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Conceptualising the Importance of Metaverse in Education: A Bibliometric Analysis

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Abstract

The unification of metaverse in education asserts a transformative alteration, redefining the conventional learning pedagogy. This study explores the swelling integration of artificial intelligence and immersive technologies in education system. As the learners and educators increasingly engage themselves in the digital medium of communication, the metaverse offers a wider scope for inclusive and experiential learning. The metaverse's ability of transcending topographical boundaries provides an all-encompassing platform for comprehensive education, nurturing cross cultural knowledge with varied perspectives. While the metaverse presents unparalleled prospects for innovation, it also raises considerations pertaining to accessibility and privacy. Through this study the authors have analysed the contemporary topics of metaverse in education by blending multi perspective approach using bibliometric analysis with diverse and disciplinary features of the metaverse and its metamorphic outcome. Ultimately, this study accentuates the budding landscape of education with metaverse as a prevailing tool embracing engagement and all-inclusive learning experience.

Keywords: *Metaverse, Bibliometric Analysis, Education, Metaverse In Education, Artificial Intelligence.*

Introduction

In the present-day scenario metaverse is driven by innovation, creativity, and technological advancements, it is recognized as the forthcoming edge of social interaction. As stated by Farjami et al. (2011 September) & Kye et al. (2021) it refers to an artificially created universe where individuals can "live" according to the laws established by the creator. A metaverse can either exist as a completely virtual realm or have a hybrid nature, encompassing entirely fundamental environments, such as virtual reality (VR) systems, or partially virtual components, as seen in the integration of augmented reality (AR) within real-world settings (Avila, 2017). Mark Zuckerberg's vision of the incipient metaverse concept necessitates an immersive environment in which the distinctions between the virtual and physical realms become inconspicuous to users. Mark Zuckerberg's depiction of the widely embraced metaverse concept envisions a unifying and immersive environment where the divisions between virtual and augmented reality are indistinguishable to users. This enables the utilization of avatars and holograms for work, interaction, and socialization through simulated communal encounters (Meta 2022).

"Metaverse" with the restoring perspectives has become more significant as a result of recent technological advancements. Existence in the rapidly evolving technology environment and technological adaptation are essential (Collins, 2008). Following and implementing new technologies in this environment is essential, especially in the domain of education. The evolution phase from the "passive receiver" state to the "active participant" state, which takes place during the process of receiving and transmitting knowledge, is curated using recent and upgraded means of communication technologies, according to Suh & Ahn (2022). The ability for students to complete their education and training independently of physical environments has been made possible by the new technology approaches being implemented in an educational institution.

During pandemic, the world witnessed a paradigm shift in how people interacted, embracing a transformation where human connections primarily occurred through social media and phone calls, rather

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than face-to-face encounters (Koo, 2021; Kye et al., 2021; Kim et al., 2022; Lee et al., 2022). The world has witnessed a variation whereby offline physical activities have been transformed into online visual mode. Hence Online-based conversations, conferences, e-learning, E-commerce, video call have become a daily routine and a common practice in modern life. Therefore, the aspiration for technologically advancing virtual world has increased (Suzuki et al., 2020). Due to emerging progress of AI, AR, VR, block chain, crypto currency and the metaverse a 3D digital era with new and better avenues in Education has surfaced.

The integration of two words META and VERSE, where meta means going beyond and verse means Universe. "Metaverse" simply meaning going beyond the Universe by associating the virtual realm and the real world. Neal Stephenson first introduced the term "metaverse" in his science fiction novel "Snow Crash," where he envisions a virtual reality-driven alternative to the Internet. In mentioned book, different personalities try to escape the suffering of the factual world through interacting with various digital avatars and exploring a virtual world. Subsequently it has endured numerous explanations, analysing and incusing of collective space in virtual reality, embodied internet/spatial internet, a creative Internet application and social form that assimilates a variation of innovative expertise and post reality (Ning et al., 2021).

The incorporation of the metaverse into academics signifies an exceeding leap in the way we learning environments are perceived and engaged (Farjami et al., 2011 September; Kye et al., 2021).. The metaverse is a combination of shared platform that incorporates the aspects of internet, Augmented reality and Virtual reality offering unparalleled prospects to reform experiential learning (Avila, 2017) and Bourlakis et al., 2009; Jovanovi'c & Milosavljevi'c, 2022; Park & Kim, 2022).. This all-inclusive learning helps the students to realistic learning outcomes (Davis et al., 2009; Daz et al., 2020)..

Topical developments in technology have boosted the concept of metaverse far ahead in terms of educational innovation (Thawonmas & Fukumoto, 2011). Organizations are aggressively investing in educational platforms through digitization and metaverse. Metaverse in Medical Science has helped the interns and Senior Doctors by enabling them dissection of organs virtually assisting them to undertake complicated medical procedures.

