Exploring research trends of metaverse in education: a bibliometric analysis

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Abstract

Purpose – By a thorough bibliometric examination of the area through time, this paper analyses the research landscape of metaverse in education. It is an effort that is focused on the metaverse research trends, academic production and conceptual focus of scientific publications.

Design/methodology/approach – The Web of Science (WoS) database was explored for information containing research articles and associated publications that met the requirements. For a thorough analysis of the trend, thematic focus and scientific output in the subject of metaverse in education, a bibliometric technique was used to analyse the data. The bibliometrix package of R software, specifically the biblioshiny interface of R-studio, was used to conduct the analysis.

Findings – The analysis of the metaverse in education spanning from 1995 to the beginning of 2023 reveals a dynamic and evolving landscape. Notably, the field has experienced robust annual growth, with a peak of publications in 2022. Citation analysis highlights seminal works, with Dionisio *et al.* (2013) leading discussions on the transition of virtual worlds into intricate digital cultures. Thematic mapping identifies dominant themes such as "system," "augmented reality" and "information technology," indicating a strong technological focus. Surprisingly, China emerges as a leading contributor with significant citation impact, emphasising the global nature of metaverse research. The thematic map suggests ongoing developments in performance and future aspects, emphasising the essential role of emerging technologies like artificial intelligence and virtual reality. Overall, the findings depict a vibrant and multidimensional metaverse in education, poised for continued exploration and innovation.

Originality/value – The study is among the pioneers that provide a comprehensive bibliometric analysis in the area of metaverse in education which will guide the novice researchers to identify the unexplored areas.

Keywords Metaverse, Education, Virtual reality, Augmented reality, Artificial intelligence

Paper type Literature review

1. Introduction

The metaverse is buzzword in the present scenario and recognised as the next generation of social connections (Hwang and Chien, 2022). The goal of the metaverse is to mesh together all online worlds, allowing people to move between them as if they were a single entity (Shiau and Huang, 2022). The extended applications of the metaverse starts recognising in every sector including education (Morfaki and Skotis, 2023; Lester and Crawford–Lee, 2023; Li *et al.*, 2022). This hype was started during the Covid-19 world-wide pandemic and resulted a sudden shift to remote and online education with the utilisation of information and communication technology (ICT) and Internet of Things (Adtani *et al.*, 2023; Negm, 2023; Pandita and Kumar, 2023). Hence, recent years has witnessed more interest towards metaverse applications in education both in academia and in practice (Hwang and Chien, 2022). The metaverse research in education investigated various aspects such as definition

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and roles (Hwang and Chien, 2022), its importance (Contreras *et al.*, 2022), its pros and cons (Tlili *et al.*, 2022) and applications (Hare and Tang, 2022). Whereas a holistic view of these research was not discussed in previous studies. Considering that gap, the present study investigates the overview of metaverse research in education using a bibliometric analysis.

2. Metaverse – an overview

The concept of a completely immersive, interconnected virtual environment where people may interact with each other and with digital objects in a common, three-dimensional realm is known as the "metaverse" (Dwivedi *et al.*, 2022). Science fiction has helped to popularise the concept of a metaverse, especially works by Neal Stephenson and Ernest Cline like "Ready Player One" and "Snow Crash" (Wesemann, 2022). Typically, users of virtual reality (VR) or augmented reality (AR) equipment are able to access the metaverse as a massively multiplayer online world (Reddy *et al.*, 2023; Duan *et al.*, 2021). It is envisioned as a sophisticated, dynamic environment with its own economy, social institutions and cultural norms that is totally produced and maintained by its users (Henz, 2022). Essentially, it is a virtual environment that aims to mimic many parts of reality while putting an emphasis on user creativity and self-expression (Bourgeois-Bougrine *et al.*, 2020).

The development of VR and AR technologies, as well as the expansion of social media and online gaming platforms, have all contributed to a renewed interest in the idea of the metaverse. In recent years (Bojic, 2022) businesses like Facebook and Roblox are investing in the creation of virtual worlds that enable users to engage with each other and with digital things in fresh and creative ways while also actively exploring the concept of a metaverse (Kraus *et al.*, 2022). Although the concept of a metaverse is still primarily speculative, there are numerous possible uses for such a system (Azar *et al.*, 2022; Hwang and Chien, 2022; Bojic, 2022). The metaverse might be utilised, for instance, for remote work, virtual conferences and immersive learning (Lee *et al.*, 2022). Also, it can present fresh chances for artistic expression, sociable contact and amusement (Dionisio *et al.*, 2013).

The metaverse does, however, bring up several issues related to control, security and privacy (Zhao *et al.*, 2022; Chen *et al.*, 2022; Di Pietro and Cresci, 2021). If a single corporation or group of companies controls the metaverse, there is a chance that they would abuse their dominance to manipulate the economy, stifle free speech and invade users' privacy (Guinard, 2022). Addiction, mental health and the effects of prolonged exposure to virtual environments on human behaviour are other issues that need to be addressed (Valentine, 2023; Usmani *et al.*, 2022; Cerasa *et al.*, 2022; Liu *et al.*, 2022). Advances in VR and AR technology are bringing us closer to this idea of an entirely immersive virtual world, even though it is still essentially a work of science fiction (Slater and Sanchez-Vives, 2016). Although the metaverse's potential uses are intriguing, there are numerous privacy, security and control issues that must be resolved if this kind of technology is to be effective (Gupta *et al.*, 2023; Njoku *et al.*, 2023).

3. Metaverse in education

In recent years, as virtual reality technology has advanced and grown more widely used, the idea of a metaverse has gained popularity (Slater and Sanchez-Vives, 2016). People can engage with one other and with digital items in the metaverse, a virtual environment where they frequently use avatars to represent themselves (Holts, 2013). There is a lot of promise for the metaverse in education, even though it has traditionally related to games and entertainment.

The metaverse has the potential to transform education by providing a new, immersive, interactive method of teaching and learning (Hirsh-Pasek *et al.*, 2022). Students

can experience learning in a way that is not possible with traditional classroom instruction by utilising virtual reality and augmented reality technology (Pellas *et al.*, 2021). For instance, in a history class, students could virtually tour ancient Rome or the Egyptian Pyramids, and in a science class, they could investigate the human body or carry out experiments that would be too risky or expensive to carry out in a real laboratory (Dwivedi *et al.*, 2022).

