

A Bibliometric Analysis: Metaverse in Education Concept

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Abstract—During the last decade technological transformation prospered, and digital environments such as Metaverse started to come to life. Metaverse is a hypothesis of the next generation of the Internet, which consists of an online 3D virtual environment and limited physical interaction. Due to the growth of Metaverse technology in various fields and the importance of using it in education, it is being observed that published research related to this topic is also growing. Therefore, the purpose of this study is to review and identify the application areas of this emerging technology for the education field by providing a bibliometric analysis of the literature related to Metaverse. This research contributes to literature as it addresses the status, gaps, and the direction for future research. In the bibliometric analysis, an electronic search was done via a scientific database named Dimensions by combining topic-related keywords for ‘metaverse’ and ‘education’ within the time frame of 2004 and 2022. The data gathered by a data extraction table from 5,048 articles retrieved and analysis run by VOSviewer data visualization tool. Of 5,048 articles found through the initial search, most of the studies (48.02%) were published in 2022, and Singapore, Japan, China, and UK are the main countries for the studies and citations appearing dominantly. The main three keywords for ‘metaverse’ and ‘education’ articles include: virtual worlds, video and metaverse platforms. The use of metaverse in education has been expanding rapidly in literature during recent years. Yet this study reveals that research is still limited to the main four countries, and studied subtopics are very primitive and vague. Available citations show weak link strength meaning the depth of the studies in the literature is not satisfactory, yet, which is because the metaverse itself is not enough without the supporting technologies. Educators and scientific researchers could rethink what types of technologies belong to the metaverse and how it has the potential to influence the education sector. Policymakers and educators could refer to this study for metaverse learning environment expansion of their future policy and executions.

Keywords: Metaverse, education, virtual reality, bibliometric analysis, VOSviewer

I. INTRODUCTION

A. Metaverse Concept

Both a "new concept in use" and an "idea still under construction" are the terms used to describe the metaverse [1]. It is a compound word derived from two words: “meta” and “universe” [2]. It can be easily interpreted as combination of virtual world and real world [3]. Due to the rapid advancement of technology and changes in consumer preferences, virtual reality in Metaverse is currently a hot topic of discussion [4]. The graphics have improved thanks to technological developments like 3D progress, giving the metaverse a more realistic feel [5]. In the end, it combines a virtual world with a physical reality that has been enhanced to encompass both with a new specific technology known as eXtended Reality (XR), which includes Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR) [6].

Beginning in 2022, when Facebook's online social media platform changed its name to Meta, the term "metaverse" became widely recognized in the industry [7]. With its new name, Facebook expanded on the "metaverse," a three-dimensional environment [8]. This also brought up the discussions about whether it is a new business innovation or not. There were several business-wise reasons behind this name change. However, the name change also was perceived as an unlocking of a new technological era. The rebranding of Facebook has significantly raised public attention in XR technologies. This progress also was a guidance to the full potential of the metaverse [9]. Critics claimed that the Metaverse was nothing more than hype with no tangible benefits [10]. According to Rana et al. metaverse is an intersection of augmented and virtual reality [11]. Based on this, the metaverse contributes to the structure that shapes and limits user actions [12]. Under the light of these recent evolutions, metaverse became a hot topic for societies. It is still an interesting area to research due to its immature nature, and that is why it is the focus of this research.

It is also crucial to understand the interest of the consumers in this new era. Worldwide Google searches for the keyword “metaverse” can be reported as below Fig. 1. As it is seen the public interest started by the end of 2020 with a strong jump while it was almost zero before. This is still showing a very fluctuating trend and yet it is not a mature and not a continuous interest about the new concept.



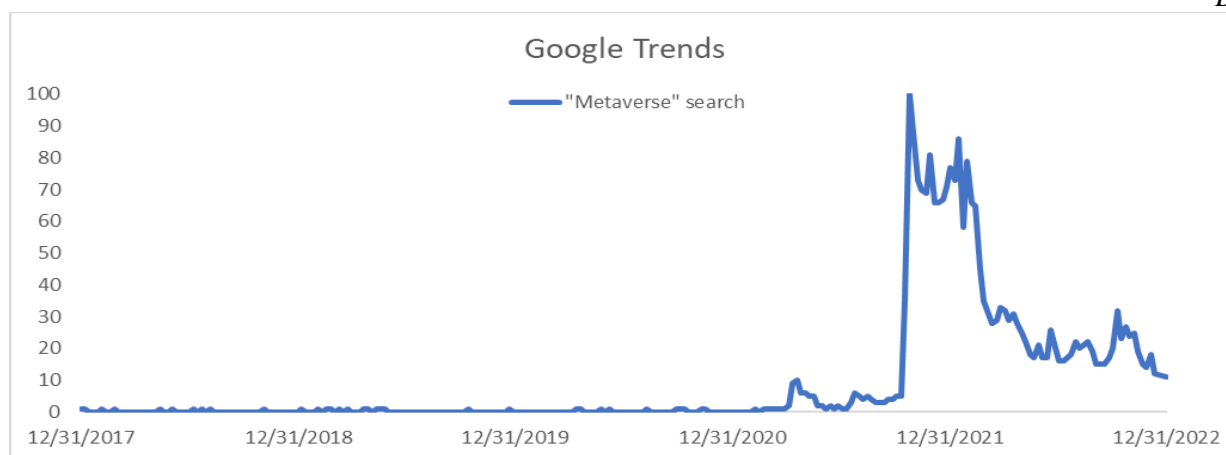


FIG. 1. Worldwide Google searches for 'metaverse'. The maximum popularity during the analyzed period is indicated by an index equal to 100.

