiction, further studies are needed to establish a theoretical foundation for this topic, whose trend is increasingly expanding. Furthermore, these studies must include a variety of samples used in experiences triggered by the metaverse in an educational context. Likewise, it is necessary to include different areas that transcend the boundaries of higher education.

Also, it is necessary to take into account that the metaverse and its technologies allow the development of new instructional approaches, providing teachers and students with a different way of teaching and learning. The adoption of the metaverse as a teaching tool has allowed a new generation of students to join universities due to the

use of interactive technology in different professional careers. In addition, it allows the teacher to use and implement different types of pedagogies, for example, collaborative learning, which gives them the possibility to make their classes more flexible, participatory, and dynamic.

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REFERENCES

Agustini, K., Putrama, I. M., Wahyuni, D. S., & Mertayasa, I. N. E. (2023). Applying gamification technique and virtual reality for prehistoric learning toward the metaverse. *International Journal of Information and Education Technology*, *13*(2), 247-256. https://doi.org/10.18178/ijiet.2023.13.2.1802

Aksnes, D. W., & Sivertsen, G. (2019). A criteria-based assessment of the coverage of Scopus and Web of Science. *Journal of Data and Information Science*, *4*(1), 1–21. https://doi.org/10.2478/jdis-2019-0001

AlGerafi, M. A. M., Zhou, Y., Oubibi, M., & Wijaya, T. T. (2023). Unlocking the potential: A comprehensive evaluation of augmented reality and virtual reality in education. *Electronics*, *12*(18), 3953. https://doi.org/10.3390/electronics12183953

Center for Educational Studies of the Miguel de Cervantes University. (2022). Metaverse and virtual reality in education. *Bulletin of Ibero-American Opinions on Education*, *4*(37), 1-36.

Cordero, A., Herrera, B., & Pérez, J. (2022). Education and emerging technologies as a means of solution for SME projects. In P. Manuel, P. Silvia, & H. Santa (Eds.), Technological advances in education and learning. In (pp. 127–139). Campeche, Mexico: Editorial CIATA.org – UNACAR.

Damaševičius, R., & Sidekerskienė, T. (2024). Virtual worlds for learning in metaverse: A narrative review. *Sustainability*, *16*(5), 2032. https://doi.org/10.3390/su16052032

De Felice, F., Petrillo, A., Iovine, G., Salzano, C., & Baffo, I. (2023). How does the metaverse shape education? A systematic literature review. *Applied Sciences*, *13*(9), 5682. https://doi.org/10.3390/app13095682

Di Natale, A. F., Repetto, C., Costantini, G., Riva, G., Bricolo, E., & Villani, D. (2024). Learning in the metaverse: Are university students willing to learn in immersive virtual reality? *Cyberpsychology, Behavior, and Social Networking*, *27*(1), 28-36. https://doi.org/10.1089/cyber.2022.0395

Guerra, S. M., Rodríguez, P. J., & Artiles, R. J. (2019). Collaborative learning: An innovative experience for university students. *Revista de Estudios y Experiencias en Educación*, *18*(36), 269-281. https://doi.org/10.21703/rexe.20191836guerra5

Hernández-Sellés, N. (2021). Tools that facilitate collaborative learning in virtual environments: New opportunities for the development of digital learning ecologies. *Educatio Siglo XXI*, *39*(2), 81-100. https://doi.org/10.6018/educatio.465741

Jia, Y., Wang, X. E., Sin, Z. P. T., Li, C., Ng, P. H. F., Huang, X., . . . Li, Q. (2024). Knowledge-graph-driven mind mapping for immersive collaborative learning: A pilot study in Edu-Metaverse. *IEEE Transactions on Learning Technologies*, *17*, 1794-1808. https://doi.org/10.1109/TLT.2024.3406638

Johnson, D., & Johnson, R. (1999). *Learning together and alone*. Buenos Aires, Argentina: Aiqué.