Education may become more inclusive and accessible thanks to the metaverse. The metaverse provides a mechanism for students to take part in class from anywhere in the world if they are unable to attend in person due to illness, a handicap or other reasons (Ayub *et al.*, 2022; Tlili *et al.*, 2022). The metaverse offers a mechanism to receive top-notch education from anywhere, which benefits students who reside in remote places or in impoverished nations with scarce educational resources (Dziuban *et al.*, 2018; Klimova, 2021).

The metaverse can improve learning opportunities and engagement while also fostering the growth of critical abilities like teamwork, communication and problem-solving (Azar *et al.*, 2022). Students can collaborate on projects and find immediate solutions to issues in a metaverse setting, gaining vital skills that are useful in the profession (GÖÇEN, 2022). The ability to design immersive and interactive learning experiences is one of the metaverse's primary benefits (Hirsh-Pasek *et al.*, 2022). The level of detail that may be achieved in a virtual field trip to a historical place or scientific lab, for instance, is unattainable in the real world (Azuma, 1997; Spicer and Stratford, 2001). In comparison to traditional classroom learning, students can explore the area and interact with objects and other users in the virtual environment (El Beheiry *et al.*, 2019).

The metaverse also allows for the personalisation of educational experiences. The speed of instruction, the subject matter and the examinations are frequently the same for all pupils in a traditional classroom setting (Lin *et al.*, 2022; Hines and Netland, 2022; Zhang *et al.*, 2022). Learning can be tailored to the unique requirements and skills of each student in a metaverse setting (Sá and Serpa, 2023). For instance, a student who is having trouble with a specific subject can get extra help and direction, and a student who is doing well can be given more difficult material to work with Srisawat and Piriyasurawong (2022).

There are several issues that need to be resolved despite the potential advantages of the metaverse in education. The expense of adopting the technology needed to build and access the metaverse is one of the main obstacles. To support the technology, educational institutions would need to spend a lot of money on expensive virtual reality and augmented reality hardware as well as high-speed Internet connections (Duan *et al.*, 2021; Henz, 2022). Another issue is the lack of qualified teachers who can design and lead learning activities in the metaverse (Talan and Kalınkara, 2022). Instructors would need to receive training in immersive and interactive learning experiences, as well as the usage of virtual reality and augmented reality technology (Tira Nur Fitria *et al.*, 2022; Sá and Serpa, 2023).

By providing a new, more immersive, dynamic and entertaining method of teaching and learning, the metaverse has the potential to revolutionise education. It can increase education's accessibility and inclusivity, support the growth of crucial skills and offer individualised learning opportunities (Bhavana and Vijayalakshmi, 2022; Sharma and Dash, 2023). The advantages of the metaverse in education are obvious, notwithstanding some issues that need to be resolved (Allam *et al.*, 2022). The metaverse is probably going to become a more crucial educational tool as virtual reality technology develops.

4. Research objectives

This qualitative analysis aims to conduct a bibliometric and co-citation analysis to answer the following research questions:

RQ1. Who are the prominent contributors and thought leaders in the metaverse with a focus on educational applications?

RQ2. What is the trajectory of annual scientific publications concerning the integration of the metaverse in education?

RQ3. To what extent do nations engage in the advancement of metaverse technologies for educational purposes?

RQ4. In which scholarly journals is the work of authors prominent in the field of metaverse education frequently published?

RQ5. Which individuals have garnered the highest number of citations for their contributions to the intersection of metaverse and education?

RQ6. What are the emerging themes and frequent keywords derived from the conceptual framework of the metaverse in the context of education?

Using R-Studio, a bibliometric study was carried out. Although there are many software tools available for systematic literature review and bibliometric analysis; and the selection of the tool will depend on the purpose and nature of research that is undertaken.

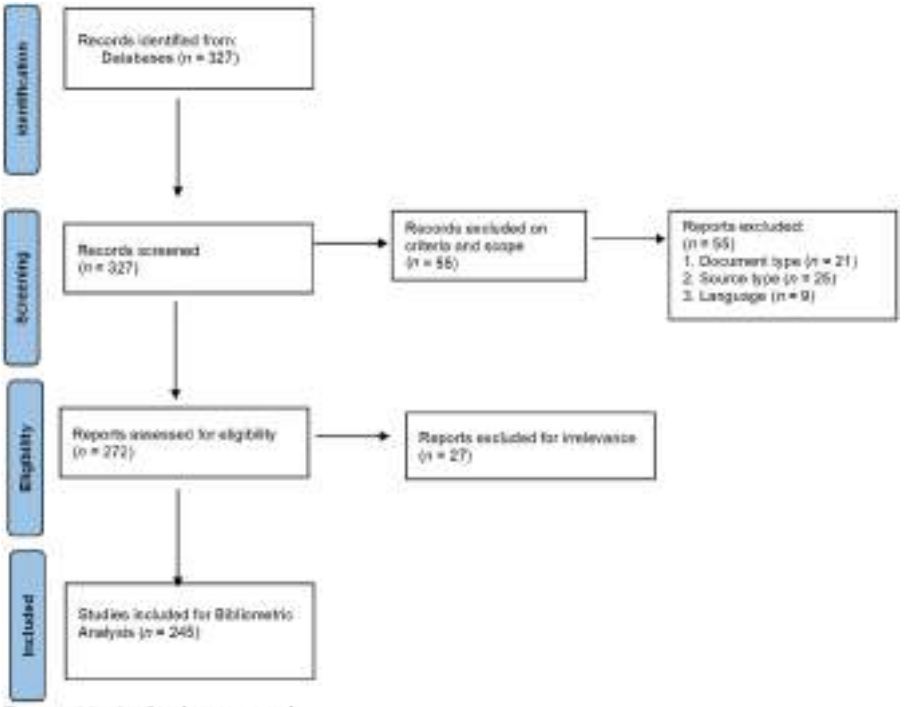
5. Methodology

A bibliometric analysis of the published output relevant to hybrid/blended learning was conducted to answer the research questions. A structural representation of publications was established through measurement and analysis of the bibliographic data generated in the specific topic (Akhil, 2022).

