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Virtual Reality (VR) Potential for Education in the Future: A Bibliometric Analysis

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A B S T R A C T

Language learning apps, interactive multimedia, and virtual classrooms help students learn independently and differently, improving teaching and achievement. VR brings new scenarios and experiences to education. Many consider it a valuable learning tool. VR education can replace multimedia because it's affordable and improves critical thinking and community engagement. Education VR technology was bibliometrically analyzed from 2020 to 2024 using R Studio and Biblioshyni. VR education articles rose from 34 in 2020 to 172 in 2022. Educational and Information Technology published most VR articles, then Heliyon Journal. USAISR, FT Sam Houston, Wang Y, and Texas, USA are the top ten VR education authors. FT Sam Houston, USA, USAISR, and Texas had the most documents. The US had the most VR education articles from 2020 to 2024. China has 182 articles, Canada 84. Australia, Brazil, Germany, India, South Africa, Spain, and the Netherlands produced 80 articles. Human was the most-used VR term in education from 2020 to 2024, appearing 179 times. COVID-19 shows that time and space shouldn't limit research. VR was most cited in 44 education and IT articles. Chinese authors dominate VR research and US scientific publications, making VR media in education appealing in Indonesia

INTRODUCTION

Technology integration in the educational process has made significant progress, as evidenced by the increasing sophistication and ease of use of digital tools. Research has shown that incorporating technology into language education has significantly improved teaching techniques and student achievement. Technology is instrumental in creating an engaging and immersive learning environment essential for language proficiency. Tools like language learning apps, interactive multimedia, and virtual classrooms enable different learning approaches and improve learner involvement and independence. The advancement of technology has led to the development of advanced tools that provide instant feedback and customized learning experiences, effectively meeting the unique needs of each learner. The convergence of globalization and technological advancements has amplified the availability of resources and significantly improved language proficiency and teaching efficacy. Educators face the challenge of adapting to these advancements, which, while making it easier for students to gain knowledge, can also lead to a sense of satisfaction and a tendency to underestimate difficulties due to the abundance of readily accessible information. (Wizaka, 2020).

Virtual reality (VR) is a significant technological advancement that is set to revolutionize education. It will bring about profound changes in the lifestyle and organizational structure that humans have grown accustomed to. VR offers unprecedented experiences and scenarios and is widely recognized as a highly effective tool for enhancing learning outcomes. The positive effects of VR in classrooms, where it has been successfully implemented, are a testament to its potential. The urgency and necessity of understanding how to use VR effectively and exploring its various applications cannot be overstated. This is the key to its successful integration into education. Because Virtual Reality (VR) allows users to immerse themselves in a computer-generated, interactive audio-visual environment using various visual and auditory interfaces and devices (Xanthidis, 2020) on the same side, (Wang, 2020) Argued that Virtual reality (VR) can create diverse and realistic scenarios, offering a heightened sense of presence, enjoyment, complete engagement, discovery, interactive experiences, and immediate visual responses. While (Feng, 2020) Virtual reality integrates computer graphics, artificial intelligence, diverse image processing techniques, multiple modalities, sensor technology, and other fields to create an immersive and interactive experience within a virtual environment. This level of engagement and interactivity is unprecedented in the field of education, promising a new era of learning. In (Adžgauskaitė, 2020) Virtual Reality (VR) educational experiences, which immerse students in a virtual environment, have gained attention as potential alternatives or additions to current multimedia educational tools. This is due to their growing affordability and proven ability to enhance essential skills in students, such as critical thinking and community engagement. Based on some previous findings, VR was complex as a learning tool to break some problems in the education sector; VR was interactive, accurate, and detailed in display.

The trending use of technology in the world of education makes it even more attractive to research, especially some current trending issues such as the use of VR Technology in the field of education, which provides a much more lively, interactive, and attentive feel as has been written by several experts such as (Cowan, 2023), (Bernardo, 2022), (Predescu, 2023), (Curran, 2022), (Feng, 2020), And (Lo, 2022). The presence of these studies motivates a bibliometric analysis of the utilization of Virtual Reality Technology in education. The inquiry pertains to the research on Virtual Reality in education from 2020 to 2024.

METHODS

This Bibliometric analysis used the dimensions database to collect documents using the keywords Virtual Reality, Education, and Prospect. Dimensions is a dynamic, easy-to-use research data platform that can quickly find and analyze research data. Dimensions combine a wide range of publication data connected to a diverse research ecosystem, a channel for finding research resources, and measuring the impact of publications with static values. Dimensions is a global digital science data connection that fits into the modern research system. Dimensions aims to (1) provide a cutting-edge research publication data platform to meet the needs of research organizations, funders, and publishers; (2) reduce access barriers and costs of accessing research data; (3) provide a platform for relevant and clear metrics (statistics). Once the data is obtained, it is stored in CSV, excel, RIS, and plain text.

