International Journal of Education, Modern Management, Applied Science & Social Science (IJEMMASSS)
An International Quarterly bi-lingual Multidisciplinary Double Blind Open Access Peer Reviewed Refereed Journal
ISSN: 2581-9925, Impact Factor (Cosmos: 7.555 & I2OR: 5.105), Volume 08, No. 03(I), July-September, 2026, pp. 33-40

Bibliometric Analysis of Virtual Reality (VR) in Education

Vardaan Sharma[1*] | Vandana Sharma[2]

[1]B.A. (Hons.) Humanities and Social Sciences, University of Delhi.
[2]Professor, Department of Political Science, Bareilly College, MJP Rohilkhand University.

[*]Corresponding Author: vandanashrmably@gmail.com

Citation: Sharma, V. & Sharma, V. (2026). Bibliometric Analysis of Virtual Reality (VR) in Education. International Journal of Education, Modern Management, Applied Science & Social Science, 08(03(I)), 33–40. https://doi.org/10.62823/IJEMMASSS/8.3(I).9198

ABSTRACT

Virtual Reality (VR) has emerged as a transformative educational technology, enhancing teaching and learning across disciplines such as medical education, engineering, and teacher training. The growing affordability of VR devices and advancements in software have led to a rapid increase in research on VR in education. Although existing studies report positive learning outcomes, the literature remains fragmented, with most reviews focusing on specific disciplines or educational applications rather than the overall development of the field. This study employs bibliometric analysis to examine research on Virtual Reality in education published between 2010 and 2024. It aims to identify publication trends, influential authors, leading journals, countries, institutions, collaboration networks, citation patterns, and emerging research themes. By providing a systematic and objective overview of the intellectual structure of the field, the study highlights research gaps and future directions. The findings will assist researchers, educators, and policymakers in understanding the evolution of VR in education and supporting its effective integration into teaching and learning.

***Keywords**: Bibliometrcs, Virtual Reality, Education, Trend Analysis, Science Mapping.*

Introduction

Virtual Reality (VR) has changed from an experimental technology to a useful educational tool in many areas, such as medical training, engineering, and teacher education. With cheaper hardware and better software tools, research on “Virtual Reality in education” has increased quickly over the past ten years (Radianti et al., 2020). Studies and reviews show good learning results and new teaching opportunities (Makransky & Petersen, 2019; Radianti et al., 2020), but they also highlight issues like variable methods, small sample sizes, and a lack of focus on long-term results.

Most existing syntheses focus on either content or specific areas. They do not show the overall structure of the field, such as who the influential authors are, how research topics connect, and how collaboration and citation patterns have changed. Bibliometric Analysis offers a more systematic, repeatable, efficient, and visual way to address these questions and support traditional reviews (Donthu et al., 2021; van Eck & Waltman, 2010). A bibliometric study spanning the years 2010 to 2024 is particularly relevant because it covers the period of platform maturity and the rising use of VR in education.

The current literature on the topic of "Virtual Reality in education" is currently extensive and highly fragmented. The existence of experimental studies, research articles, case studies, conferences, reviews, etc., all at once makes the literature extremely wide-ranging. The Bibliometric Analysis will offer

an objective macroscopic view of how this topic has evolved over time and how interdisciplinary links have developed.

In this report, a bibliometric study is conducted on Virtual Reality (VR) applications in educational settings during the period between 2010 and 2024. Scopus is the primary database for collecting data and VOSviewer and Excel are used for the analysis and visualization of the results. The dataset consists of 18,290 papers and reveals fast growth, thematic diversity, and increasing collaboration in this field. The use of the bibliometric mapping technique can be particularly helpful in studying the development of VR applications in education.

Aim

To conduct a systematic bibliometric analysis of studies on Virtual Reality in education from 2010 to 2024.

Research Objectives

- To measure annual publication and citation trends.
- To identify leading authors, journals and institutions through citation impact.
- To visualize the co-occurrence of keywords to determine the presence and labeling of thematic groups.
- To map co-authorship patterns and collaborative networks.