The publication period was limited to the years 1995–2023 in order to assess the recent, rapid growth of the metaverse. Many subject areas were covered because the study was cross-disciplinary and multidisciplinary. When examining the publication's source categories, only peer-reviewed journal articles, book chapters and conference papers were taken into account as they were believed to produce more reliable findings. Only papers that were published in English were used for this investigation.

A total of 327 published results were initially gathered based on the search terms. Of these, 55 publications were ignored since they at this time did not meet the criteria set out by the research design in terms of document formats, publication sources and language. After the remaining 245 publications completed an eligibility check by looking at their titles and abstracts, a total of 27 papers were eliminated for being unrelated to the study. To analyse and map bibliographic data, the researcher set up the most recent version of R Studio on Windows 11 and the bibliometrix package in the R environment. The properties of bibliometrix were then used to provide the desired results. The bibliometrix program makes use of the "readfile" and "convert2df" methods. The "convert2df" function extracts and creates a data frame that corresponds to the unit of analysis in the Web of Science (WoS) output file, as opposed to the "readfile" function, which imports and converts text data to UTF-8.

Duplicates, incorrectly detected bibliometrics and unnecessary data were eliminated from the WoS database, leaving the final 245 records, which were exported in "BibTex" format. These documents were utilised in the ensuing bibliometric analysis. Data was filtered and the most pertinent information was included using the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) technique to produce the desired results.



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6. Results and discussion

Table 1 presents the key details regarding the extracted data. Using the word "metaverse in education" we conducted a topic search and after PRISMA analysis, 245 pieces of eligible bibliographic information from the online Web of Science (WoS) database between 1995 and 2023 were proceeded for further analysis. Only the title, abstract, author keywords and keywords plus were searched for in the content. It reveals that 245 articles were written by a total of 756 people. The key to authorship in the metaverse, where 61 authors have written solely, is collaboration. Despite the fact that we downloaded 245 files, the overall number may change as new articles are published. Examples of the document types that were chosen include articles, proceedings papers, early access articles, editorial content, reviews and notes.

From 1995 through the beginning of 2023, the field of metaverse has experienced an annual growth rate of 11.49%, according to analysis from the Bibliometrix R package. Four articles were registered in 2008; afterwards, there was a downward tendency, and in 2012 there were none. With 9 publications in 2021, which marks the start of the field's rapid growth, the number of publications reached 159 in 2022, making it the biggest publication year ever noted. 27 years' worth of scientific production are analysed. Nonetheless, the last two years have seen the most growth in publications published. According to the analysis's findings, as the subject of metaverse is still developing, it is anticipated that the scientific contribution will continue to increase yearly. The details are given in Figure 1.

Figure 2 shows the list of 10 most cited documents based on the number of total citations. The document by Dionisio *et al.* (2013) is the most cited document in the domain of metaverse

Description	Results
Timespan	1995:2023
Sources (Journals, Books, etc)	153
Documents	245
Annual growth rate %	11.49
Document average age	2.14
Average citations per doc	3.727
References	1
Document contents	
Keywords plus (ID)	335
Author's keywords (DE)	669
Authors	
Authors	756
Authors of single-authored docs	61
Authors collaboration	
Single-authored docs	70
Co-Authors per doc	3.41
International co-authorships %	29.39

Table 1. Main information

Source(s): Authors' own work

in education, while the article by Park and Kim (2022) is the second most cited document. The individual citation of these documents is more than 113 and 75, respectively. Article by Choi and Kim (2017) is the third most cited document with a total 46 number of citations. Bourlakis *et al.* (2009) and Dwivedi *et al.* (2022) are just behind in forth (43 citations) and fifth (34 citations) position respectively. According to Arsyad *et al.* (2018), in order to have the comparable impact as an article in a related area, each article should have a minimum of 25 citations. The number of citations for any work increases when the reporting requirements are followed, and the number of citations also rises when a methodologist is involved in editing and peer-review (Paiva *et al.*, 2012).

According to Dionisio *et al.* (2013), modern virtual worlds are now intricately detailed settings with integrated spatial speech, advanced economy and increasingly realistic 3D graphics. These evolving features allow them to function more and more like digital cultures than just games, acting as elaborate environments for work, sociability, creativity and play. In order to provide a parallel setting for social interaction and culture, virtual world development must now overcome a significant new challenge: how to transition from a collection of complex but entirely isolated immersive environments to a vast integrated network of 3D virtual worlds or metaverse. The work of Dionisio *et al.* (2013) has stated that accomplishing considerable progress in relation to four characteristics—realism, ubiquity, interoperability and scalability—that are seen as key components of a fully realised metaverse is what success in this endeavour is described as.

There are three components, namely hardware, software and contents, as well as three methodologies, namely user interaction, implementation and application, that together make up the concepts and fundamental techniques required to realise the metaverse (Park and Kim, 2022).

metaverse exhibition content that was successfully generated by combining augmented reality and a virtual world presents a strategy for using beacons and Head Mounted Displays (HMD) to deploy content services for visitors' museum experiences (Choi and Kim, 2017). This project creates the idea of a service that offers a virtual world experience by coupling a