The virtual interaction experience is not sufficient alone without a physical component. Thanks in large part to wearable technology, which gives the impression that the experience is as real as a physical interaction, the metaverse has begun to be an intriguing aspect for many industries [13]. Watching movies, working, visiting various locations, or even trying on clothes are virtually all possible activities [14]. Based on immersive interaction, the metaverse expands with a variety of social meanings that go beyond gaming, fashion, and education [15]. But many other possible industries are on the pipeline such as banking, real estate, and so on. To encourage participation in the Metaverse, an economic system is in place [16]. The idea of the Metaverse is still evolving, and no definitive definition has been provided [17]. But many industries are working on solutions that can include virtual space that can lead their industries to the next level. It sounds like a great opportunity and a great angle to work on in terms of product differentiation and experience expansion.

Some fictions give signals to us about the possible future expectations, and they eventually come to life. Many of the features that were predicted in fiction are now possible because the underlying technologies of the metaverse have developed over time [18]. For example, the gaming industry was the only area where the metaverse had a wide-scale application when it first appeared in the early 2000s [19]. Another industry is orthopedic surgery. It has been aided by the technology company Oculus [20]. Beyond these industry examples, some supporting technologies needed to evolve as well. Currently, some platforms provide users with metaverse-like experiences that are combined with virtual economies such as cryptocurrencies. Starting from the world of video games, these supplementary tools are allowing their users to engage in these virtual experiences [21]. Second Life was the first usable VR for many people involved in the field by 2003. It had been released as a social platform. At the time, Second Life or the online game World of Warcraft were the most well-known platforms [22]. People might tend to think of it as a game, but the essence is different because mutual communication is possible [23]. The market's interest in this technology is growing, and several companies, including Microsoft, Nvidia, and Meta, have shared their predictions for the future [24]. In 2021, many industries, including the healthcare sector, have adjusted to the metaverse phenomenon

[25]. Medical imaging-guided diagnosis and therapy can be developed, evaluated, and improved with the help of metaverse [26]. The zero-contact business culture has had a significant impact on the medical field [27].

The top highlighted industries for metaverse concept obviously are not limited to virtual social platforms, games, or health industry. Many more are in the pipeline to leverage on the new technologic era. The education sector is one of them. Education has huge potential to benefit from the technological updates due to its nature to make learning more entertaining.

In this research, it is aimed to contribute to the metaverse literature by analyzing the recent performance and dynamics of this innovation, which is tomorrow's new internet also for education industry like many other industries. The industry focus of this research is the education industry. No bibliometric analysis of publication has been observed till now for metaverse impact in education. Due to the development of software tools and improved capacity for handling massive amounts of data, the bibliometric approach to reviews has recently grown in popularity [28]. This research aims to explore the literature interest on metaverse in education from a bibliometric perspective. The research uncovers further research opportunities related to metaverse in education. In terms of methodology the Dimensions publications will be scanned and search results for the term 'metaverse' and 'education' will be analyzed by conducting keyword frequency method. Then, keyword mapping will be constructed by a viewer tool such as VOSviewer.

B. Research Goal And Research Questions

To ensure that a substantial range of literature was captured relating to the topic of interest, the following initial search questions defined to guide the search:

1. How is the metaverse in education concept covered in literature scope and how has the research progress so far?
2. Which countries, which researchers, which key topics are the focus in the literature for metaverse in education concept?

The following structure is planned for this study, and it is as follows. A literature review related to the metaverse in

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education is presented in Section 2. The methodology used is detailed in Section 3 and the analytical part is presented in Section 4. The insights found in this study are presented in Section 5. Finally, the conclusions, including future research directions are covered in Section 6.

II. LITERATURE REVIEW

The literature was reviewed to understand deeply the studies about metaverse in the education industry. Metaverse workspaces are dimensionless and accessible by simply using VR glasses [29]. Social VR will keep expanding because it gives users a sense of presence in space [30]. Learners rarely have the chance to directly perceive social and linguistic cues through online interactions [31]. The term "Eduverse," which refers to the Metaverse's educational effects, was combined to describe this phenomenon [32]. The COVID-19 outbreak during the pandemic years caused a shift in the type of education from offline to online [33]. The pandemic has forced the closure of in-person classes and adaptation of the knowledge transmission through education [34]. With the lockdown months, it has been experienced that distance learning was not as effective as it used to be in the class. Students may decide to turn off their video camera to play games or watch movies, even though there are reminders to keep cameras on [35]. The Metaverse could be an amazing solution as it enables participants to respond and fully interact. When the decision was made to go back to the classrooms with the masks, the job was easier. But there were still a lot of struggles with breathing with the masks [36]. It could be a way to give the feeling of being with the others in the same room while being tremendously distant. That's is exactly what was needed. Educators can define a hybrid delivery modality with a VR education environment integrated with existing education [37]. In teaching-related studies, a mix of real and virtual environments such as simulations offer students many benefits. Students can learn about a new subject while being engaged in a more interesting way [38]. Metaverses help to present to their users a high degree of interactivity. The metaverse can be successfully used in subjects such as medical and engineering classes [39]. The game type of experience-based world is expected to have a positive effect on a user's learning motivation [40]. One of the other benefits could be that they can proceed at their own pace [41]. For mathematics, the application of Metaverse may contribute to students' learning outcomes [42]. The modality can help them to use analytical approaches for interactive and attractive for students who don't like numbers. Not to mention the benefit to the industries could be that it may be cheaper to maintain a virtual product and service in the long term as metaverse technology advances [43]. A workable alternative might be to alter the learning materials in a digital textbook using metaverse [44]. Literature researchers are not limited to the given perspectives, obviously there is more to it.