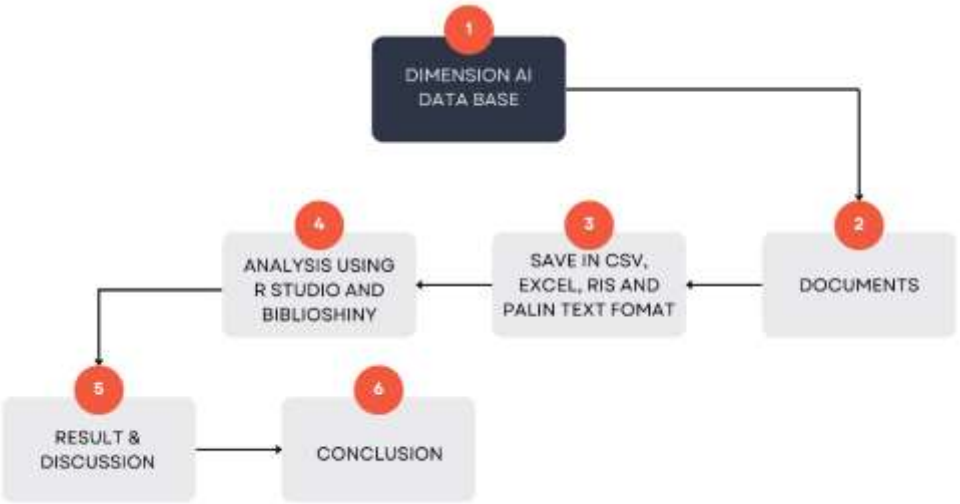

Figure 1.: Research Flowchart

Table 1. Document Search

Criteria	
Keywords	*: Virtual Reality (VR) Future Prospects in Education*
Database	*: Dimensions*
Fields	*: Full data*
Inclusion Criteria	*: Journal in dimensions database*
	: Journal with a complete bibliography
	: open access journal
Exclusion Criteria	*: Using English Language*
	: Incomplete Bibliography Journal
	: Publication Years (2020-2024)

Table 1 provides a concise overview of the document retrieval process utilizing the keywords Virtual Reality, Education, and Future Prospects. The searched documents are limited to those within the 5-year timeframe of 2020-2024. All documents produced during the search were incorporated into the analysis. Table 2 presents details regarding the primary data. We used a Biblioshiny application with R-studio, a bibliometric data analysis software, to analyze the results.

Table 2. Main Information About Data

Description	**Results**
MAIN INFORMATION ABOUT DATA	
Timespan	2020:2024
Sources (Journals, Books, etc)	147
Documents	500
Annual Growth Rate %	18,92
Document Average Age	1,84
Average citations per doc	13,73
References	0
DOCUMENT CONTENTS	
Keywords Plus (ID)	355
Author's Keywords (DE)	355
AUTHORS	
Authors	1835
Authors of single-authored docs	81
AUTHORS COLLABORATION	
Single-authored docs	82
Co-Authors per Doc	3,84
International co-authorships %	18,8
DOCUMENT TYPES	
article	496
Chapter	4

Source: Analysed by R Biblioshiny

Figure 2. Main Information

RESULTS AND DISCUSSION

1. Trend Publication and Citation

Figure 3 shows the trend of documents discussing the prospects of Virtual Reality applications in the last five years. In 2020, 34 articles already existed about VR. In the next three years, namely 2021, 2022, and 2023, writings related to VR in education Future Prospects increased significantly, especially in 2022, with 172 articles. While there has been a decrease in publications in the next two years, namely in 2023 and 2024, the virtual reality (VR) field continues to captivate researchers exploring its potential in education and health. This is demonstrated by the fact that in 2024, which is still in the middle of the year, the number of published papers reached 68. This relatively high publication level is commendable, given the ongoing development of VR-related research in line with the growing demands.