Through this research the authors are attempting to garner the attention of all readers towards a major factor that is, for steering the growth of education sector metaverse acts a powerful means to transcend and share knowledge globally with enhanced and practical learning outcome.

The paper through its Bibliometric analysis aims to answer the following questions:

- The role of Metaverse in Education
- The impact/outcome of Metaverse in Education

Metaverse in Education

Metaverse holds a numerous potential application in divergent sectors like medicine, nursing, healthcare, education, science and technology, military and defence training, manufacturing and trading purpose and also learning and education ones. Metaverse too enables to explore beginners to have number of opportunities and challenges to experience, learn and teach with new ideas, better concepts taking a step in new world and also working and interacting with people across. With the metaverse they can even enhance and enrich in these perspectives where they were not able to practise in the tangible domain. Taking into instance maximum of them might not catch the chance to serve at supervising level of practising to flutter a plane but through met averse it seems to be possible if the originator goals virtually to provide the skill or learning beyond the limits in the direction of beginners. Thus, one can say Metaverse has originated with maximum of its potential applications enriching education in the advanced manner to make it easier for the learners.

Metaverse and Its Educational Outcomes: A Literature Review

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As contended by Collins (2008) on diverging on the virtually components and techniques Metaverse may be the next phase where people will meet together, socialize, interact, generalised conversations imposing a proactive usage of it for better and advanced teaching and learning making it as daily habit and a source of life.

The 3D digital virtual environment is too going to deliver interface and communication through the use of avatars, which enhances the sense of existence (Schlemmer & Backes, 2015). Furthermore, a summit meeting was organized in 2006 at the International Stanford Institute to generate a roadmap for the development of the Metaverse technology. A 10-year plan concerning the future of the internet was envisioned and predicted by academics from diversified fields, technological designers, entrepreneurs, and futurists (Metaverse Roadmap Summit, 2006).

Both virtual and real-world learning results can be enhanced by the metaverse. The usage of computer-generated tools and immersive metaverse surroundings in the teaching of physics and mechanics to scholars at the Universidad Militar Nueva Granada has advanced due to the rapid growth of digital technology (Jaramillo-Mujica et al., 2017). The metaverse stage can enable users the abilities to create fundamental settings that can mimic real-world learning experiences and get through COVID-19-related obstacles. Simulated based integration in the metaverse can recover the drawbacks of online learning plus yield better edifying results than video-based instruction (Lee et al., 2022). VoRtex, a metaverse platform, can offer effective spaces for students on the way towards cooperation and communicate through one another. Hence forth the metaverse can simplify hybrid and enhance learning activities boosting on various learning skills and levels (Kanematsu et al., 2014).

Through virtual reality technologies, the metaverse offers a variety of contemporary teaching approaches where in it enhance educational outcomes according to (Anacona et al., 2019). As stated by Ribeiro et al. (2013), incorporating social networks in the metaverse has enough capacity to greatly improve learning consequences. Beginners' gratification levels, knowledge and vast experiences, and existence in the learning environment can be determined by a stage utilizing fundamental reality, amplified reality techniques, profound learning technology, and metaverse content (Cho et al., 2022). Mexican pupils' math performance has improved because to the usage of enlarged actuality tools grounded on the movable metaverse (Reyes, 2020). Teachers can employ appropriate teaching techniques to improve learning results by using avatars with blinking systems in problem-based metaverse classes to detect users' emotions and reactions to difficult mathematical problems (Barry). With the combination of various tools and new technologies the metaverse holds a considerable potential for transforming and modernising the old teaching methodology improvising into an educationaloutcomes beneficial for the advanced learning.

With This Perspective Following Are the Research Questionnaire Address as Follows;

RQ1: What are the most prevalent keywords that are progressed and changed during the last thirteen years?

RQ2: Which are the top and popular journals contributing?

RQ3: Which are the top and widespread publications contributing?

RQ4: Does metaverse will impact higher learning in an education system and the contribution of article will be impactful for the recent development?

Methodology

Bibliometric analysis signifies investigating and managing the bibliometric information obtained from various scientific journals. (Verbeek et al., 2002). It is combination of simple process like publication year, publishing journals and complex details like co-citation analysis. (Wu & Wu 2017). It involves a set of relevant keywords, literature review and building of bibliography for identifying the gaps in existing

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literatures. (Xu e tal., 2020). To get better insight of the theoretical perspective of the research topic the study has restricted itself to top tier publication. The study extracted the data base from Thomas ISI Web of Science (WoS) for data collection. (Di Stefano et al., 2010). Moreover, to ensure that only top- tier journals were included in the study, articles published in high indexed journals were considered. (Liu etla.,2015).WoS has strong presence since 1990 and hence Social Science Citation Index (SSCI), Science Citation Index Expanded and Arts and Humanities Citation Index articles from 2010 to December 2020 were explored for analysis. The Clarivate Analytics, WoS core collection includes the maximum collection of citation and bibliometric records in social science and humanities hence it was use for retrieving of articles from database (Olijnyk,2015). The research process was carried out in synchronized manner for this study. The study was initiated in WoS data base by using Metavesre in Education as search term leading to collection 265 papers which were used to bibliometric analysis.