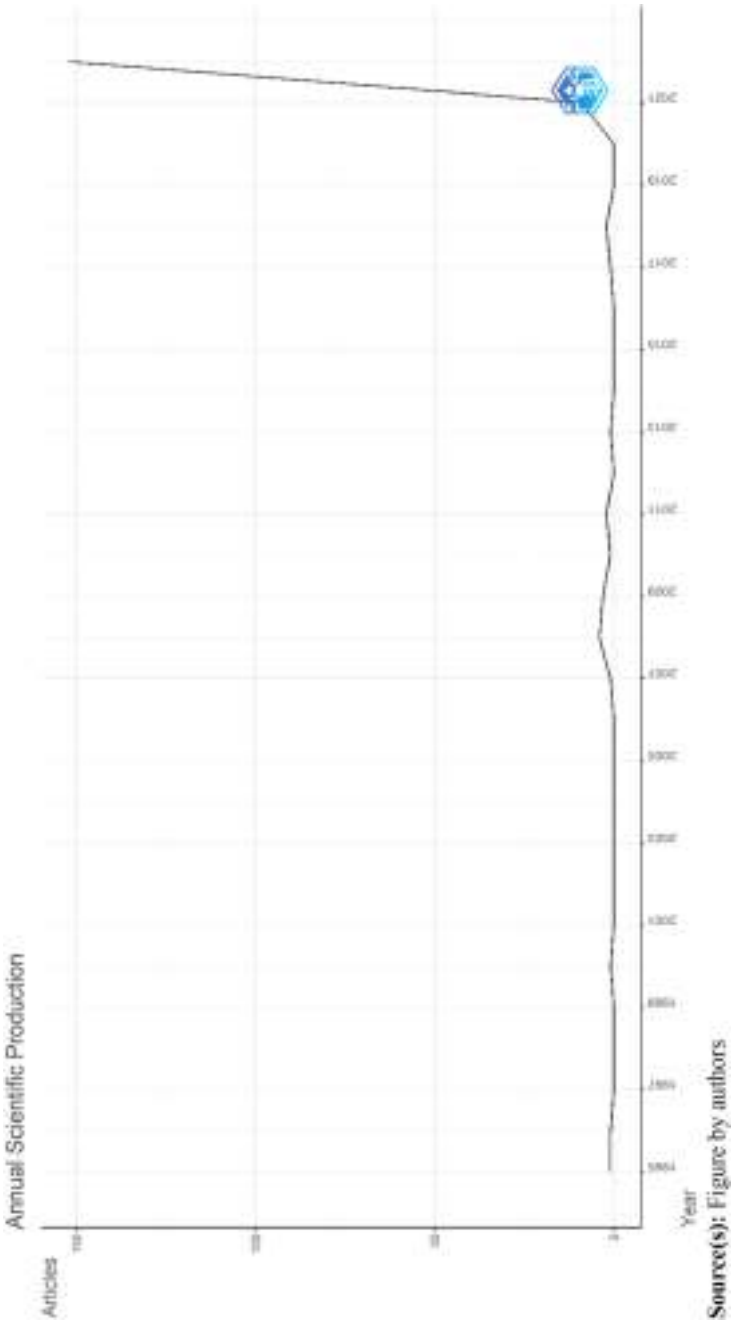


Figure 1.
Annual scientific production

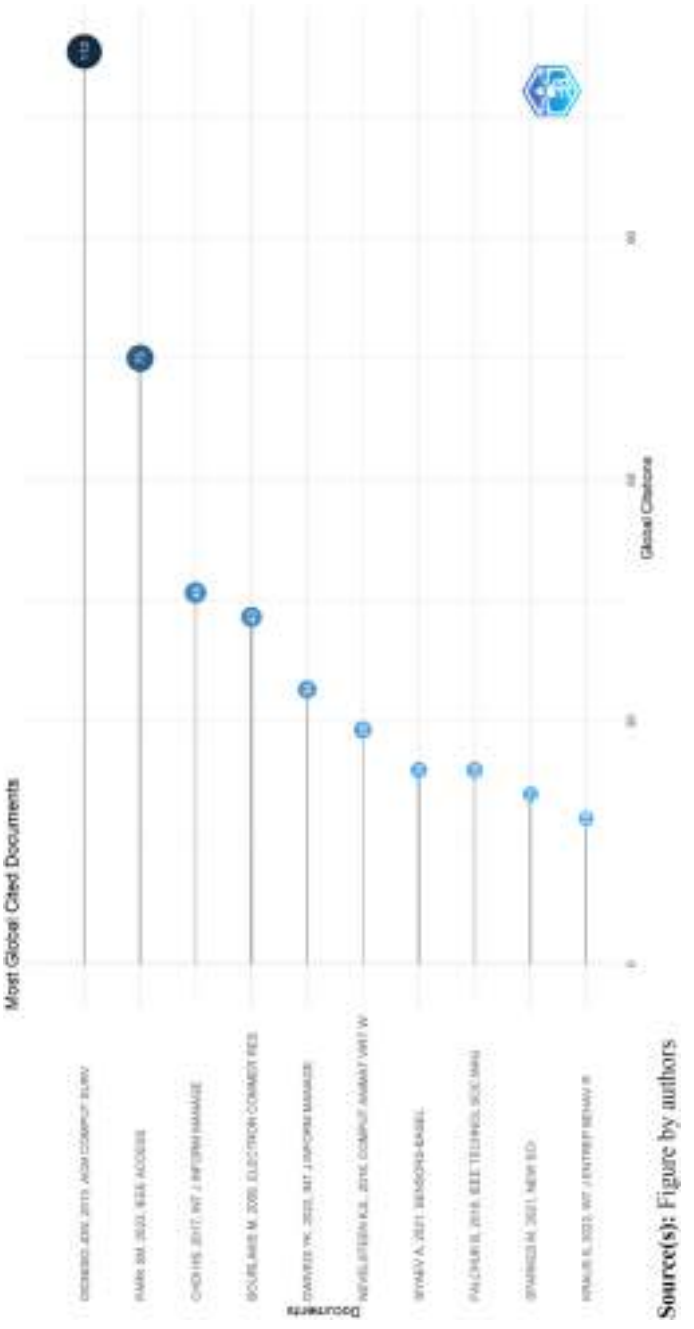


Figure 2.
Top cited documents

Head Mounted Display to a beacon situated in real space, in this case, an exhibition room. The service also includes a narrative component that presents information on objects' qualities and stories in order to diversify the user experience. Meaningful museum experiences can be both offline and online thanks to the service design.

Shopping has changed over time from traditional to electronic to metaverse (Bourlakis *et al.*, 2009). The writers examine second life in relation to the metaverse phenomena, and a number of conclusions are drawn. One important result is that, if shops want to compete at the metaverse stage as well, they must develop their promotional campaigns using a comprehensive and all-encompassing approach.