Review of Literature

Below I have presented the reviewed literature in the form of five interconnected topics:

- **Theme 1 : Learning Effectiveness and Cognitive Outcomes**

After analysis, it is clear that VR enhances learning processes, task completion, and involvement of learners. Moderately positive effects were observed when using meta-analysis and experimental approaches; however, the results depended on the accuracy of design, interaction, and method of measuring learning outcomes (Makransky & Petersen, 2019).

- **Theme 2 : Design, Usability, and Technological Feasibility**

The literature review on design examines the user-friendliness of interfaces, interactions with technology and general design considerations (Jensen & Konradsen, 2018; Radianti et al., 2020). Factors like cybersickness, accessibility, and device ergonomics become recurring issues. This theme influences our approach to interpreting clusters associated with system design and hardware.

- **Theme 3 : Domain-specific Educational Applications**

Many studies under Virtual Reality can be classified under domain-based studies such as medicine, engineering experiments, language education, and many others that mostly concentrate on scientific disciplines and have domain-specific requirements and assessment techniques (Freina & Ott, 2015; Mikropoulos & Natsis, 2011). In this report, such studies are categorized as topic-based sub-clusters and would be easier to understand.

- **Theme 4 : Research Trends and Methodological Advances**

Meta-level studies and bibliometric reviews discuss visualization techniques, indicators, and evolving research directions (Chen, Hu, & Liu, 2012; Donthu et al., 2021). These works will guide the methodological choices for me to conduct this bibliometric analysis effectively like the selection of indicators, thresholding, and interpretation of maps and other tasks.

- **Theme 5 : Bibliometric Tools and Mapping Methods**

The application of tools and methods like VOS viewer and Bibliometrix is common practice in creating maps for bibliometrics (van Eck & Waltman, 2010; Aria & Cuccurullo, 2017). The present study follows methodology guidelines suggested by these authors.

Given Below is the Review Matrix of the literature based on the themes the sources have been classified into:

Notes on the matrix:

- “Yes” indicates the primary theme(s) emphasised in the paper.

- The matrix demonstrates that while content themes (1–3) are well-represented, methodological and bibliometric perspectives (4–5) are fewer — justifying a bibliometric mapping study.

Table 1: Review Matrix

Name of the Study	Theme 1: Learning Effectiveness	Theme 2: Design & Usability	Theme 3: Domain Applications	Theme 4: Research Trends and Advances	Theme 5: Bibliometric Methods / Tools
Makransky & Petersen (2019)	Yes	Yes	Yes		
Radianti et al. (2020)	Yes	Yes			
Jensen & Konradsen (2018)		Yes			
Freina & Ott (2015)			Yes		
Mikropoulos & Natsis (2011)	Yes		Yes		
Chen, Hu, & Liu (2012)				Yes	Yes
Donthu et al. (2021)				Yes	Yes
van Eck & Waltman (2010)					Yes

Research Methodology

- **Design**

  Bibliometric analysis adopting quantitative methods based on Scopus database searches.

- **Tools**
  - Scopus is used to perform the advanced search and examine results before exporting all records, including cited references.
  - Microsoft Excel was employed to clean the data, de-duplicate, normalize and prepare comma-separated values (CSV) format compatible with VOSviewer.
  - Microsoft Excel was be employed to clean the data, de-duplicate, normalize and prepare comma-separated values (CSV) format compatible with VOSviewer.
  - VOSviewer was utilized to analyze keyword co-occurrences, co-citations and authorships. The software is capable of reading Scopus exports (Scopus CSV) and generating graphical maps. VOSviewer uses standard bibliometric normalization and clustering techniques (van Eck & Waltman, 2010).

- **Sample**
  - Time frame: 2010–2024 (inclusive).
  - Language: English.
  - Document types: Peer reviewed journal article or conference paper (reviews included). Exclude editorials, book review or any non-peer reviewed literature.
  - Topical scope: Scopus records whose title OR abstract OR author keywords include VR and education concepts.

- **Ethics**

The paper employs publicly accessible bibliographic metadata and does not require any human subjects. Ethics require accurate citation, non-misrepresentation when paraphrasing other works, and refraining from reselling paywalled materials. Scopus and the original journals are cited as the source of the data.