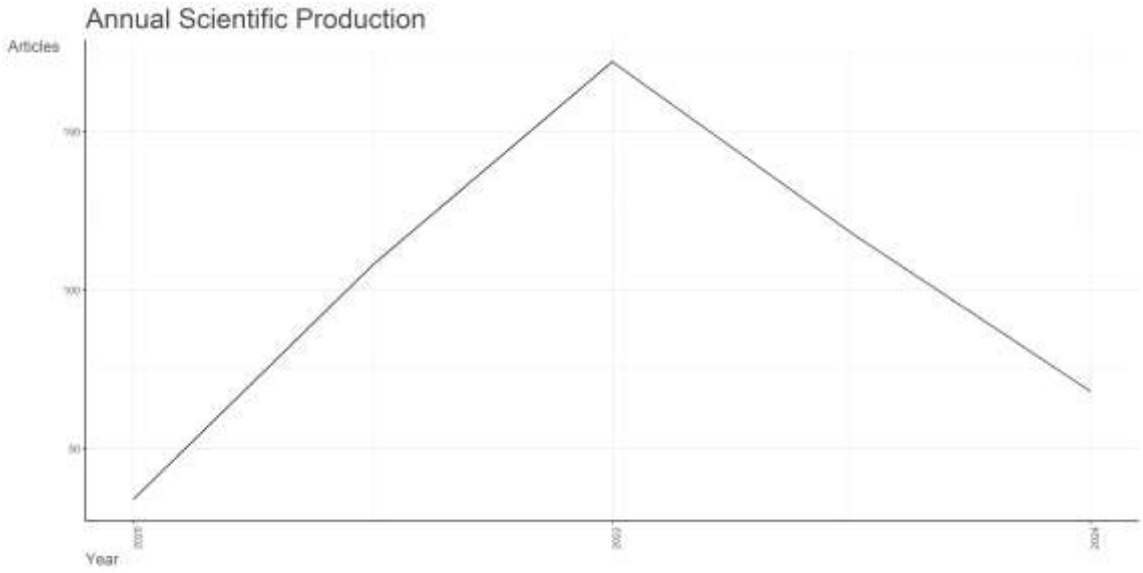

Figure 3. Annual Scientific Production

The data analysis conducted over the past five years (2020-2024) reveals variations in citation count. In 2021, the citation rate peaked at 6.07, totalling 108 publications. In 2020, with 34 articles, the citation rate was 5.84, indicating a good performance. However, in 2022, despite a high publication rate, it only received 4.48 citations. In the year 2024, the lowest number of citations recorded is 0.54, derived from a total of 68 articles. (see Figure 4).

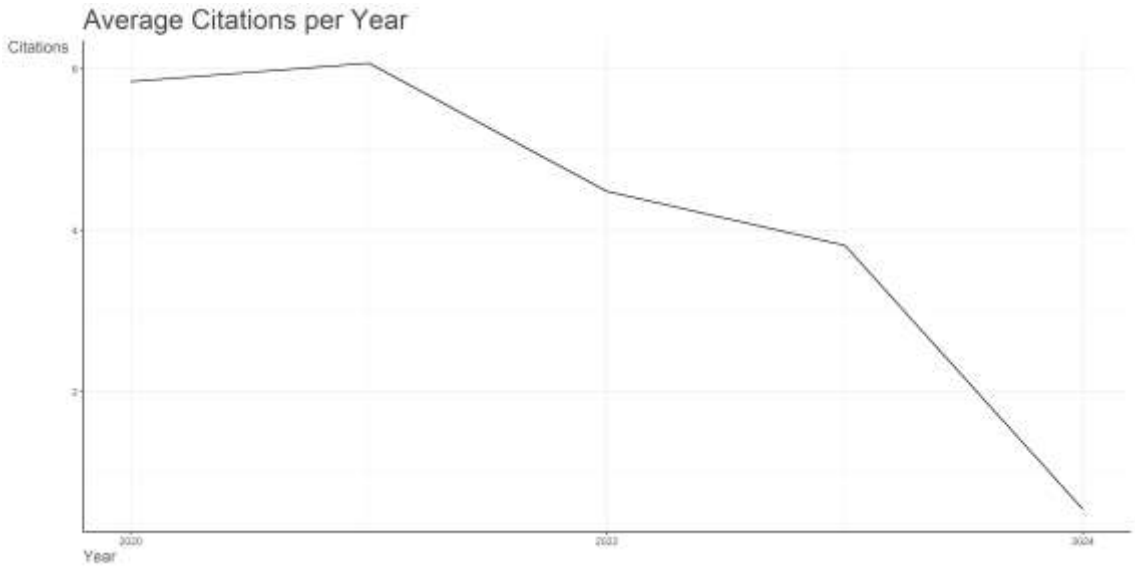

Figure 4. Average Citation per Year

2. The Most Global Cited Documents

Following an analysis of the average number of citations per year for each article, the following data is provided for the 10 papers with the highest citation rate. The document with the highest number of citations is "Education and Information Technologies, Nguyen A, 2022," which receives 65.67 citations annually. Following closely is the British Journal of Educational Technology, Oliveira G, 2021, which receives 57.75 citations annually. Positioned third is a Post digital Science and Education article that receives 41.80 citations annually, while other articles receive fewer than 40 citations per year.