Some literature combines an informative narrative with a multi-perspective approach from specialists with a variety of scholarly backgrounds to study the issue of the metaverse and its transformative effects. This study adopts a "beyond the hype" viewpoint and provides insightful information on the advantages and difficulties of the increased use of the metaverse, from many angles and impacted business and societal sectors (Dwivedi *et al.*, 2022).

Figure 3 shows the average citation rate for metaverse in the field of education per year. This outcome demonstrates how much of an annual impact the publication has on the domain. The outcome reveals that from 1995, which seems to be the start of the discipline, until 2008, the papers received few citations. Since 2011, there has been a significant increase in citations, with 2013 seeing the highest number. The quantity of works in this particular field has been rapidly growing recently, as seen in Figure 1, which has an impact on the decline in citations.

Figure 4 depicts Lotka's Law, which details how frequently authors publish in a certain topic. According to the results, 94.1% of all authors will only have one publication, 4.8% have two publications, and the leftover authors have more than two publications in the field of the metaverse.

Bradford's law of scattering, which describes how papers in a discipline are scattered across the universe of journals, is depicted in Figure 5. It demonstrates that Applied Sciences-Basel is the top publisher of majority of papers, followed by IEEE access and Sustainability.

Figure 6 lists the top nations in terms of their contributions to the educational metaverse. The results showed that China is the most productive nation in the metaverse domain, with a total production of 84 publications, followed by South Korea with 70 publications and the United States with 61 publications. According to the graph, the majority of western European and American nations collaborate the most with other nations in the field of metaverse in education.

In the following analysis, the top 10 countries by both total and average citation volume are displayed. The top two countries are South Korea (235) and the USA (207). Remarkably, with 57 total citations and 1.84 average citations, China—which in terms of publication counts seems top among the nations—fall to fourth place. This implies that despite the fact that many countries may not have produced a sizable number of scientific articles in metaverse, those handful that have been published have had a big impact. The UK and Sweden are among the top countries whose contributions to the area have a significant impact, as seen in Figure 7.

The field of metaverse in education is depicted thematically in Figure 8 and is essentially separated into four quadrants (Q1 to Q4). Driving themes are represented in the upper right quadrant (Q1), underlying themes in the lower right quadrant (Q4), extremely specialised themes in the upper left quadrant (Q2), and emerging or fading themes in the lower left quadrant (Q3). Particularly, the chart shows that the driving themes that can organise the research field are "system," "augmented reality," "information technology," and "virtual world." This indicates that the role of information technology and artificial intelligence continue to be the dominant themes in the industry. The fundamentals were the focus of the