Joshi, S., & Pramod, P. J. (2023). A collaborative metaverse based A-La-Carte framework for tertiary education (CO-MATE). *Heliyon*, *9*(2), e13424. https://doi.org/10.1016/j.heliyon.2023.e13424

Karami, A. F., Nurhayati, H., & Arif, Y. M. (2024). Design and evaluation Maliki V-Lab: A metaverse-based virtual laboratory for computer assembly learning in higher education. *International Journal of Information and Education Technology*, *14*(6), 814-821. https://doi.org/10.18178/ijiet.2024.14.6.2106

Kee, T., Kuys, B., & King, R. (2024). Generative artificial intelligence to enhance architecture education to develop digital literacy and holistic competency. *Journal of Artificial Intelligence in Architecture*, *3*(1), 24-41. https://doi.org/10.24002/jarina.v3i1.8347

Kirby, A. (2023). Exploratory bibliometrics: Using VOSviewer as a preliminary research tool. *Publications*, *11*(1), 10. https://doi.org/10.3390/publications11010010

Lewis, K. O., Popov, V., & Fatima, S. S. (2024). From static web to metaverse: Reinventing medical education in the post-pandemic era. *Annals of Medicine*, *56*(1), 2305694. https://doi.org/10.1080/07853890.2024.2305694

Mapile, R. F. G., & Lapinid, M. R. C. (2023). Online collaborative learning: Applicability in comparison with individual learning and face-to-face collaborative learning. *Mathematics Teaching Research Journal*, *15*(2), 21-44.

Márquez-Díaz, J. E., & Morales-Espinosa, L. A. (2020). Augmented reality as a tool to support the learning of algebraic and transcendental functions. *Engineering Education*, *15*(29), 34-41.

McAllister, J. T., Lennertz, L., & Atencio Mojica, Z. (2022). Mapping a discipline: A guide to using VOSviewer for bibliometric and visual analysis. *Science & Technology Libraries*, *41*(3), 319-348. https://doi.org/10.1080/0194262X.2021.1991547

Mitchell, A. (2024). Metaverse adoption for the teaching and learning of project management: An exploratory study of student use. *International Journal of Information Systems and Project Management*, *12*(1), 76-92. https://doi.org/10.12821/ijispm120104

Mosquera, T. J., & Higuera, P. M. F. V. (2022). Social networks as a collaborative learning tool in architectural education. *Sophia*, *18*(2), 1–16. https://doi.org/10.18634/sophiaj.18v.2i.1170

Mourtzis, D., Angelopoulos, J., & Panopoulos, N. (2023). Metaverse and blockchain in education for collaborative product-service system (PSS) design towards university 5.0. *Procedia CIRP*, *119*, 456-461. https://doi.org/10.1016/j.procir.2023.01.008

Onggirawan, C. A., Kho, J. M., Kartiwa, A. P., Anderies, & Gunawan, A. A. S. (2023). Systematic literature review: The adaptation of distance learning process during the COVID-19 pandemic using virtual educational spaces in metaverse. *Procedia Computer Science*, *216*, 274-283. https://doi.org/10.1016/j.procs.2022.12.137

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., . . . Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ*, *372*, n71. https://doi.org/10.1136/bmj.n71

Pérez-García, S., Díaz-Calzada, M., Herrera-Miranda, G., Roig-Martínez, Y., & Pérez-García, S. (2024). The teaching-learning process based on collaborative learning. *Rev Ciencias Médicas*, *28*(1), e6018.

Pyae, A., Ravyse, W., Luimula, M., Pizarro-Lucas, E., Sanchez, P. L., Dorado-Diaz, I. P., & Thaw, A. K. (2023). Exploring user experience and usability in a metaverse learning environment for students: A usability study of the artificial intelligence, innovation, and society (AIIS). *Electronics*, *12*(20), 4283. https://doi.org/10.3390/electronics12204283

Reyes, J. I., & Meneses, J. (2024). Is collaborative learning inclusive? A case study on its implementation in an online university. *RIED-Ibero-American Journal of Distance Education*, *27*(2), 83–101. https://doi.org/10.5944/ried.27.2.39072