Data Analysis

The data set was drawn from the year 2010 to 2022 from WOS database which broadly covered the publication year, author name, publication title, keyword, journal citation, country in plain text form which was further analyzed through VOS viewer software version 1.6.15. The software was used for designing of maps and analysis through VOS clustering and mapping tools. VOS is used as an alternative to (MDS) Multidimensional Scaling as it focuses on placing items into dimensional area which are low and they reflect that distance between two of them and relativeness very clearly (Appio et al., 2014). Analysis such as key word co-occurrence, citation analysis and co -citational analysis have been performed due to patterns which were built on mathematical relationships(Khan & Gupta, 2022). Keyword co-occurrence analysis can be used to examine the transition of a research filed during a particular time period.(Zhao, 2017). It also aids in identifying the topics which are relevant in different areas (Li et al., 2016). Citation analysis on the other hand efficiently analyses the key research trends, techniques and also identifies the key research issues along with exploring the main issues attached with the study(Allahverdiyev, & Yucesoy, 2017). Co citation analysis basically focuses on to identify relevant structure of data (and is one of most favoured bibliometric tool used by the researchers.(Liu et al., 2015).

Results

Descriptive Statistics

Year wise publications and their citation index has been shown in Fig 1. It can be observed that number of publication and number of citation have been growing steadily and have witnessed exponential growth in last two years . This shows the relevance and the novelty of the study undertaken. Further analysis revealed that the publication related to application of metaverse in education extended to 64 different countries comprising of China, Korea, USA, Spain and India. Figure 2 explores the research areas covering 13 published articles.

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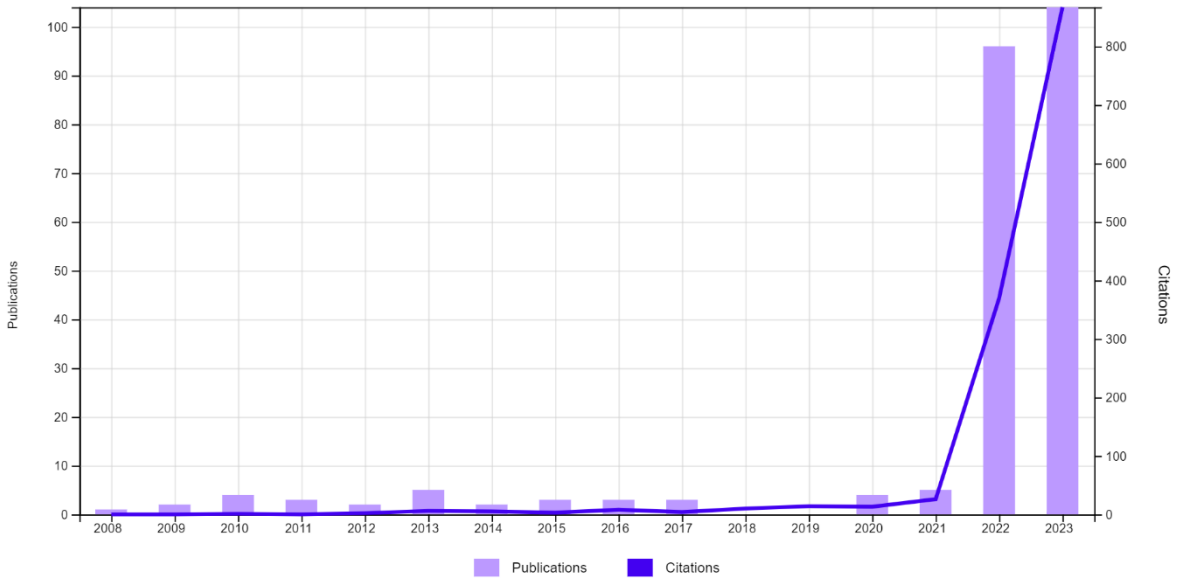