Table 3. Most Global Cited Documents

Author and Paper	DOI	TC per Year
Oliveira G, 2021, British Journal of Educational Technology	10.1111/BJET.13112	57,75
Czerniewicz l, 2020, Postdigital Science and Education	10.1007/S42438-020-00187-4	41,80
Nguyen A, 2022, Education and Information Technologies	10.1007/S10639-022-11316-W	65,67
Sapci Ah, 2020, JMIR Medical Education	10.2196/19285	28,80
Moro C, 2021, Anatomical	10.1002/ASE.2049	33,75

Sciences Education		
Kreijns K, 2021, Educational Psychology Review	10.1007/S10648-021-09623-8	32,00
Katz M, 2021, JMIR Medical Education	10.2196/25892	31,00
Alfaisal R, 2022, Journal of Computers in Education	10.1007/S40692-022-00256-6	38,00
Zhang L, 2022, British Journal of Educational Technology	10.1111/BJET.13191	38,00
Timotheou S, 2022, Education and Information Technologies	10.1007/S10639-022-11431-8	37,67

3. The most relevant articles

The data presented in Figure 5 and Table 4 indicate that Education and Information Technologies has the highest number of publications on the potential of virtual reality (VR) in future education, with 44. Following closely is the Heliyon Journal, which has published 42 publications. This indicates that most authors are very interested in researching the use of VR in integrating technology with education. Apart from the world of education, the use of VR is also very interesting for researchers and writers who want to study the use of VR in the world of heal

Table 4. Most Relevant Sources

Sources	**Articles**
Education and Information Technologies	44
Heliyon	42
International Journal of Environmental Research and Public Health	33
BMC Medical Education	24
Anatomical Sciences Education	22
Prospects	21
Plus one	17
Computational Intelligence and Neuroscience	12
Medical Teacher	12
Educational technology research and development	10

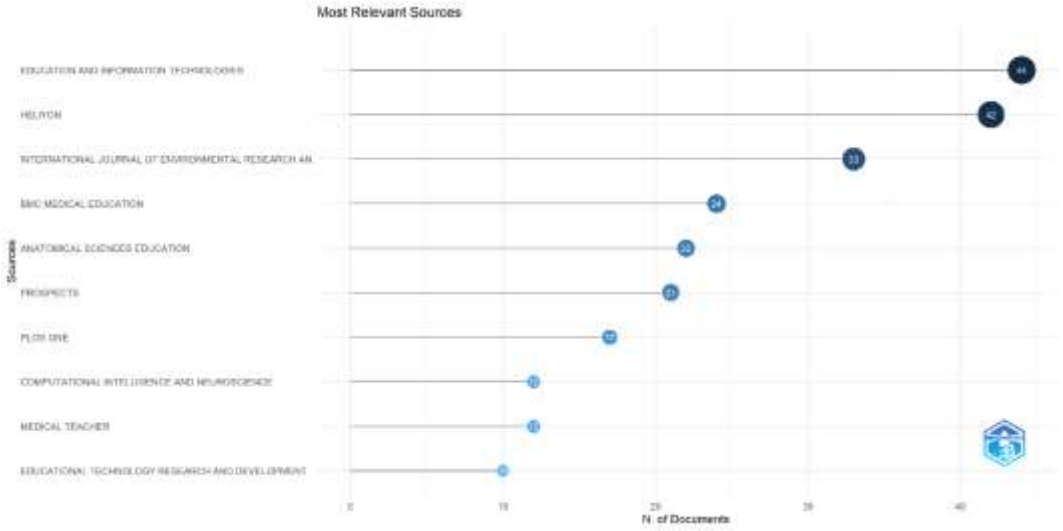

Figure 5. Most Relevant Sources
Source: Local Impact by H Index

Figure 6 illustrates the journals that significantly influence the quantity of citations within a particular geographical area. Based on data from 500 documents, the Education and Information Technologies journal has the highest citation count of 16, followed by the International Journal of Environmental Research and Public Health with 11 citations, and Heliyon and Prospect, each with 10 citations.