According to the provided background analysis we aim to contribute to literature in several ways by deepening the scope in the selected research area. As it is observed in literature, metaverse affects several industries including education, and education is one of the main industries that can adapt it. When the literature has been analyzed in terms of industry evolution gaming, healthcare and education are the top three industries that have been highlighted. That's why the topic of this

research focuses on education specifically. As literature development also grew up rapidly with the COVID-19 era, literature needs to be analyzed in depth to define the research dimensions and aspects covered so far in terms of countries, institutions, authors, keywords, citation links and so on. Bibliometric analysis helps to understand the trends and effectiveness of bulk research data. It also reveals an overview and a synthesis of the big data which could be more meaningful rather than analysis of each study one by one.

In terms of theoretical framework of this research, literature review highlighted many references to get inspired and guided with. One of the research frameworks that was studied deeply is about model validation for combining the bibliometric and text-mining tool by using bibliometric analysis of the literature [45]. Another bibliometric analysis framework was seen for understanding the studies done for structure international entrepreneurship [46]. One of the most widely used visualization tools was noticed during the literature scanning was VOSviewer. A huge increase for global publications on COVID-19 was studied with bibliometric analysis and visualized by VOSviewer [47].

We identify studies focusing on metaverse in education in literature and perform the analysis of papers in terms of publications and citations trends. Additionally, we identify which countries, institutions, and scholars have been particularly influential and at which fields of research. We also identify the mainstream journals that are leading in publishing bibliometric studies, with results showing that these journals have particularly high-growing scholarly impact. Further, we suggest future research agendas, based on review-based approaches, to further develop the scholarly impact of metaverse in education literature. In conclusion, it can be easily commented that bibliometric studies are crucial for the academic world.

III. MATERIALS AND METHODS

According to Baker et al. [48] this research follows a bibliometric analysis, incorporating both quantitative and qualitative aspects of literature. Under this approach, we run the following analyses: (1) trends of total publications and citations, (2) bibliometric analysis of keyword/network analysis, (3) bibliometric analysis of citations by countries and (4) bibliographic coupling by authors.

A. Search Plan And Data Sources

In this research, bibliometric review was conducted by searching scientific databases by combining topic-related keywords including "metaverse" and "education". A common and precise technique for looking over and analyzing sizable amounts of scientific data is bibliometric review, which is a type of systematic review [49]. The time that was considered for this research included all the publications starting from January 1st, 2004, and until December 31st, 2022. As of the end of 2022, 5.048 publications have been retrieved by the database of Dimensions platform by Digital Science [50]. The articles' data that utilized the keywords "metaverse" and "education" were retrieved using the Dimensions platform.

Scientific Procedures and Rationales for Systematic Literature Review (SPAR-4-SLR), one of the review protocols used to evaluate publications, aims to help

researchers conduct systematic reviews of the literature and defend the choices they make along the way [51]. There are three different stages of SPAR-4-SLR which are assembling, arranging, and assessing (Fig. 2). We assembled and arranged 5.381 publications retrieved from the Dimensions database, having “metaverse” and “education” in the full text, and title of the publication. 333 publications were excluded due to still being in preprinting phase at the time of this research. Eventually 5.048 publications were left to proceed with the bibliometric analysis.

viewer, which aims to make the visualization of bibliometric maps simple [53]. This method allows us to effectively collect literature and identify the relationships of the selected publications within the alternatives. In this research the model was framed to analyze literature by open/closed access publications, journals/organizations, network visualization by keywords, citation by countries and bibliographic coupling by authors.

IV. RESULTS

A. Trends of Publications and Citations

As the research period start with 2004, there are not many visible records and citations until 2009. The graph below (Fig. 3) represents the publication and citation trends for literature over the last two decades. After 2016 the research field showed a boost in terms of publications, and it is reflected in citations accordingly between 2017 and 2019. After a slowdown during pandemic years, it is again showing another peak starting from 2021.