Figure 1- Distribution Chart of Published Articles

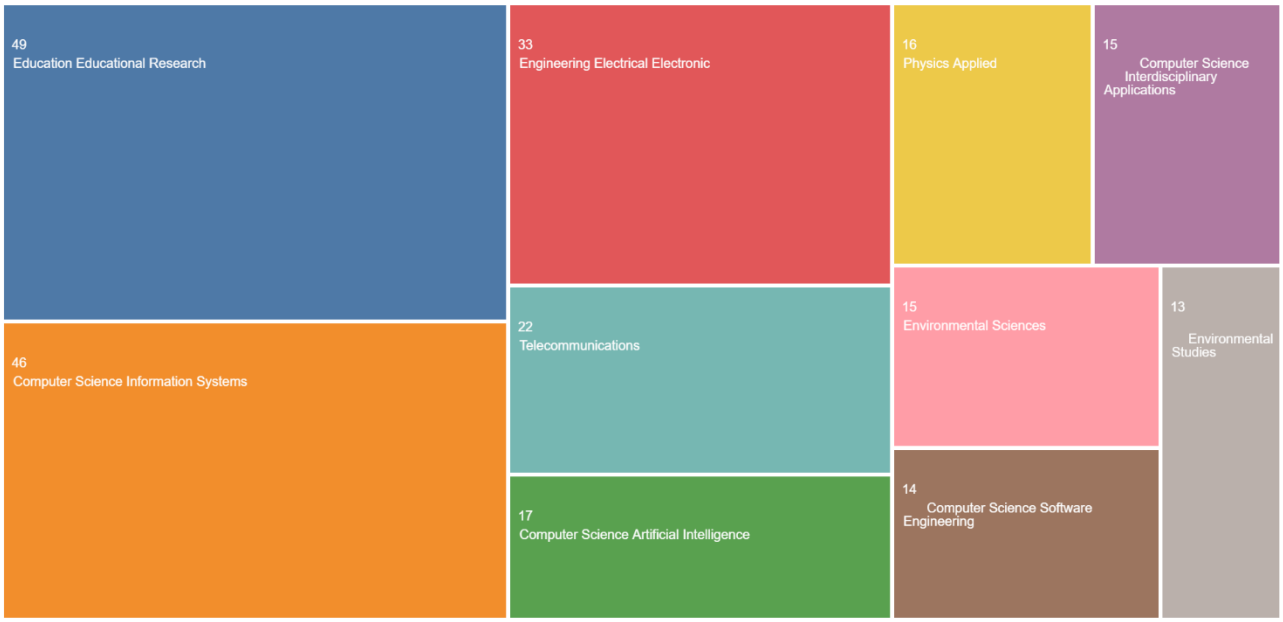

Figure 2 – Research Areas with More Than 13 Published Articles

Bibliometric Analysis

Analysis Of Key Words

In the dataset of 265 papers, set of 1025 key words were used. Co-occurrence analysis was performed with keywords which got a minimum repetition of 5 times in the studies. A total set of 47 keywords met the criteria which transformed into five different clusters. The cluster has been represented in figure 3 which on further analysis revealed that they reflect the connections within the topics used in the research paper. The largest cluster yellow consists of keywords like metaverse, motivation, gamification, performance, higher education, design. The blue cluster includes keywords like education, games, framework, simulation, machine learning, healthcare, system. The purple cluster has words like virtual reality, communication,

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augmented reality, learning, mixed reality, and teaching. The green cluster included words like virtual reality, students, adoption, technology acceptance, world, model adoption, perceived usefulness educational technology. The red cluster has words like block chain, extended reality, avatar, hybrid, artificial intelligence, digital twin, virtual world, e-learning. Thus, we can conclude that clusters are assembled in close proximity to one another which reflects that researcher who are in related clusters have more chance to be cited in given contexts.