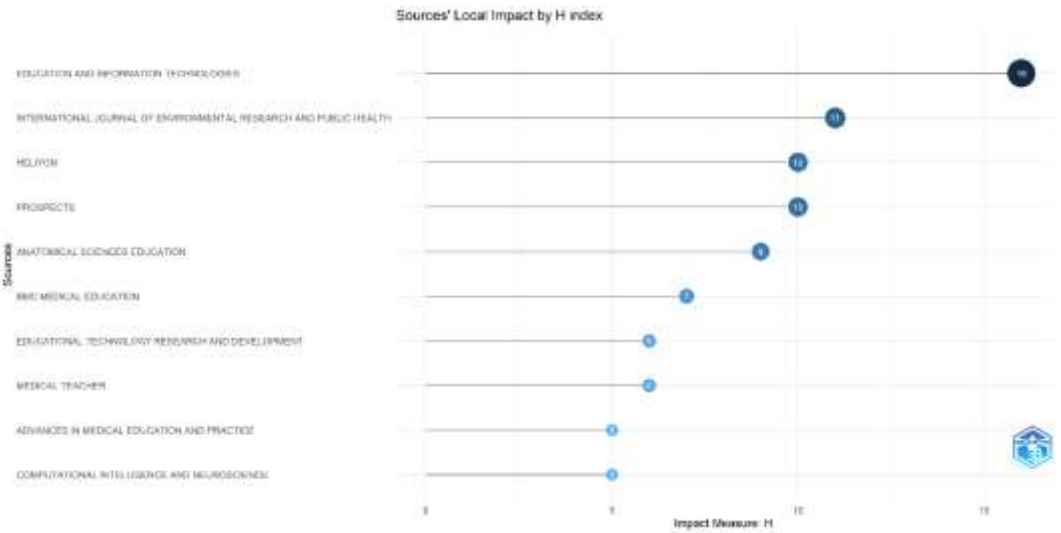

Figure 6. Source Local Impact by H Index

4. **Authors' Production over Time**

Figure 7 in this section displays a graph illustrating the top ten prolific authors on Virtual Reality as a potential future educational asset. This figure demonstrates that the graph can exhibit two distinct forms of analysis. The first analysis is predicated on the magnitude of the circle point attributed to each author, whereby a more significant circle point represents a higher quantity of publications generated by an author. A second analysis can be conducted by

examining the density of color associated with each author. The circle point with the darkest color indicates the author who has received the highest number of citations on Virtual Reality as a future educational prospect.

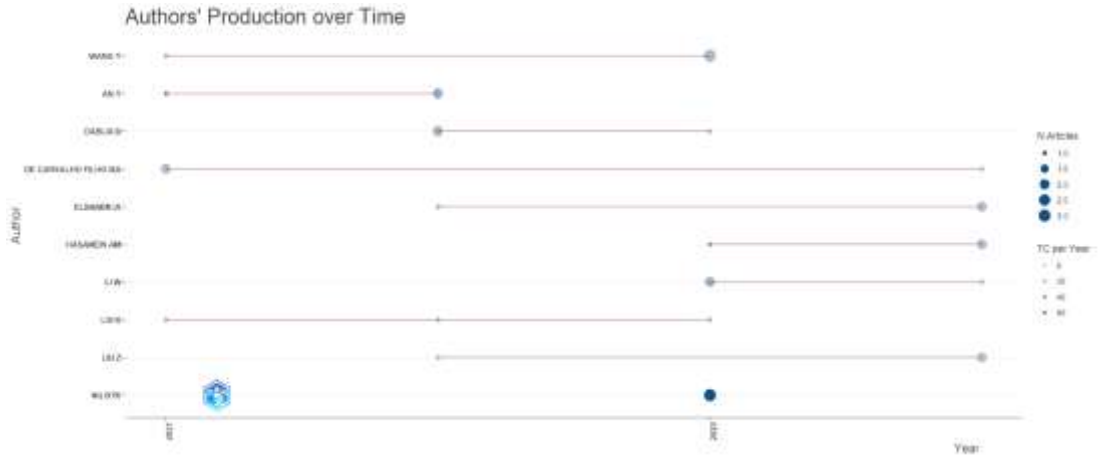

Figure 7. Authors' Production over Time

5. Most Relevant Authors

The figure illustrates authors' productivity in Virtual Reality as a potential future educational opportunity from 2020 to 2024. According to the graph, Wang Y is the most productive author with 4 publications, while the other authors have each published 3 scientific articles.