Bibliometric Analysis

- **Overview of the Dataset**

The sheer number of review papers about Virtual Reality, 1,814, indicates that this discipline has grown in its significance since its inception. It is now essential to compile the available literature on Virtual Reality in order to understand its essence and structure in a more systematic way. The results from a Scopus database search returned 18,290 publications on VR in education between 2010 and 2024. Of all the collected publications, 12,817 (70.1%) are journal articles, 3,659 (20.0%) are conference papers, and 1,814 (9.9%) are review papers. The aforementioned statistics demonstrate the duality of VR science. On one hand, it is a practical science that is confirmed by the significant share of conference papers in the dataset. On the other hand, VR has evolved into a theoretical subject matter that creates peer-reviewed research papers.

From the sample of 18,290 entries, 15,857 documents (86.7%) contained at least one keyword assigned by the author, generating a total of 85,939 keyword tokens with 31,946 different keywords. This broad vocabulary indicates the multidisciplinary nature of research into VR in education, incorporating terminology from such varied fields as education sciences, cognitive psychology, clinical medicine, computer sciences, and engineering. A further 13.3% of entries lacked any keywords from the author and were not analyzed for this reason.

Table 2: Sample composition from Scopus export

Document Category	Count (%)
Journal Articles	12,817 (70.1%)
Conference Papers	3,659 (20.0%)
Review Articles	1,814 (9.9%)
Total Documents	18,290 (100%)
Documents with Keywords	15,857 (86.7%)
Total Keyword Tokens	85,939
Unique Keyword Terms	31,946

- **Annual Publication and Citation Trends**

There is a steady increase in publication each year throughout the fifteen years covered by the study. In the year 2010, there were 183 publications, which continued to increase in every successive year until the total number reached 4,013 publications in the year 2024. This amounts to a 22-fold growth from what was recorded in 2010. The compound annual growth rate during the entire period is 24.7%, and this is higher than what many fields of study have been able to achieve, making VR in education the fastest growing field of study.

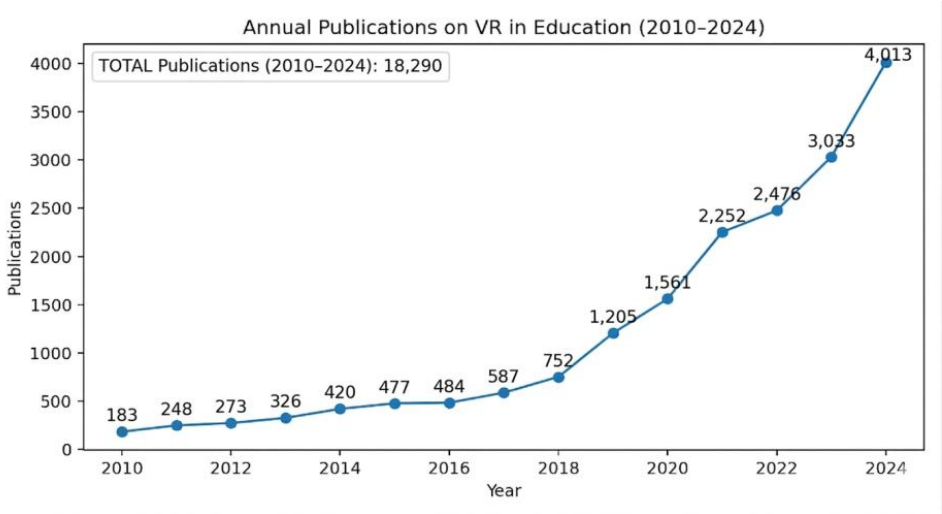

Figure 1: Annual Publication Trends (2010-2024)

- **Leading Authors, Journals, Institutions, and Countries**

The number of different author names in the full name of the author variable came to 70,437 in the 18,290 records, showing the broad and dispersed character of the VR literature. The top individual contributor to the VR research during the period of study was Konge, Lars with 52 articles, followed by Riva, Giuseppe with 48 articles, Calabrò, Rocco Salvatore with 37, De, Suvranu with 33, Makransky, Guido with 27, and Alcañiz, Mariano with 27. The highest-producing scholars in the field have worked in various disciplines: Konge has been a surgeon in the surgical education domain, Riva, a clinical psychologist and cyberpsychology researcher, Calabrò, a doctor conducting medical rehabilitation studies, De, a surgical simulation expert, and Makransky, an educational psychologist studying cognitive loads in virtual reality environments.