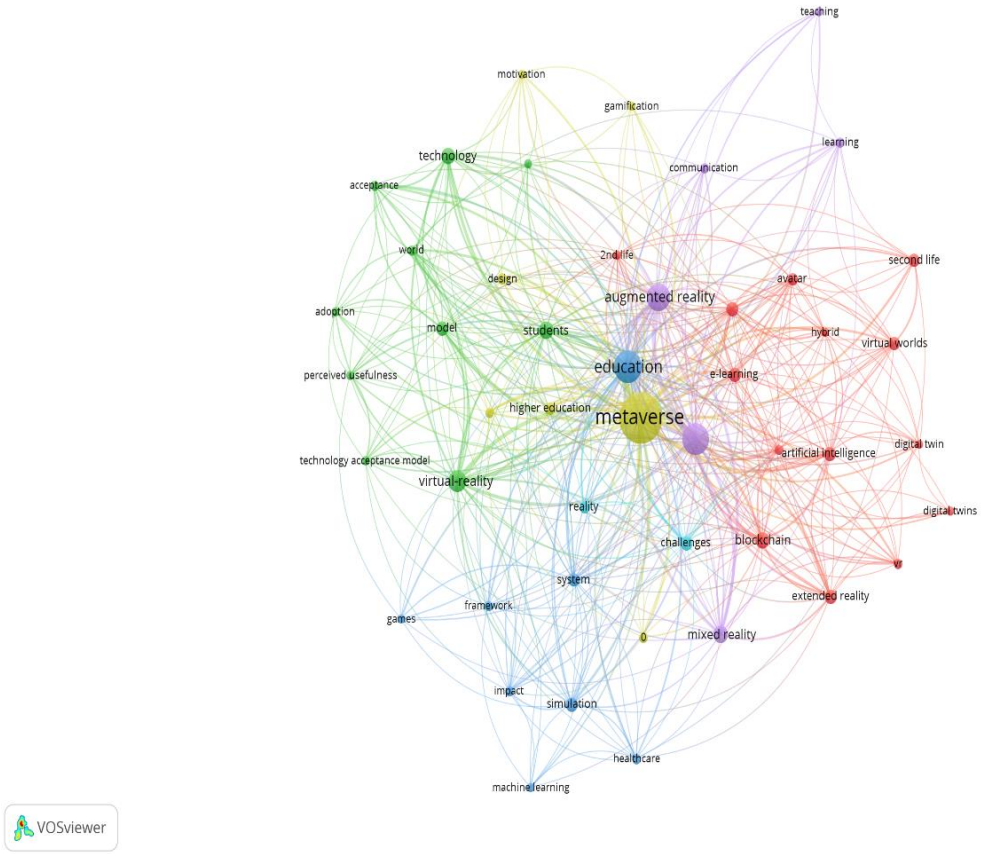

Figure 3 – Keywords Co-Occurrence Network Map

The over lay visualization of key word co-occurrence analysis gives a deep insight to identify the current and trending key words topic according to the year. Figure 4. It is observed that the trends in metaverse in education is shifting to topics like virtual reality, blockchain, technology, motivation, students, acceptance, impact and health care. This reflects that mentioned topic has been able to catch the attention of researchers in current years.

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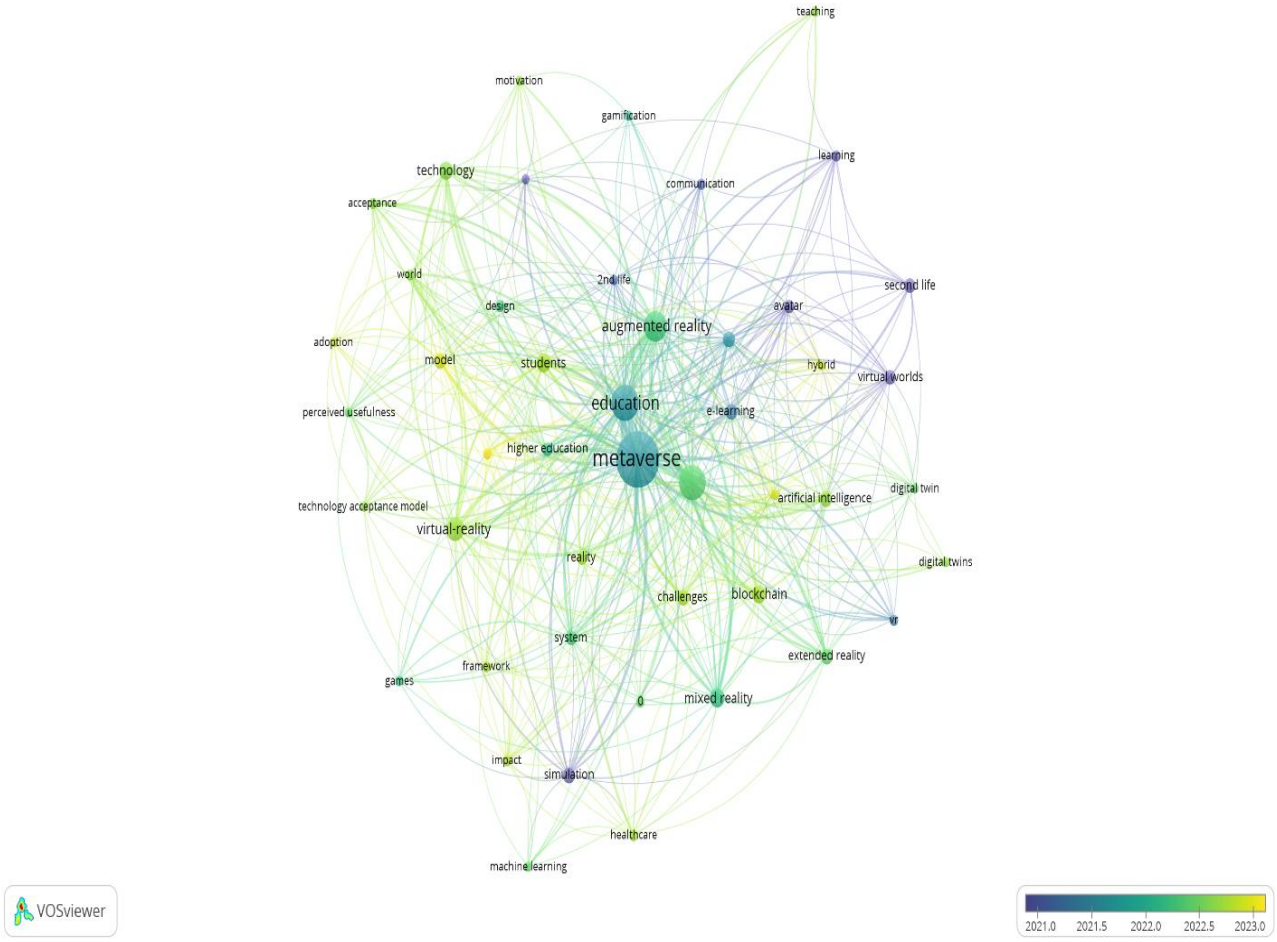