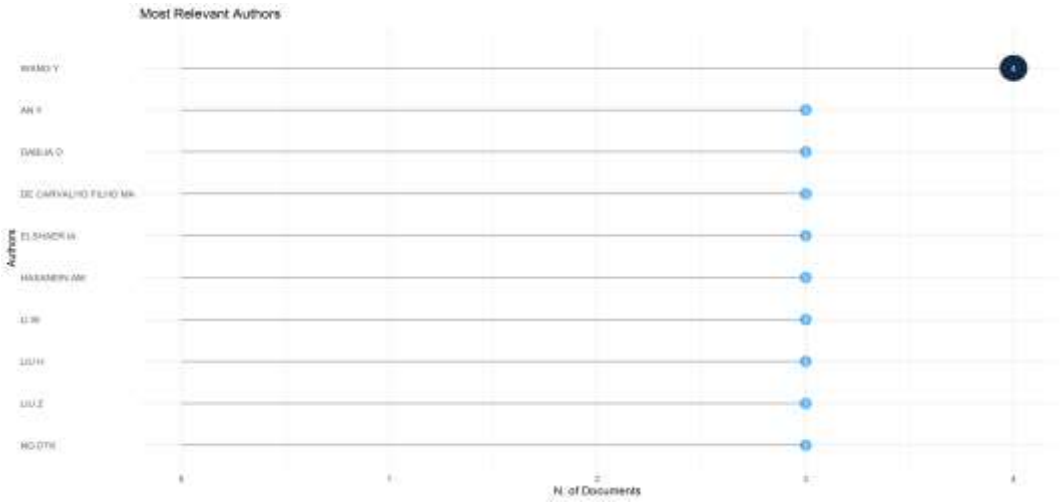

Figure 8. Most Relevant Authors

6. Most Relevant Affiliations

Among the top 10 affiliates that reported on Virtual Reality as a possible future educational opportunity, USAISR, FT Sam Houston, and Texas, USA stand out as the affiliates with the highest number of documents, totaling 50. Publications from the Department of Anesthesia, Intensive Care and Prehospital Emergency at Magniore Hospital Carlo Alberto Pizzardi, Bologna, Italy, and the Department of Mechanical Engineering at Rajshah University of

Engineering & Technology, Rajshahi 6204, Bangladesh, amount to only 13 documents. The remaining documents fall within the range of 10-12.

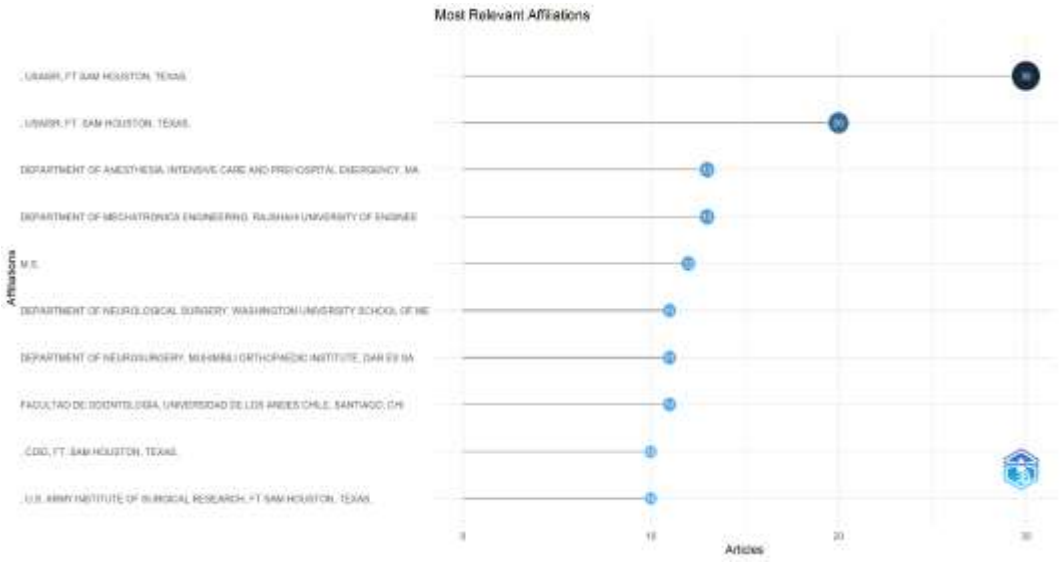

Figure 9. Most Relevant Affiliations

7. Countries' Scientific Production

According to data analysis on Virtual Reality as a prospective future educational opportunity from 2020 to 2024, the USA is the most prolific country generating articles on this topic, with 331 articles. China follows closely with 182 articles, while Canada produces 84 articles. Other countries, such as Australia, Brazil, Germany, India, South Africa, Spain, and the Netherlands, exhibit article production rates below 80.

Table 5. Countries' Scientific Production

Country	Freq
USA	331
CHINA	182
CANADA	84
AUSTRALIA	74
BRAZIL	52
GERMANY	47
INDIA	47
SOUTH AFRICA	47
SPAIN	44
NETHERLANDS	37

The citation data analysis results indicate that the United States has the highest number of citations, with 994, followed by China, with 467. However, Australia is an exception. Suppose the number of Australian articles is only in fourth place. In that case, Australia is in third place in terms of citations, with 404 citations, surpassing Canada, which was in third place regarding the number of publications. Intriguingly, countries with a total of fewer than 40

articles published are included in the line-up with the highest number of citations, including Finland with 254 citations, Saudi Arabia with 243 citations, and Malaysia with 198 citations. Spain, Brazil, South Africa, and the Netherlands, previously included in the top 10 most published countries, have been omitted from the top 10 countries with the highest number of citations (Figure 10).