Rodríguez-García, A.-M., Moreno-Guerrero, A.-J., & Lopez Belmonte, J. (2020). Nomophobia: An individual's growing fear of being without a smartphone—a systematic literature review. *International Journal of Environmental Research and Public Health*, *17*(2), 580. https://doi.org/10.3390/ijerph17020580

Rudolphi-Solero, T., Lorenzo-Álvarez, R., Domínguez-Pinos, D., Ruiz-Gómez, M. J., & Sendra-Portero, F. (2024). An interuniversity competition for medical students to learn radiology in the second life metaverse. *Journal of the American College of Radiology*, *21*(5), 812-821. https://doi.org/10.1016/j.jacr.2023.09.012

Ruiz-Campo, S., De Matías-Batalla, D., Boronat-Clavijo, B., & Acevedo-Duque, A. (2023). Metaverses as a teaching tool in the training of higher education teachers. *Latin American Journal of Educational Technology*, *22*(1), 135–153. https://doi.org/10.17398/1695-288X.22.1.135

Said, G. R. E. (2023). Metaverse-based learning opportunities and challenges: A phenomenological metaverse human–computer interaction study. *Electronics*, *12*(6), 1379. https://doi.org/10.3390/electronics12061379

Shu, X., & Gu, X. (2023). An empirical study of A smart education model enabled by the edu-metaverse to enhance better learning outcomes for students. *Systems*, *11*(2), 75. https://doi.org/10.3390/systems11020075

Shwedeh, F. (2024). Harnessing digital issue in adopting metaverse technology in higher education institutions: Evidence from the United Arab Emirates. *International Journal of Data and Network Science*, *8*(1), 489-504. https://doi.org/10.5267/j.ijdns.2023.9.007

Sinlapaninman, U., Yonwilad, W., & Pattanachai, N. (2023). Promoting virtual learning management competencies in the metaverse with mobile technology to support competency-based learning for computer major preservice teachers. *International Journal of Interactive Mobile Technologies*, *17*(21), 97-114. https://doi.org/10.3991/ijim.v17i21.41933

Soler-Costa, R., Lafarga-Ostáriz, P., Mauri-Medrano, M., & Moreno-Guerrero, A.-J. (2021). Netiquette: Ethic, education, and behavior on internet—a systematic literature review. *International Journal of Environmental Research and Public Health*, *18*(3), 1212. https://doi.org/10.3390/ijerph18031212

Thohir, M. A., Ahdhianto, E., Mas'ula, S., April Yanti, F., & Sukarelawan, M. I. (2023). The effects of TPACK and facility condition on preservice teachers' acceptance of virtual reality in science education course. *Contemporary Educational Technology*, *15*(2), ep407. https://doi.org/10.30935/cedtech/12918

Vaillant, D., & Manso, J. (2019). *Guidelines for collaborating in teacher training and classroom work*. Chile: SUMMA.

Valdés, G. J. C., & Ángel, R. C. J. (2023). Collaborative work in EDIT, exploring immersive learning in the metaverse. *Revista de Educación a Distancia*, *23*(73), 1-20. https://doi.org/10.6018/red.539671

Valero Franco, C., & Berns, A. (2024). Development of virtual and augmented reality apps for language teaching: A case study. *Revista Iberoamericana de Educación a Distancia*, *27*(1), 163–185. https://doi.org/10.5944/ried.27.1.37668

Yahaya, S. N., Bakar, M. H., Jabar, J., Abdullah, M. M., & Segaran, Y. (2024). Evaluating students acceptance of AI chatbot to enhance virtual collaborative learning in Malaysia. *International Journal of Sustainable Development and Planning*, *19*(1), 209–219. https://doi.org/10.18280/ijsdp.190119

Yang, X. (2023). A historical review of collaborative learning and cooperative learning. *TechTrends*, *67*(4), 718-728. https://doi.org/10.1007/s11528-022-00823-9

Zhou, Q., Suraworachet, W., & Cukurova, M. (2024). Detecting non-verbal speech and gaze behaviours with multimodal data and computer vision to interpret effective collaborative learning interactions. *Education and Information Technologies*, *29*(1), 1071-1098. https://doi.org/10.1007/s10639-023-12315-1