Figure 4 - Keywords Co-Occurrence Overlay Visualisation Map According to Year

Authors /Year	Article Title	Journal	Times Cited (WOS Score)
Dwivedi et al.,2022	Metaverse beyond the hype: Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy	International Journal of Information Management	153
Kye B et al., 2021	Educational applications of metaverse: possibilities and limitations	Journal of Educational Evaluation for Health Professionals	98
Dede et al., 2017	Introduction: Virtual, Augmented, and Mixed Realities in Education	Virtual,Augmented and Mixed realities in education	62
Xi et al ., 2022	The challenges of entering the metaverse: An experiment on the effect of extended reality on workload	Information Systems Frontiers	58
Tlili et al., 2022	Is Metaverse in education a blessing or a curse: a combined content and bibliometric analysis	Smart Learning Environment	42

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Jovanovic, A and Milosavljevic, A,2022	VoRtex Metaverse Platform for Gamified Collaborative Learning	Electronics	38
Diaz et al., 2020	Virtual World as a Resource for Hybrid Education	International Journal of Emerging Technologies in Learning	37
Suh, W and Ahn, S,2022	Utilizing the Metaverse for Learner-Centered Constructivist Education in the Post-Pandemic Era: An Analysis of Elementary School Students	Journal of Intelligence	36
Almarzouqi et al., 2022	Prediction of User's Intention to Use Metaverse System in Medical Education: A Hybrid SEM-ML Learning Approach	IEEE Access	34
Lee, H and Hwang, YH	Technology-Enhanced Education through VR-Making and Metaverse-Linking to Foster Teacher Readiness and Sustainable Learning	Sustainability	32

Table 1- List Of Top Authors and Their Research Contributions

Journals	**No of Published Articles**	**citations**
Applied Sciences-Basel	7	52
Electronics	9	29
Frontiers in Psychology	5	16
Ieee Access	10	17
International Journal of Emerging Technologies in Learning	2	7
International Journal of Information Management	1	6
International Journal of Technology in education	3	9
Journal of Educational Evaluation for Health Professions	2	11
Smart Learning Environments	2	67
Sustainability	13	5

Table 2- List Of Major Journals and Their Citations

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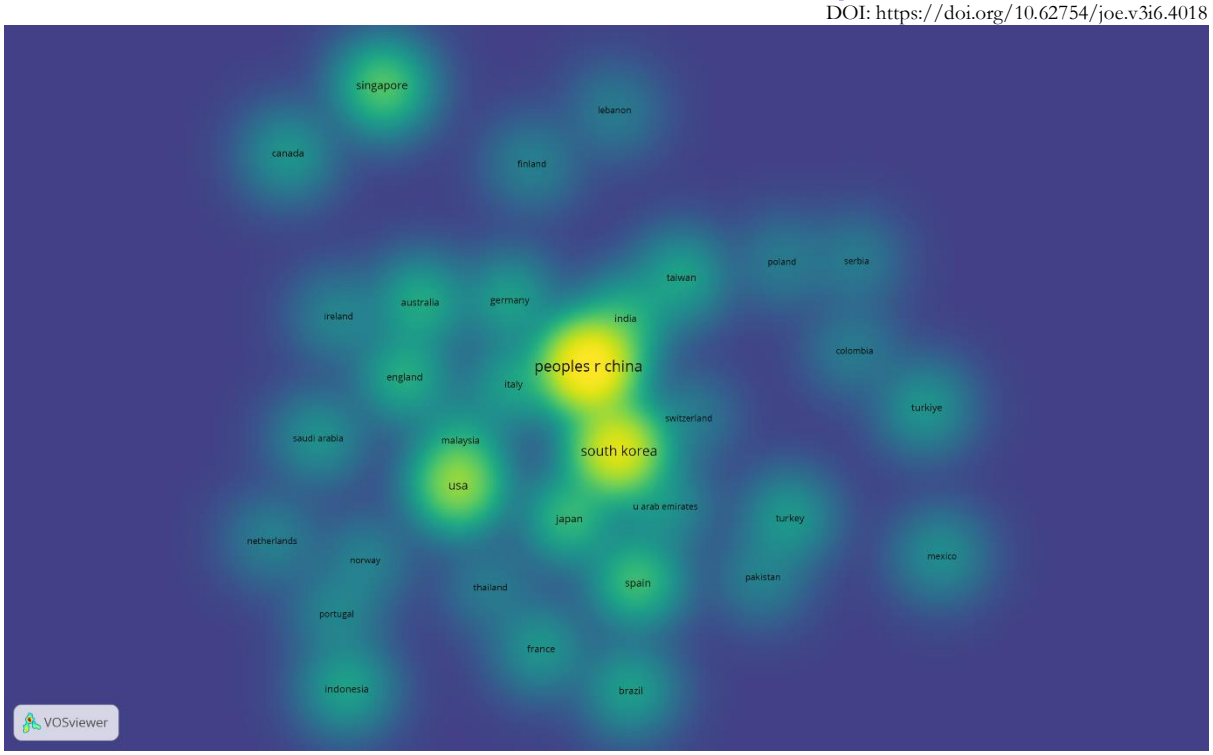