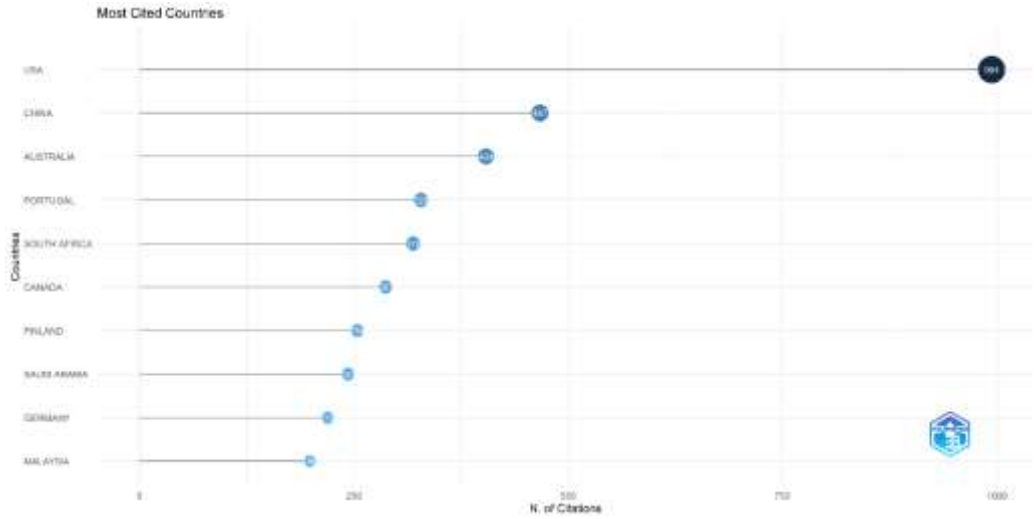

Figure 10. Most Cited Countries

8. Most Relevant Words

The following analysis focuses on research trends regarding the potential of Virtual Reality in education. It utilizes keywords or terms associated with research on implementing virtual reality in learning methodologies, such as the utilization of virtual reality in educational settings. The primary purpose of keywords is to emphasize the critical aspects of a research or written work. The mapping results indicate the rise of keywords or phrases associated with Virtual Reality research as a promising area of direction in education. The analysis findings will be displayed using a high-frequency word graph, word cloud, and tree-map visualization.

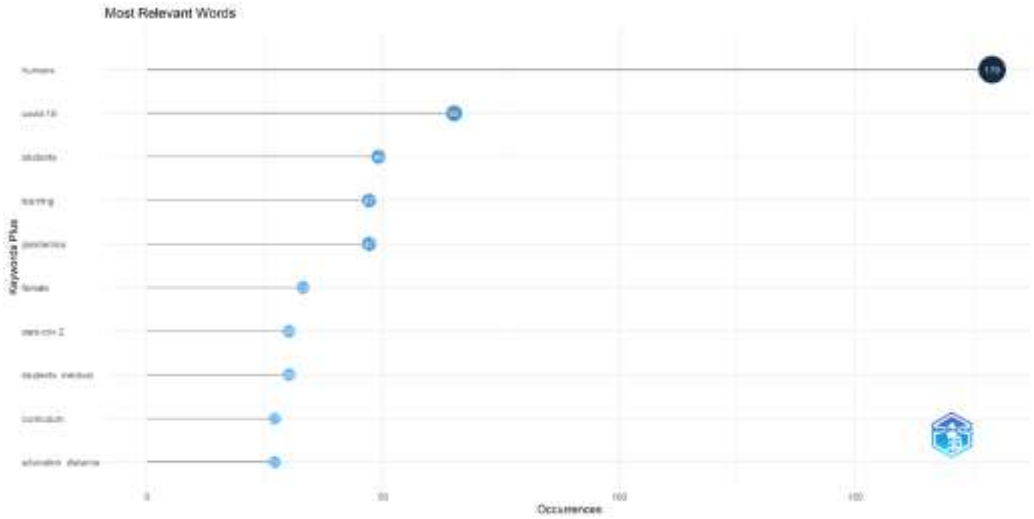

Figure 11. Most Relevant Words

The data presented above indicates the prevailing words or phrases associated with Virtual Reality as a prospective technology in Education from 2020 until 2024. The most frequently occurring term is "humans," appearing 179 times. Additionally, "Covid-19" appears 65 times, followed by "students" at 47 occurrences, and both "learning" and "pandemic" also at 47 instances. Other terms, such as "female," "SARS-CoV-2," "medical student," "curriculum," and "distance education," appear fewer than 40 times each.