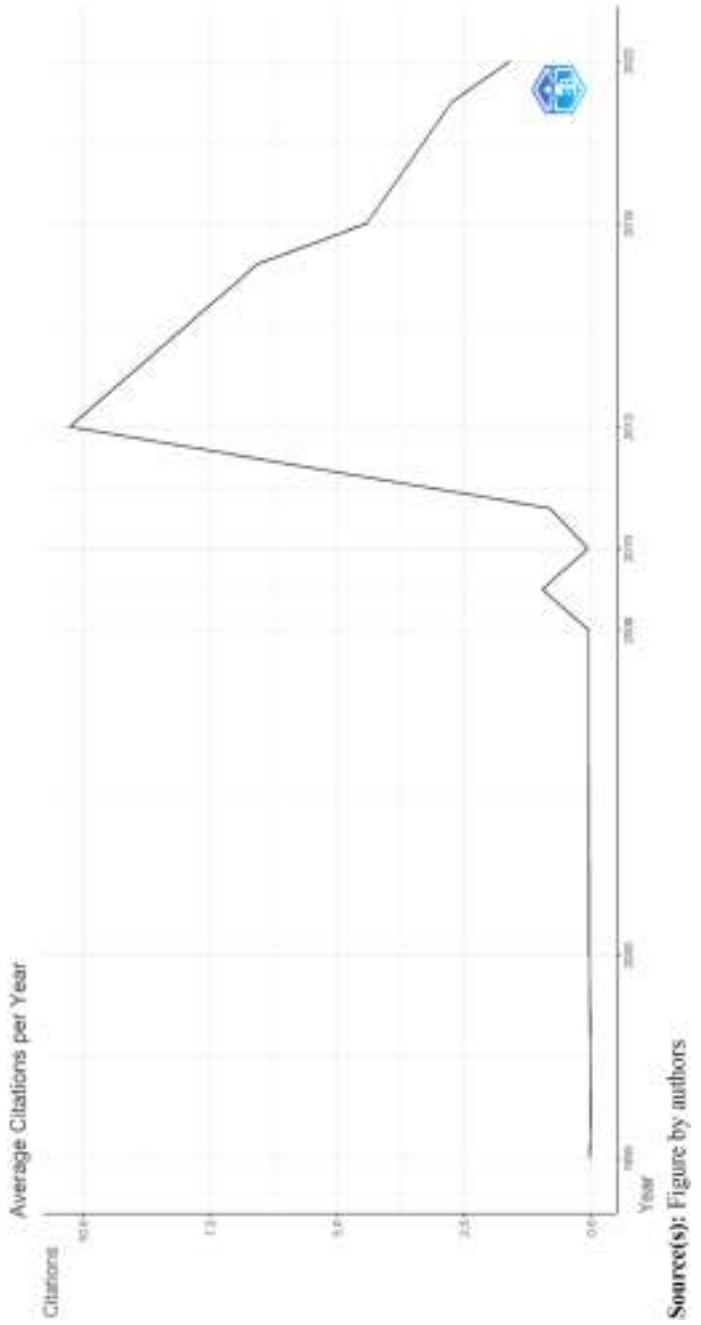


Figure 3.
Average article citation per year

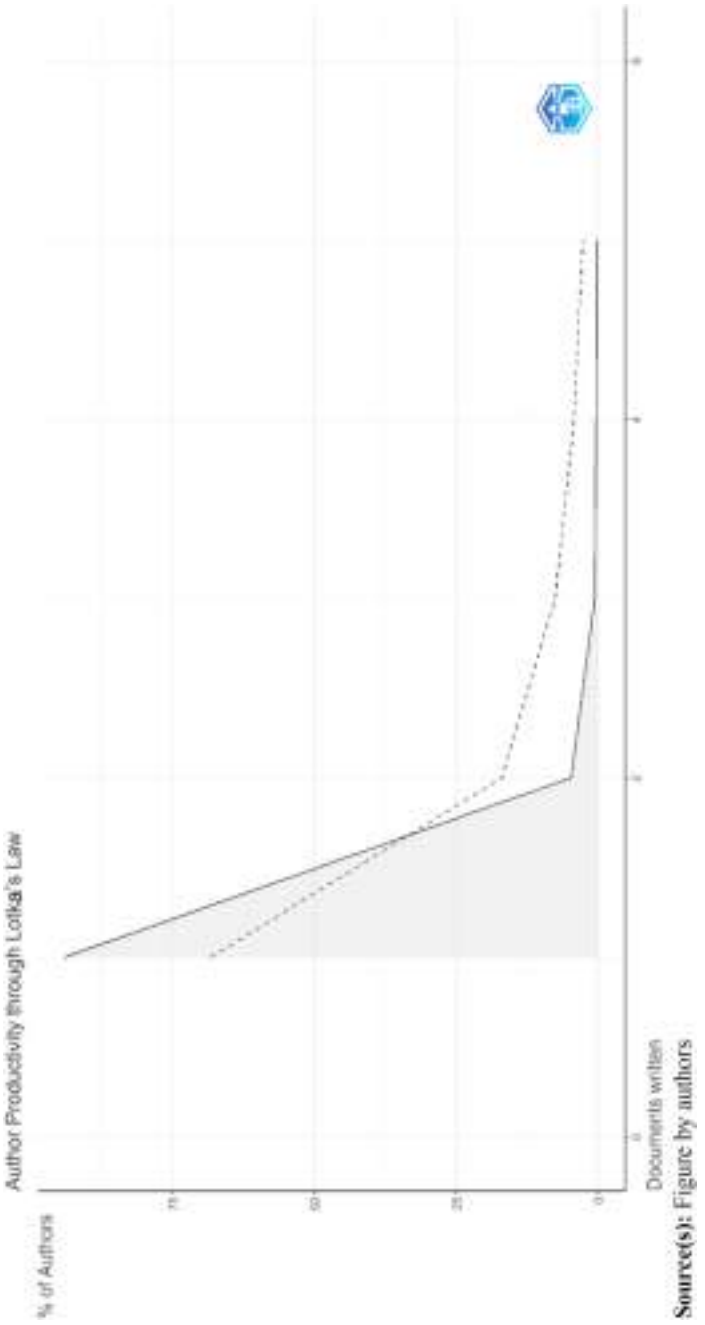


Figure 4.
Lotka's law

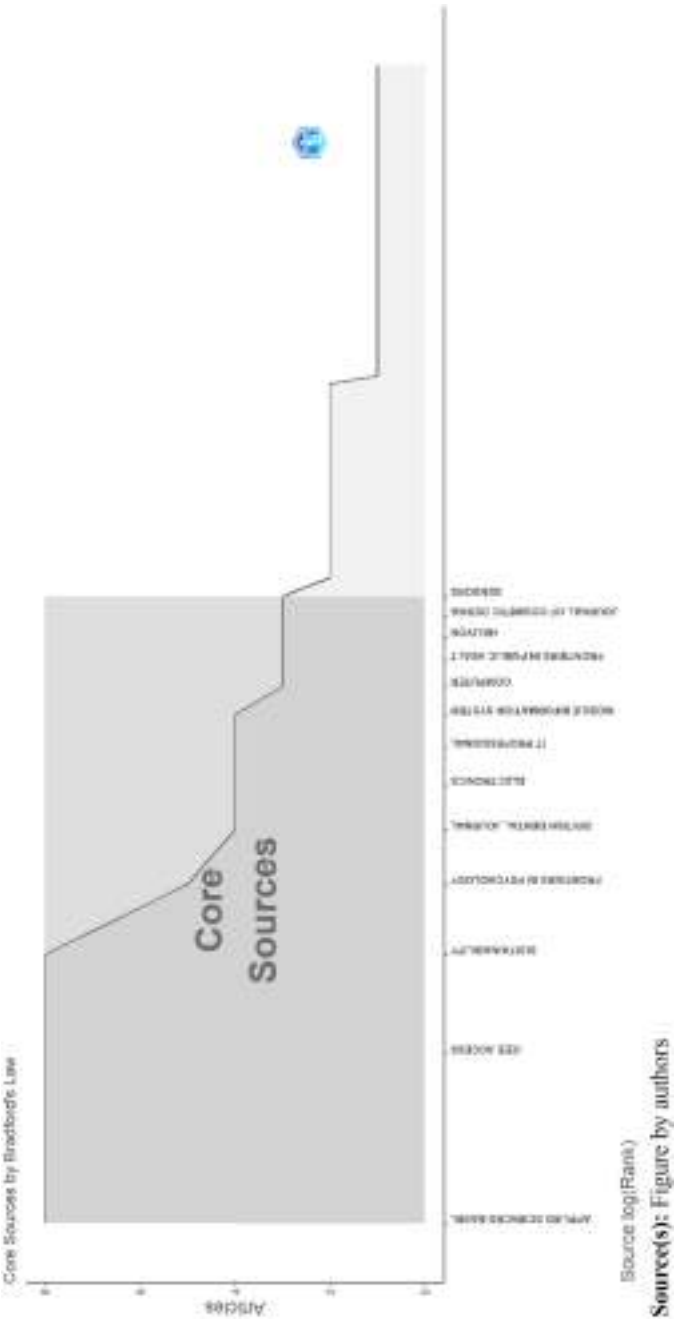


Figure 5.
Bradford's law

Source(s): Figure by authors

Figure 6.
Country specific scientific production

fourth quarter's theme, "Internet," which is crucial for the advancement of the industry. Although the themes from Q2 have formed internal linkages, they still only make a small contribution to the growth of the metaverse in education. This conclusion shows that themes from Q2 like media and communication may need to be more closely related to the metaverse. In Q3, the subject of "performance" and "future" seems to be forming, and in Q4, the themes of "future" and "behaviour" cross, suggesting that some of its elements are fundamental and essential for growing the area. According to the thematic analysis, additional steps are required to create themes in order to forge stronger connections with the "metaverse." This initiative is required because emerging technologies like artificial intelligence, virtual reality and robotics have the potential to greatly influence the structure, future and sustainable development of the metaverse.