Table 3: Top 10 most prolific authors by total publication count

Author	Publications
Konge, Lars	52
Riva, Giuseppe	48
Calabrò, Rocco Salvatore	37
De, Suvranu	33
Makransky, Guido	27
Alcañiz, Mariano	27
Smith, Matthew J.	25
Latoschik, Marc Erich	24
Quartarone, Angelo	23
Pedroli, Elisa	23

These 18,290 publications appeared in thousands of individual outlets. The top publication outlet is IEEE Access (370 articles), an interdisciplinary, open access journal published by the IEEE, which is representative of the significant engineering and computer science nature of hardware and interaction development in VR. This publication outlet is followed by Applied Sciences (Switzerland) (290 articles) and the Journal of Physics: Conference Series (288 articles). Among more specialized journals, Frontiers in Psychology (212 articles) is the leading journal for psychology, highlighting the importance of psychological presence in the research of VR in education. Frontiers in Virtual Reality (178 articles), which started in 2020, quickly became a dominant journal on immersive technologies. There are many medical and health education journals that have a high number of publications in this area. They include BMC Medical Education (121 articles), JMIR Serious Games (115 articles), and Journal of Medical Internet Research (113 articles), totaling 349 articles. MDPI takes up the bulk of publishers with 2,118 papers published, indicating the increased impact of open access publications in highly dynamic technological areas. IEEE contributes to 1,126 papers, whereas Elsevier is behind 1,254 papers, Frontiers Media publishes 1,027 papers, Springer produces 974 papers, and ACM comes last with 485 papers.

Table 4: Top 12 most productive journals/sources in the dataset

Journal / Source	Publications
IEEE Access	370
Applied Sciences (Switzerland)	290
Journal of Physics: Conference Series	288
PLoS ONE	270
Lecture Notes in Computer Science (LNCS)	268
Frontiers in Psychology	212
Frontiers in Virtual Reality	178
International Journal of Emerging Tech. Learn.	126
Journal of NeuroEngineering & Rehabilitation	124
BMC Medical Education	121
JMIR Serious Games	115
Journal of Medical Internet Research	113

- **Keyword Co-occurrence Analysis and Thematic Clusters**

Following standardization of the variants for virtual reality (such as VR, virtual reality (VR), VR technology, immersive virtual reality), virtual reality is found to occur 7,587 times in the keyword entries and hence must be considered the most central node in any network created from this data set. Second to this are the keyword augmented reality (1,034 entries), proving that VR does not have a limited hardware-defined boundary and includes the broader spectrum of immersive technologies. Virtual reality + augmented reality is also found to be the highest occurring co-occurrence keyword pair (743 co-occurrences), suggesting that the majority of the research papers have placed VR in direct association with AR. Network analysis of the keyword co-occurrence indicates five main themes which can be linked to the theoretical framework of this literature review:

- **Cluster 1: Learning Effectiveness and Cognitive Outcomes**

The first and foremost cluster is defined by keywords such as education (748), learning (292), higher education (231), immersive learning (140), educational technology (138), e-learning (166), and online learning (100). All these keywords co-appear often alongside assessment (107), cognition (100), and presence (118). Presence appears to function as a link between the two sub-clusters of learning effectiveness - learning outcomes on one hand and design/usability on the other. The keyword combination of virtual reality + education occurs next frequently (378 occurrences) after the cluster's main keyword, thus serving as the defining edge.

- **Cluster 2: Immersion, Presence, Usability, and Design**

The second cluster centers on the technical and experience-oriented features of VR applications. The major keywords within this cluster are: immersion (148), presence (118), user experience (129), usability (118), human-computer interaction (112), head-mounted display (85), and virtual environment (255 inclusive). The pairs of concepts co-occurrence presence+virtual reality (88 papers) and immersion+virtual reality (99 papers) comprise the theoretical basis for this cluster.