Figure 5- Density Map of Top Contributing Nations

Figure 5 represents the top 20 contributing nations for the area under study. The figure reflets that China, South Korea USA, Germany, Australia, Singapore are in forefront in contribution towards research on application of metaverse in education. From the geographical outlook China, South Korea and USA are the hub for top contributing institute towards research on this topic

Co -Citation Analysis

Co-citation analysis investigates the connections between articles based on their common references, highlighting associations with particular research fields (Ardito et al., 2019) The documents are considered co-cited when they share references in their publication reference lists which points towrads their correlation with the same research domain. (Fahimnia et al., 2015). The detailed analysis of cluster formed due to co-citation analysis can reveal the research domain of that cluster which can be subject to further examination. The co- citation analysis of the authors who have published papers are represented in the figure

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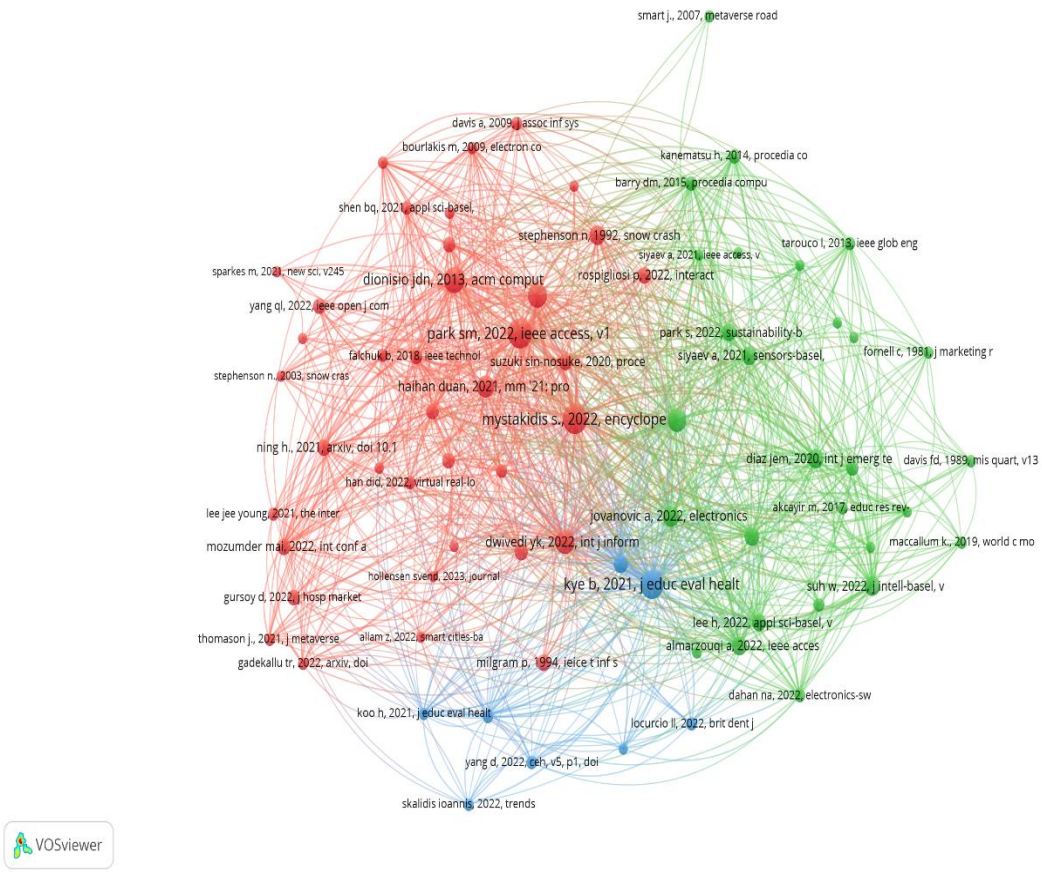

Documents cited by more than 20 times ie the most important co cited pairs have been shown in the figure. The documents which haven cited more are represented through larger nodes while the heavier link reflects higher co citation of the nodes which were connected with each other. The map shows 3 clusters and 74 items. The research dimensions and content of the research publications in each cluster have been thoroughly examined to figure out the research focus of three clusters.