Figure 9 shows network visualisation of articles with the theme "metaverse in education". The size of the nodes reveals how frequently the keywords occur. The co-occurrences of the nodes are shown by the curves connecting them in the same publication. The more closely spaced two nodes are, the more frequently the two keywords occur simultaneously. The final analysis included keywords that were used by the authors and that appeared more than five times in the WOS core database.

Most frequent keywords used by the authors were shown in Figure 10. Since metaverse is solely depends on technology and Internet, the keywords also related to those areas only. The most frequent keywords were virtual reality, augmented reality, system, impact, information technology, Internet, artificial intelligence, etc.

7. Summary of findings

- Publication Growth and Trends:

The field of metaverse in education has experienced a notable annual growth rate of from 1995 to the beginning of 2023. There was a decline in publications after reaching a peak of articles in 2008, with no publications in 2012. However, a significant resurgence began in 2021, reaching its zenith in 2022. The last two years have seen the most substantial growth in published works, suggesting a continuing upward trend in scientific contributions to the metaverse.

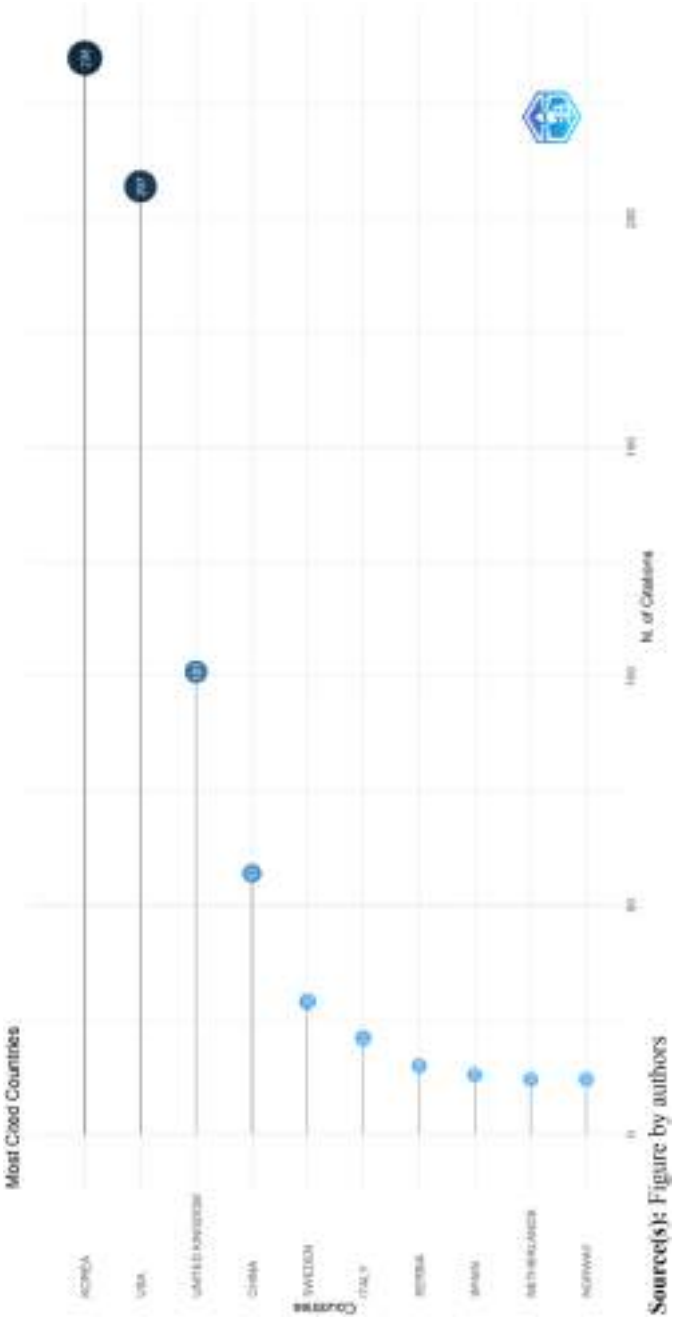
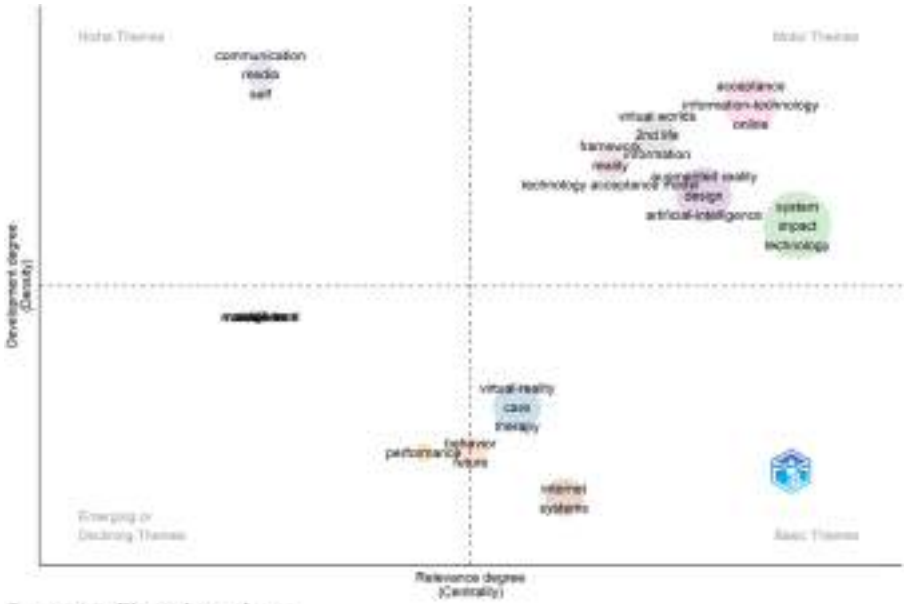
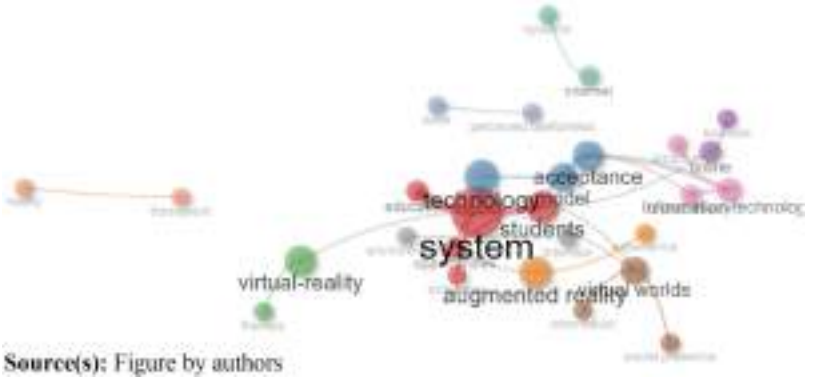