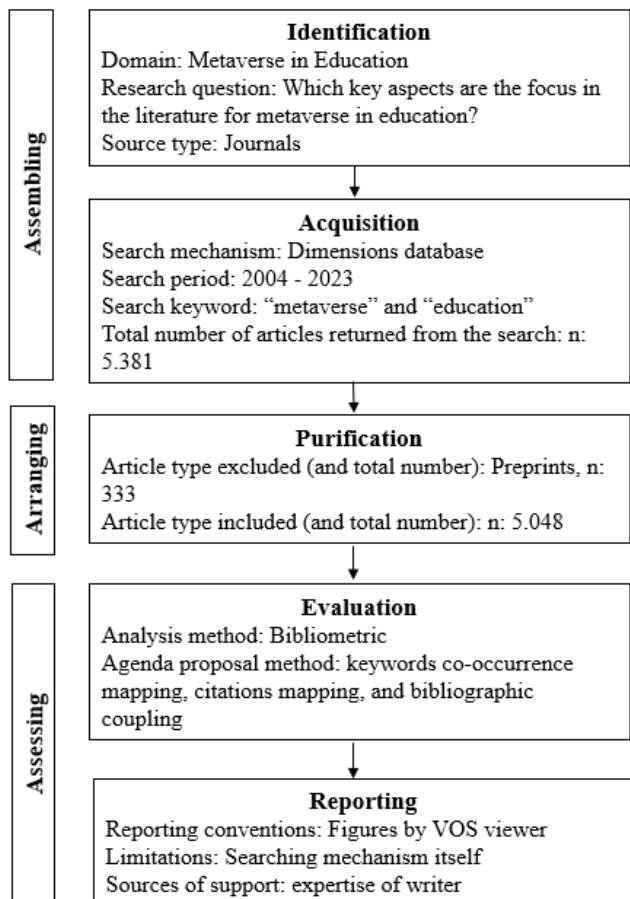


FIG. 2. SPAR-4-SLR review stages

B. Data Analysis

After selecting related studies, data extraction was done on a data extraction table designed in MS Excel 2019 as CSV format. This table has many data filtering items such as year of publication, language, journal, title, author, keywords, and counts of citation. The date of the retrieval was January 21, 2023.

After data extraction, the data was analyzed through the content analysis method, and the results were summarized and reported in related tables and figures. Various software programs and bibliographic mapping techniques that can be used to visualize research on a topic offer the presentation of results [52]. The received results have been downloaded in CSV format to be processed using VOSviewer (version 1.6.18) to visualize and analyze the trends in the bibliometric form. Bibliometric analysis is an accurate method for analyzing large volumes of big data. Growing in popularity in bibliometric research is the visualization of similarities (VOS)

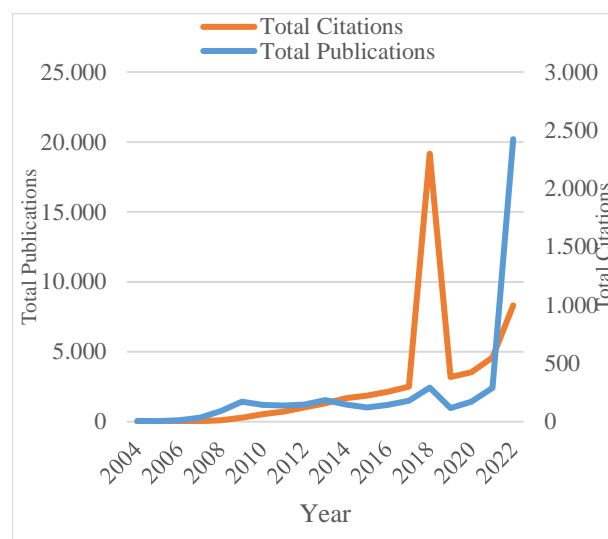


FIG. 3. Total publications and total citations trend

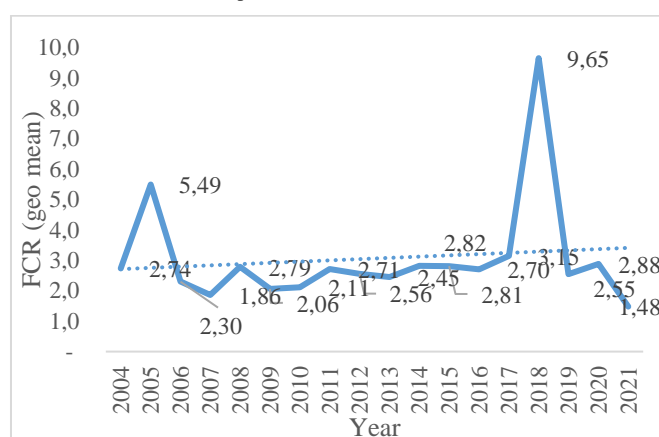


Fig. 4. Trends of total publications with FCR (geo mean)

The Field Citation Ratio (FCR) can be thought of as the average of all journal citation rates in each network. It shows how well a publication performs in terms of citations when compared to similarly aged articles in its field [54]. A value of more than 1.0-1.5 indicates higher than average citation, when defined by publication year. The FCR is calculated for all

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publications in Dimensions which are at least 2 years old and were published in 2004 or later. The highest geo mean score is 9.65 in 2018 (Fig. 4) showing the most impactful period of the research done in this area.

B. Focus on Open and Closed Access Publications

In the scientific literate Open Access (OA) is an important pillar to understand accessibility of the work. Open Access (OA) refers to the free, full-text availability of scholarly journal articles without a subscription, fee, or registration [55]. Compared to closed access articles, open access articles are cited more frequently [56]. The awareness on open access journals became evident in recent years and after 2017 it surpasses the closed article publications continuously (Fig. 5). Starting from 2021 the gap between OA and Closed publications are widening more evident.

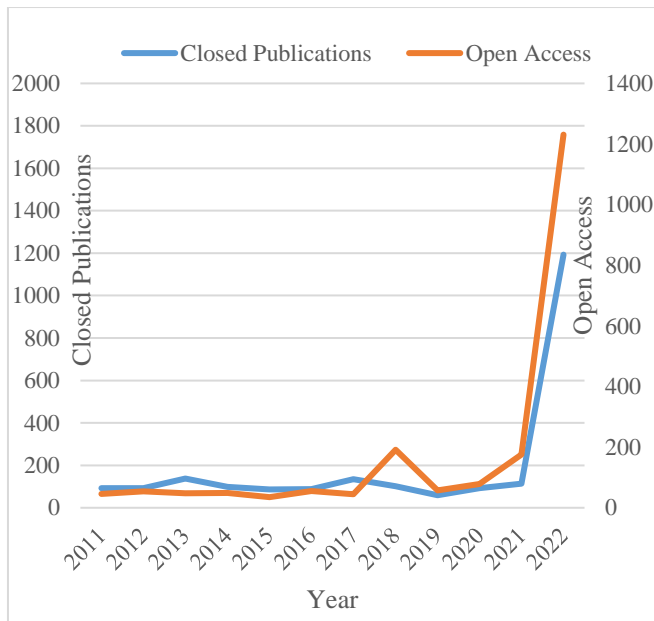


FIG. 5. Closed and open access publications

Overall total publications (TP) for closed publications are higher than open access publications 2,792 versus 2,256. However, total citations (TC) are remarkably higher for open access publications as well as TC/TP is 13.37 for open access while it is 7.51 for closed access journals (Table 1).