Out of the 74 studies items, 38 items were cited in cluster 1 (red) which represents the most significant cluster comprising of majority of the documents. On further examination the analysis reveals that focus of the research was on both contextual and practical knowledge of metaverse in education and how increase in application of technology is providing better pedagogy and immersive learning for the students. (lee et al 2023; Allam z 2022, Dwivedi et al., 2022). Studies in cluster 2 (green colour) deals with design and implementation of metaverse in education and proposes framework for future application of metaverse. (Diaz jem et al., 2020, Dahan et al.,2022). The study further examined the creation of innovative educational environment (Park & Kim 2021). Cluster 3 (blue) mainly focused on application of metaverse in diverse fields of medical science and human anatomy. (Locurcio 2022). It further revealed its potential opportunity and limitations of its application in educational sector (Kye et al.,2021). Another study highlighted its utility inn disease education, prevention, diagnosis and cardiovascular interventions (Skalidis et al., 2022).

Discussion

Theoretical Implications…

The present study contributes to existing literature about the applications of metaverse in education sector and further enlarges the existing options. It recommends application of bibliometric analysis (based on

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citation and co citations) to examine the significant contribution towards application of metaverse in education sector. From the above analysis three cluster have been identified which focuses from conceptualization to application of metaverse in education. It also highlights the relationship between the clusters and recommends that with technological upgradation the scope of immersive learning will improve. The study further reveals that application of metaverse in education has become a topic of interest and has attracted several researchers towards this field. It offers an immense potential for the institutions and researchers to collaborate and innovate and improve the education system. The paper also encourages the researchers to integrate bibliometric analysis apart from literature review and meta-analysis in their future research. The authors have focused on discussing the innovation and application of new technology in education sector. One interesting observation was the adaptability of teachers and students in endorsing the new technology and relating with its future growth. This paper will further encourage more insightful research into application of augmented reality and virtual reality into classrooms. It is observed that research related to metaverse and its application covers a very wide scope and its articles are featured in prominent journals hence it is recommended for researchers to adopt a multidisciplinary approach while exploring this topic.

Practical Implications

Covid 19 has ushered an era of online teaching and increase usage of tech enabled platform like ZOOM, Google Meet, Microsoft teams etc for imparting education to students of all sections. This has widened the scope of technological application and redefined the delivery mechanism. Previous studies have focussed on the importance of online teaching and earning which has moved from being an optional mode to a mandatory mode. (Dhawan 2020) Gamification has emerged a popular medium for teaching using video games and VR devices. (Zeng et al.,2020). VR technology if blended with educational pedagogy can vastly improve the traditional education systems. (Yuan et al.,2022). Metaverse offers the possibility of providing platform which could combine both theoretical and practical learning. It could allow the faculty and students to share knowledge and utilize the learning tools and also provide better monitoring of students' progress. (Pigultong & Ieee, 2022).

Future research could focus on bridging the gap between different technological tools like augmentation, simulation and other interactive technologies which are applied in imparting education through metaverse. (Tlili et al., 2022). Education could be made more interesting and interacting by combining diverse metaverse technologies such as AR , mirror world, VR and lifelogging. The traditional teaching methodology is going to undergo radical changes in terms of teaching pedagogy and tools and should attract researchers, educational service provider and policy makers to undertake deeper understanding of future developments and adapt accordingly.

Limitations and Conclusion

The paper makes an attempt to identify the gaps in the existing literature by conducting a bibliometric analysis of the research papers which have worked on areas related to metaverse and education

We employed VOS viewer to perform this analysis, revealing key insights. Our investigation pinpointed the most significant authors, institutions, and nations engaged in this research area and also highlighted the most frequently occurring keywords, research papers and sources. Furthermore, we dwelled into the evolving research trends and the challenges linked to implementing the metaverse in educational settings. Additionally, we explored the impacts of the metaverse on various facets of learning, including learning ecosystems, interactions, educational process, outcomes and learner attitudes. The outcomes of this study offer a robust platform and acts as a credible point of reference for future research endeavors related to the integration of the metaverse into teaching and learning.

Although this study utilized two well-established software programs, it is important to acknowledge several limitations. Firstly, constraints related to available library resources made it impossible to incorporate all pertinent literature. Secondly, the findings are rooted in the literature obtained through the mentioned programs, potentially introducing publication bias. Also, this research primarily depended on secondary

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sources, emphasizing the importance of supplementing and enhancing these findings with primary data. Lastly, as the majority of evidence was extracted from prior studies, which undermines the reliability index of the findings.

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