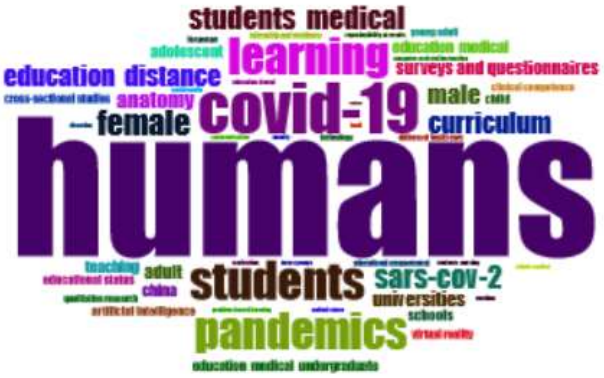

Figure 12. WordCloud

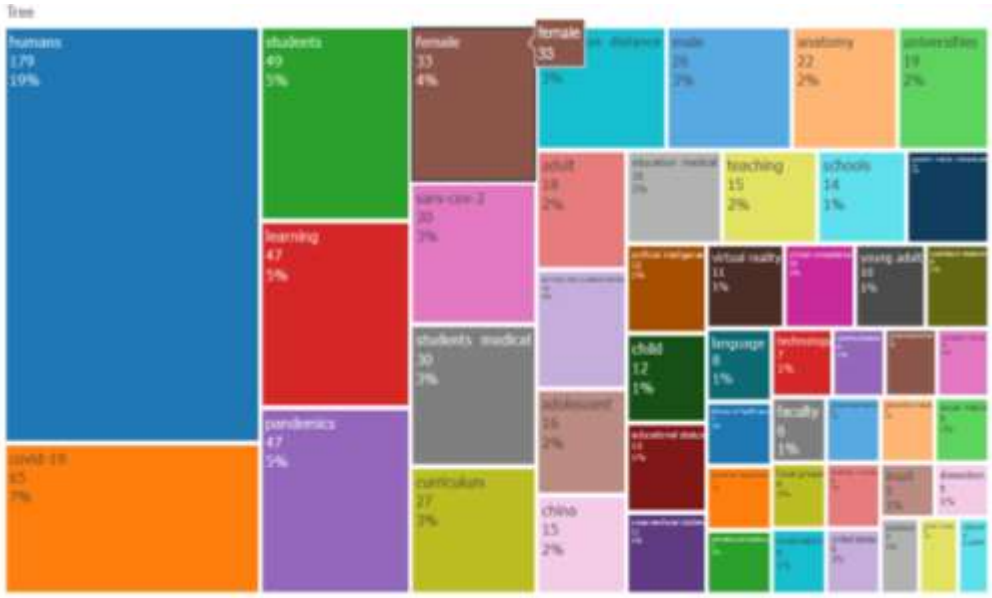

Figure 13. Tree Map

After the data is displayed using a word cloud to determine the frequency of occurrence of a term or word, a tree map is also employed to determine the percentage of occurrence of the term or word in article searches using the title. From 2020 to 2024, virtual reality will be a potential future development in education. Based on the tree map visualization, it is evident that the term "Human" has the highest level of appearance presentation, at 19%. Conversely, other terms have a percentage level of appearance below 10%, such as the term "Covid 19," which has a level of appearance of only 7%. Students,

learning, and pandemics have an appearance of only 5%, and the remaining terms are in the range of 3%.

CONCLUSIONS AND RECOMMENDATIONS

By conducting data searches on the research topic, "Virtual Reality is a prospect for future education," using Dimensions software and analyzing the results using R Studio and Biblishiny software, approximately 500 documents were identified. These documents primarily comprised articles and book chapters. A total of 496 articles were located, of which 4 were chapters. The collection of 500 documents comprises writings from 2020 to 2024, authored by 1835 individuals. Among these, there are 81 documents composed by single authors.

The study of Virtual Reality is highly intriguing, given the unparalleled progress of technology in contemporary times. The COVID-19 pandemic has demonstrated that temporal and spatial boundaries should no longer constrain studies. The bibliometric data analysis reveals that the fields of education and information technology possess the highest number of pertinent sources on Virtual Reality, totaling 44 articles. This implies that the investigation of VR media in education remains highly intriguing, particularly in Indonesia, given the prevailing dominance of Chinese authors in VR research and the supremacy of the United States in scientific publications focused on this topic.

FURTHER STUDY

This research is still very limited to analizing articles within the dimension because the articles are still very general. Therefore, it would be more interesting to collect articles from the Scopus database in the future to make the results more reputable.

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