- **Cluster 3: Domain-specific Applications (Medical, Rehabilitation, Clinical Education)**

The third cluster represents the most clinically focused category and contains the highest number of keywords. These keywords include: rehabilitation (442), simulation (593), stroke (307), medical education (316), surgical training (96), motor learning (88), autism spectrum disorder (87), and mental health (106). The second strongest co-occurrence pair in the database is the combination of rehabilitation and virtual reality (273 articles), while the third one is stroke and rehabilitation (131 articles).

- **Cluster 4: Technology Infrastructure and Emerging Platforms**

Cluster four deals with the technological and computational aspects of research on virtual reality in education. The terms used are machine learning (566), deep learning (375), artificial intelligence (355), metaverse (321), extended reality (214), mixed reality (335), EEG (118), digital twin (114), and reinforcement learning (131). The immediate and dramatic rise of metaverse (321 times, all of them in the period from 2021 to 2024) indicate a paradigm shift from VR being a stand-alone experience to being a reliable platform.

- **Cluster 5: Gamification and Game-based Learning**

Cluster five comprises the least number of keywords but is thematically related. Its core is made up of gamification (217), serious games (201), and serious game (89). The relationship between gamification and virtual reality (100 articles) and serious games and virtual reality (97 articles) shows that gaming mechanisms applied to VR learning is an important research direction. Cluster five relates to cluster four through shared terms such as engagement and motivation and to cluster three through game design and interactivity.

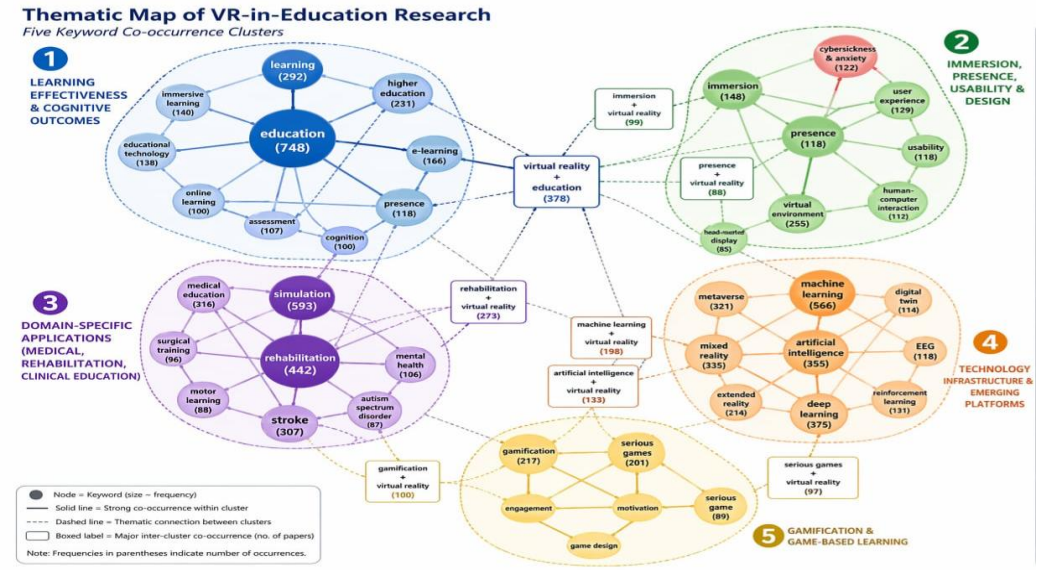

Figure 2: Thematic Clusters of VR in Education Research

Co-authorship Patterns and Collaboration Networks

Analysis of co-authors suggests a steady growth in collaborative studies during the course of this research. There is an evident growth in the average number of authors per paper in terms of time, from 4.42 in 2010 up to 5.12 in 2023 and 5.02 in 2024. This indicates an overall tendency towards team research conducted by scholars based in different places. Single authorship is rare and accounts for 6.6% of all articles (a total of 1,205 papers), which is explained by the technical difficulty of conducting such studies.