TABLE I. Open Access Publications and Citations

Publication Type	TP	TC	TC/TP
Closed	2,792	20,957	7.51
Open	2,256	30,161	13.37

C. Top contributed authors and journals

Top ten contributed authors based on publications are listed in Table 2(a) below. Niyato from Singapore has the highest number of publications with 33 and followed by Xiong again from Singapore with 27 publications. Fukumara from Japan has the highest TC/TP with 8.7 and second is Ogawa from Japan with 7.6 TC/TP indication of highest attendance.

In terms of total citations, Boulos from China is the top author with 552 citations and highest TC/TP of 92.0 as shown in Table 2(b) followed by Papagiannidis from United Kingdom with 364 citations and TC/TP of 52.0.

TABLE II. Top 10 Authors According to The Publications and Citations

Name	Country	Publications	TC/TP
Dusit Tao Niyato	Singapore	33	2.6
Zehui Xiong	Singapore	27	3.5
Hideyuki Kanematsu	Japan	25	6.9
Dana M Barry	USA	21	7.3
Chunyan Y Miao	Singapore	19	3.8
Nobuyuki Ogawa	Japan	18	7.6
Jiawen Kang	China	17	3.9
Xuemin Sherman Shen	Canada	16	3.0
Fei-Yue Wang	China	15	5.9
Yoshimi Fukumura	Japan	15	8.7

Name	Country	Citations	TC/TP
Maged N KBoulos	China	552	92.0
Savvas Papagiannidis	UK	364	52.0
Alan H D Miller	UK	223	31.9
Hideyuki Kanematsu	Japan	207	7.4
Brian E Mennecke	USA	188	31.3
Dana M Barry	USA	187	7.8
Nobuyuki Ogawa	Japan	170	8.1
Yoshimi Fukumura	Japan	154	9.6
Toshiro Kobayashi	Japan	136	10.5
Ko De Ruyter	UK	122	20.3

Another important perspective is understanding the top influential journals as future researchers will be curious to look for those journals. The most top ten influential journals are shown in Table 3 below and top three journal are: UCG Journal Group with 20,993 citations, followed by ERA with 20,535 and in the third place Norwegian Register with 14,581 citations. In terms of TC/TP ratio Norwegian Register is the most effective journal with the highest value of 17.66.

TABLE III. Top Influential Journals

Name	TP	TC	TC/TP
UCG Journal List Group II	2,120	20,993	9.90
ERA 2023	1,970	20,535	10.42
Norwegian Register Lvl I	1,767	14,581	8.25
ERA 2018	1,502	19,233	12.80
VABB-SHW	1,376	16,102	11.70
ERA 2015	1,289	17,428	13.52
DOAJ	642	2,741	4.27
ERIH PLUS	536	7,804	14.56
Pub Med	354	2,414	6.82
Norwegian Register Lvl II	296	5,226	17.66

D. Top field of research topics

We also identified field of research topics to specify the work areas. “Information and Computing Sciences” came up at the first place with 1,905 total publications and 14,837 total citations. It is followed by “Education” with 626 total publications and total citations of 6,372 (Table 4). In terms of TC/TP ration Commerce, Management, Tourism and Services has the highest ranking of 14.17 with 601 TP and 8,519 TC values. These are the leading areas of ‘metaverse’ and



‘education’ showing that all aspects of education can be adjusted by the usage of the new concept.

TABLE IV. Top 10 Fields of Research According to Publications and Citations

Field Name	TP	TC	TC/TP
Information & Computing Sciences	1,905	14,837	7.79
Education	626	6,372	10.18
Commerce, Management, Tourism and Services	601	8,519	14.17
Human-Centered Computing	588	5,439	9.25
Creative Arts & Writing	459	2,722	5.93
Language, Communication, and Culture	420	2,892	6.89
Engineering	363	4,419	12.17
Curriculum and Pedagogy	310	2,650	8.55
Education Systems	274	2,954	10.78
Screen and Digital Media	272	2,074	7.63

E. Bibliometric analysis of the keywords: Co-occurrence mapping

Keywords given by the authors of the articles and seen more than 10 times in Dimensions database were captured for the analysis done by VOSviewer network visualization with co-occurrence mapping based on text-data. The size of the nodes shows how frequently they occur. Each color represents a group of terms merged into clusters, the clusters representing the relationship between one topic and another, and the curves between the nodes indicate their co-occurrence in the same publication [57].