Figure 7.
Most cited countries



Source(s): Figure by authors

Figure 8.
Thematic map



Source(s): Figure by authors

Figure 9.
Network visualisation based on the frequency of keywords

- Citation Analysis:

The top-cited document in metaverse education is attributed to Dionisio *et al.* (2013), emphasising the evolving nature of virtual worlds into intricate digital cultures. The analysis highlights the importance of realism, ubiquity, interoperability and scalability for the realisation of a fully developed metaverse.

- Thematic Analysis:

Thematic mapping reveals driving themes such as "system," "augmented reality," "information technology" and "virtual world" dominating the research field. Strong connections between emerging technologies like artificial intelligence, virtual reality and robotics are essential for the sustainable development of the metaverse.

Source(s): Figure by authors

Figure 10.
Word cloud

- Country-Specific Contributions:

China emerges as the most productive nation in metaverse education, with 84 publications, followed by South Korea (70) and the United States (61). Citation impact analysis reveals surprising contributions from Korea, USA and UK despite a lower publication count, indicating significant influence.

- Authorship Patterns:

Lotka's Law indicates that the majority of authors contribute only one publication, emphasising the need for broader engagement within the academic community.

- Journal Distribution:

Bradford's Law of scattering identifies Applied Sciences-Basel as the leading publisher, followed by IEEE Access, reflecting the distribution of papers across journals in the discipline.

- Keyword Analysis:

Network visualisation of keywords reveals frequent occurrences of terms such as virtual reality, augmented reality, system, impact, information technology, Internet and artificial intelligence, underscoring the technological focus of metaverse research in education.

8. Conclusion

Using bibliometric analysis, this study has attempted to give a thorough evaluation of scientific publications in the metaverse in education over time. The study examined the metaverse-related themes in published works, recognised notable scholars and their contributions, glanced at social networks and cross-institutional, cross-national, and cross-regional collaborations over time, and presented a thematic analysis of the metaverse field by outlining its current state in terms of themes and future directions. The study reveals that incorporating the metaverse into education can get over traditional restrictions on time, location and money, giving students access to previously inaccessible areas. This ground-breaking method successfully addresses problems in virtual worlds that exist in the real world. The study also finds a gap in the way digital world technology is being used in metaverse teaching. There is a need for additional study concentrating on implementing digital life applications in upcoming schools given the quick improvements in technology.

Diverse technologies, such as artificial intelligence, machine learning, blockchain technology and Internet of Things (IoT) gadgets, should be used in this process of next level digital learning experience. The metaverse in education has witnessed substantial growth in publications, international collaboration and thematic evolution, driven by technological advancements and a diverse array of applications. The findings suggest a promising future for continued research and development in this dynamic and multidisciplinary field.

9. Implications of the study

This study presents a bibliometric analysis of metaverse in education, shedding light on its recurring presence over the past 2 decades. Despite not being a novel technology, recent advancements have brought it back into focus, offering both opportunities and challenges (Allam *et al.*, 2022). While many researchers are captivated by its potential, they often overlook the associated threats. The metaverse's current surge in popularity is fuelled by substantial investments from major tech corporations. However, this financial influx raises concerns, especially regarding the educational landscape. Metaverse remains in its early stages, characterised by numerous vulnerabilities such as security issues, privacy concerns, ethical dilemmas and psychological impacts (Liu *et al.*, 2022; Chen *et al.*, 2022; Anshari *et al.*, 2022). Moreover, its integration often favours institutions with advanced infrastructure, leaving those in developing countries at a disadvantage (Dwivedi *et al.*, 2022). Addressing these challenges is imperative. It is essential to explore inclusive design strategies, ensuring accessibility for all students. This inclusivity aligns with the United Nations' Sustainable Development Goals, particularly SDG-4, emphasising quality education. Despite its potential, the metaverse is often exploited by investors for profit, leading to the commercialisation of virtual spaces and the exploitation of stakeholders.

10. Study constraints and future research

The compilation of sample data is the study's main limitation. Technical limitations in the software used to analyse the data prevented integration of data from different databases at the time the study was finalised. This study's sample was drawn from the Web of Science database, thus it's probable that some crucial data was omitted. The study would surely benefit greatly from the collection of sample data from additional sources. Also, the search terms used to query the database should be expanded to include more relevant keywords. This limitation should encourage researchers to consider strategies for acquiring data from other databases with larger keywords for future in depth studies in this domain.

Future research in this field must delve into critical questions. These inquiries encompass the metaverse's effects on physical and virtual learning, data privacy in digital algorithms, the impact on students with disabilities, the consequences of losing the human element in education, and the overreliance on chatbots and meta bots. Additionally, there is a need to explore cyber syndromes and methods to humanise metaverse learning experiences.

To enhance the metaverse's implementation, technical guidance for educators is crucial. Teachers should receive training on flipped classrooms, blended learning approach, Application of different AI tools as well as fostering dynamic, engaging and collaborative virtual platforms. By addressing these aspects, the metaverse can be harnessed as a powerful educational tool, promoting accessible, equitable and quality learning experiences for all learners.

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