Table 5: Co-authorship statistics across the full dataset

Co-authorship Metric	Value
Mean authors per paper	4.85
Single-author papers	1,205 (6.6%)
2–5 author papers	11,431 (62.5%)
6+ author papers	5,649 (30.9%)
8+ author papers	2,487 (13.6%)
Mean authors per paper (2010)	4.42
Mean authors per paper (2023)	5.12
Mean authors per paper (2024)	5.02

Summary of Bibliometric Findings

In particular, the bibliometric analysis of 18,290 Scopus articles on Reality (VR) in education for 2010-2024 indicates the following four results concerning the development of the research field under discussion. First, VR in education has experienced a fast development, with the annual growth rate amounting to 24.7%, and an increase in annual publication volume by 22 times between 2010 and 2024. The largest growth occurred in 2018-2019 owing to the mass appearance of VR headsets and increased publication activity after 2020 during the COVID-19 pandemic due to the need for studying. Secondly, journal publications prevail (70.1%) in this area, indicating its maturation along with a significant increase in the number of review articles (from 4% to 12%).

Third, leadership in the VR studies is diversified among disciplines where leading authors deal with medical simulations (Konge, De), cyberpsychology (Riva, Cipresso), educational technologies (Makransky, Christopoulos) and clinical rehabilitations (Calabrò). Each discipline operates independently from the other ones. Fourth, five thematic strands can be detected within the field of VR investigations: i) Learning Effectiveness and Cognitive Outcomes; ii) Immersion, Presence and Design; iii) Domain-

Specific Application; iv) Technology Infrastructure and Emerging Platforms; v) Game-based Learning. The information about all sources was taken from the Scopus export database. The number of keyword instances refers to author-defined keywords. The total number of authors includes all authors.

Conclusion

This research paper demonstrates that Virtual Reality in Education is a dynamically developing research field. It has evolved beyond being a narrow technical domain. The statistics on the volume of publication output clearly indicate that there is a significant number of papers and that their publication rate continues to increase. The major themes covered in Virtual Reality in Education include learning efficiency, its immersion and usability aspects, its clinical applications, intelligent systems development, and game-based learning. The above mentioned topics demonstrate that Virtual Reality in Education is becoming more diversified and complex in terms of its conceptual framework. Publication statistics give researchers an opportunity to analyze the current state of affairs in Virtual Reality in Education and determine where further studies should be conducted. Virtual Reality in Education is undergoing rapid changes and its application possibilities in education are continuously expanding. Hence, bibliometric mapping is a relevant tool for visualizing the research landscape and suggesting promising directions for future research.

References

1. Aria, M., & Cuccurullo, C. (2017). bibliometrix: An R-tool for comprehensive science mapping analysis. Journal of Informetrics, 11(4), 959–975.
2. Chen, C., Hu, Z., & Liu, S. (2012). Emerging trends in bibliometrics: Review and future directions. Journal of Informetrics, 6(4), 555–563.
3. Donthu, N., Kumar, S., Mukherjee, D., Pandey, N., & Lim, W. M. (2021). How to conduct a bibliometric analysis: An overview and guidelines. Journal of Business Research, 133, 285–296.
4. Freina, L., & Ott, M. (2015). A literature review on immersive virtual reality in education: State of the art and perspectives. In eLSE 2015 Proceedings (pp. 1–9).
5. Jensen, L., & Konradsen, F. (2018). A review of the use of virtual reality head-mounted displays in education and training. Education and Information Technologies, 23, 1515–1529.
6. Makransky, G., & Petersen, G. B. (2019). The effectiveness of immersive virtual reality for learning: A meta-analysis and recommendations for future research. Educational Research Review, 29, 100338.
7. Mikropoulos, T. A., & Natsis, A. (2011). Educational virtual environments: A ten-year review of empirical research (1999–2009). Computers & Education, 56(3), 769–780.
8. Radianti, J., Majchrzak, T. A., Fromm, J., & Wohlgenannt, I. (2020). A systematic review of immersive virtual reality applications for higher education: Design elements, lessons learned, and research agenda. Education and Information Technologies, 25, 493–519.
9. van Eck, N. J., & Waltman, L. (2010). VOSviewer, a computer program for bibliometric mapping. Scientometrics, 84(2), 523–538.

❑❑❑