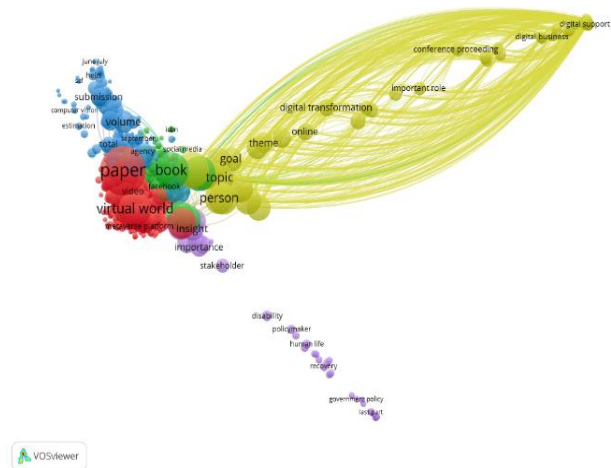


FIG. 6. Bibliometric analysis of the keyword publications of “metaverse” and “education

Five main clusters are yellow, red, green, purple, and blue ones, and are more extensive than the rest. The green cluster’s main key items are digital transformation, online, and person. The red area consists of topics related to virtual worlds, video and metaverse platforms (Fig. 6). It is an indication of the research areas are still not specialized but more generic concepts are still being researched and analyzed.

F. Bibliometric analysis of citations (by countries, authors, and organizations)

Citations of the studies have been analyzed by counties, authors, and organizations. Different colors indicate different clusters, and the size of circles indicates the counts of citations. The most dominant country which is in purple area is United States with 580 articles, 7,760 total citations with link strength of 1,195 and United States followed by China which is the second biggest cluster in blue (Fig. 7A). China has 449 articles, 2,092 total citations and link strength of 851. United Kingdom is in the third place by 321 articles, 5210 citations and link strength 763.

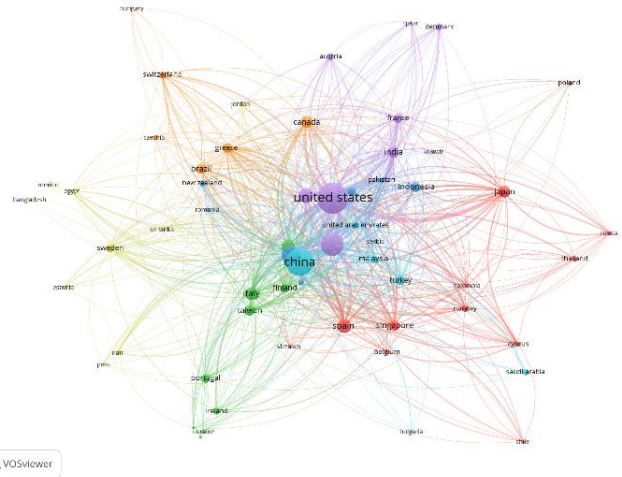


FIG. 7A. Bibliometric analysis of the citations: The citations of countries

In terms of authors perspective of citations, it is observed three main clusters with the colors of green, blue, and red (Fig. 7B). Author Kanematsu, Hideyuki from Japan has the highest number of documents 28 with 207 citations and link strength is 568. Kanematsu is followed by Barry, Dana from United States with 22 documents, 180 citations, and 495 link strength. Ogawa, Nobuyuki from Japan is at the top three of the lists, with 21 documents,170 citations and 484 link strength.

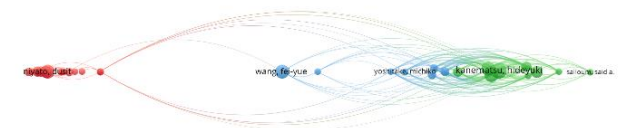


FIG. 7B. Bibliometric analysis of the citations: the citations of authors

Citations by organizations are presented in nine different clusters and colors are red, green, blue, yellow, purple, orange, pink, turquoise and brown (Fig. 7C). Nanyang Technological

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University has the highest number of documents with 40, total citations of 325, and link strength 92 from Singapore. It is followed by Hong Kong Polytechnic University with 29 documents, 389 total citations and 63 link strength. University College London is listed in the third place with 28 documents, 89 total citations and 22 link strength.

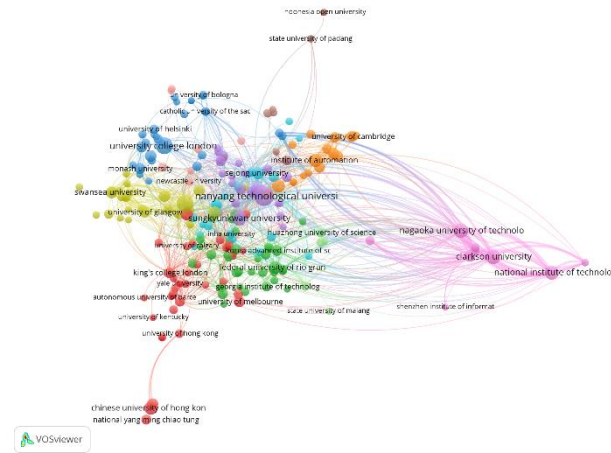


FIG. 7C. Bibliometric analysis of the citations: the citations of organizations

G. Bibliometric analysis of the bibliographic coupling (by authors, sources)

To compare citing articles, bibliographic coupling joins documents that cite the same group of cited sources [58]. The bibliographic coupling map of authors and sources are shown in Fig. 8A and 8B. In terms of authors aspect of the analysis, green cluster lead by Kanematsu, Hideyuki from Japan with 28 articles, 207 citations and 2,778 link strength (Fig. 8A). Second place is Barry, Dana from United States with 22 articles, 180 citations and 2527 link strength. Ogawa, Nobuyuki from Japan has 21 documents, 170 citations and 2630 link strength. Results are very similar to the bibliometric analysis of citations in terms of authors which is an indication of the concept being still immature.

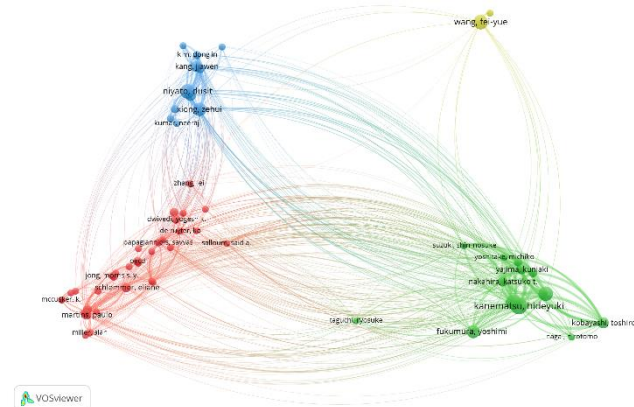


FIG. 8A. Bibliometric analysis for bibliographic coupling: bibliographic coupling of authors

In terms of sources analysis, clusters are shown as orange, red, green, blue, yellow, and purple (Fig. 8B). The first source is listed as ‘lecture notes in computer science’ with the document number of 225, total citations 455, and total link strength 2319. The next source is ‘safety and reliability – safe societies in a changing world’ with the document number of 155, total citations 16,702 and total link strength 1,720. That also highlights the fact that safety and reliability are the main two concerns for the adoption of new concepts. It is followed by ‘communications in computer sciences’ with 53 documents, 73 total citations and 804 link strength.

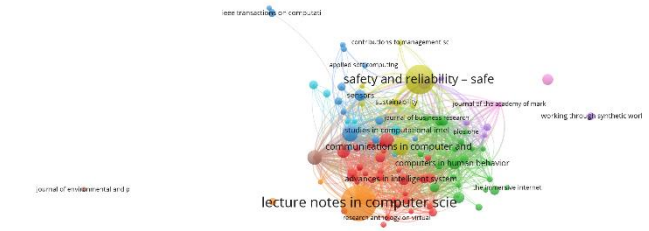


FIG. 8B. Bibliometric analysis for bibliographic coupling: bibliographic coupling of sources

V. DISCUSSION AND FUTURE WORK

According to Deloitte China’s 2022 Global XR industry insight report metaverse is in the early stage of development between 2021 and 2030 [59]. The mature stage will start from 2031 and ecosystem will be shaped as seen in Fig. 8. As is shown in the ecosystem, the education industry has been shown at the top, following the healthcare industry.

Another insights report from McKinsey & Company ‘Value Creation in the Metaverse’ in 2022 addresses the education is one of the top industries among the others for the future potential [60]. Therefore, the impact of metaverse in education is still being examined and is a hot topic for researchers to understand opportunities and challenges. It will be one of the main industries that need to be investigated further to benefit from the Metaverse concept.

According to the article by Zhang, metaverse universe and its key components have been defined as presented in Fig. 10 [61]. So, ecosystem requires contributions of other industries to evolve such as wearable devices. Technology, technology speed, and equipment developments are still not mature enough. That’s one of the reasons why defined ecosystems are still in the phase of research and not there yet for execution. Another aspect which is still under investigation for the concept and on the radar of the researchers is security, privacy, and ethics. Metaverse will be researched deeply for privacy and security issues, cyberbullying, and other forms of harassment [62].

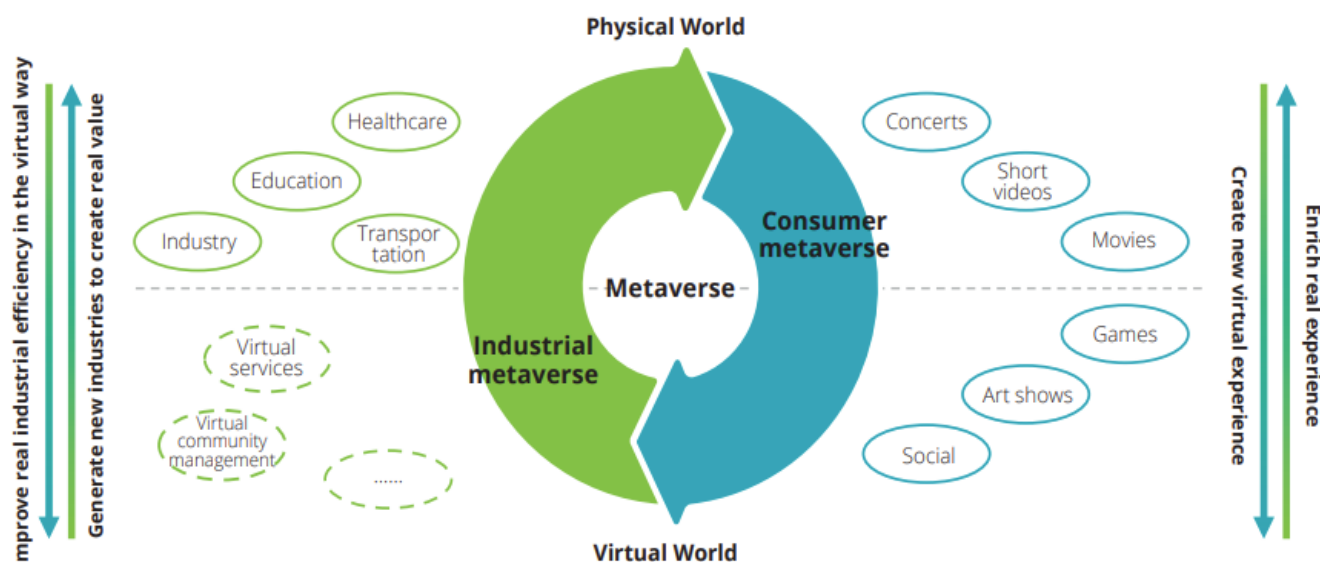


FIG. 9. Ecosystem of the Consumer and Industrial Metaverse [59]

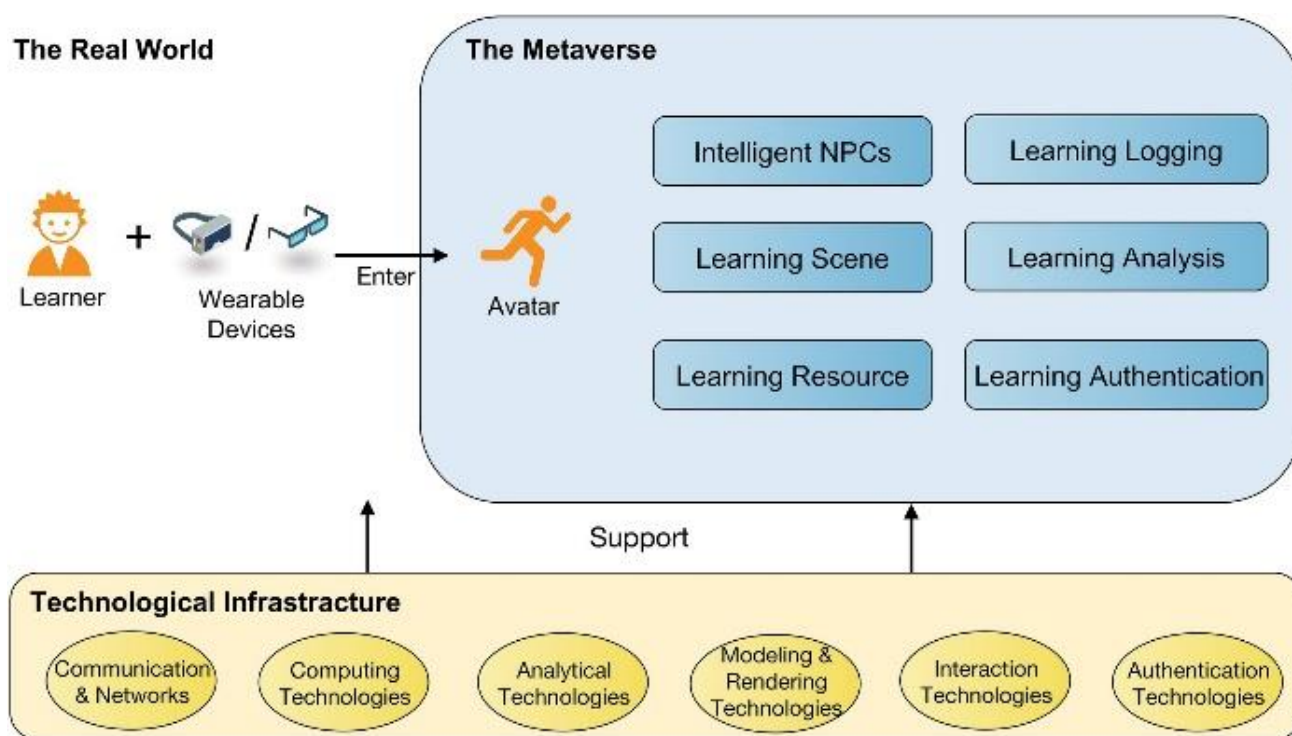


FIG. 10. The framework of metaverse in education [61]

According to our current research, 5,048 publications were indexed in Dimensions database about “metaverse”, and “education” were analyzed. The bibliometric analysis performed in terms of country, keyword, author, and citations and explained in detail. However, some limitations are unavoidable. Although a huge set of publications have been analyzed, there are still more that cannot be tracked with a single database. Research papers are being added to the databases every day. Besides, in terms of language, English articles were considered only. That would eliminate a significant number of articles. Besides, preprint articles are also not included which could cover some recent update studies as well.

In terms of future work scope, it would be recommended to extend the study for other article databases such as Web of Science or Scopus databases so that the dataset can be even larger. In terms of keywords, this study guides future research keywords such as ‘virtual world’ and ‘digital transformation’. These words or other similar concept keywords could be the scope for the future research aspects.

VI. CONCLUSION

The metaverse is perceived as an education trend as it merges with new technologies. Through effective communication while also balancing elements from the education sector, the intersection of education and the metaverse will be developed [63]. In his book, Neal

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Stephenson introduced the phrase "metaverse," which he used to describe how people would interact in a virtual world [64]. Although the infrastructure and technology are not yet in place to support the creation of virtual worlds, researchers are increasingly focusing on the metaverse's potential for transformation [65]. Industries are also going slow with the infusion of technology, maybe due to still shortage in know-how and unskilled human workforce. Although education is one of the main industries, research results for bibliometric analysis are also showing evidence of being still 'under developing' concept of metaverse. This research contributes to the scientific community highlighting directions. Top researchers and authors are among five main countries Singapore, Japan, United States, China, and United Kingdom. In terms of growing the economic impact, the emphasis on supporting technologies must be reinforced. This study guides on that scope as well. Scientific work is still limited to a handful of countries and topics are not deepen enough. Concept is still not matured or specialized in terms of research areas.

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CONFLICT OF INTEREST

The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

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