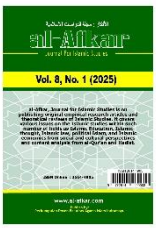

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Research Article

The Development of Virtual Classroom Spaces: A Bibliometric Review of A Decade of Scopus Research

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The Development of Virtual Classroom Spaces: A Bibliometric Review of A Decade of Scopus Research

Abstract. This study aims to analyze the development of virtual classroom studies through mapping trends in scientific publications, author contributions, institutional affiliations, productive countries, documents with the highest citations, and the development of research themes based on Scopus indexed literature. This study uses a bibliometric method by utilizing publication data from English-language journal articles indexed by Scopus and analyzed using bibliometric mapping tools to identify research development patterns. The results of the study show that publications related to virtual classrooms have increased and reached the peak of development in 2023. The United States is the country with the highest publication contribution, the University of Florida is the most prolific affiliate, and Huang Y is listed as the author with the highest number of publications. The theme analysis shows

that virtual reality, human, education, and student are the main themes in virtual classroom research, while the COVID-19 pandemic is one of the issues that drives the development of the study. This study concludes that virtual classrooms are developing as a strategic field of study in digital education transformation, with advanced research opportunities on the integration of immersive technology and pedagogical innovation.

Keywoards: Virtual Classroom, Bibliometric Analysis, Digital Learning, Virtual Reality, Educational Technology

INTRODUCTION

The era of society 5.0 is the concept of a society that uses technology (Yan, 2021) to meet daily needs (Sahin et al., 2018). In the context of education, Society 5.0 demands adaptation to innovative learning methods and Higher Order Thinking Skill (HOTS) (Margatama et al., 2024) to prepare students for the future (Tsai, 2013). This includes the use of e-learning (Acharjya & Das, 2022), virtual classroom (Liu, 2023), and various online applications for teaching and learning (Zhang, 2022).

Online learning offers practicality and flexibility (Thi Mai, 2023) in managing the study schedule, and of course can be accessed anywhere and anytime (Khlaisang & Songkram, 2019). Virtual Classroom as a Learning Media (Taufik et al., 2022) has become the focus of attention (Breuer et al., 2022) in the context of technological development (Quintana et al., 2014) Information and Communication (Alghawli & Almekhlafi, 2019).

Virtual classrooms, such as Google Classroom(Bervell et al., 2022), schoology (Pramana et al., 2020), edmodo (Pramana et al., 2020), moodle (Moreno-Ger et al., 2013), and others have become solutions in supporting online learning(Bramer, 2020), top during the COVID-19 pandemic (Patel & Taggar, 2021). Various studies also highlight the implementation (Haynes et al., 2021)Effectiveness (Jennah et al., 2023), kendala (Kostić et al., 2013), and solutions (Mardiha et al., 2023). Use of the Virtual Classroom app in the makes it easier of online learning (Brooks & Young, 2015)(Sinta Diah Ayu Wandani et al., 2022). This shows that the virtual classroom has a significant role (Shen et al., 2023) in supporting the learning process (Flores Masias et al., 2023), especially in situations where conventional learning is limited (Sa'di et al., 2022).

Research conducted by Rajab Ali Biswas (Ali Biswas & Nandi, 2020) is a research that focuses on the obstacles experienced by teachers both in terms of techniques and strategies in using virtual classrooms. From the results of this study, it is known that the obstacles found are related to the not easy adjustment of conditions and situations from face-to-face classes that switch to virtual classrooms, where teachers must conduct intense studies and trials to find out effective strategies used in virtual classsrooms.

Sara Willermark and Anna Sigridur Islind (Willermark & Islind, 2022) He also explained the results of his research that teachers have to adapt a lot from traditional classrooms to virtual classrooms. There are several things that must be considered in the transition which include structure, one-on-one communication, formalized reconciliation, comfort, peace, punctuality and of course reaching all students. In line

with research conducted by Abdellah Ibrahim Mohammed Elfeky and Marwa Yasien Helmy Elbyaly (Bloom & Reenen, 2013) who tested the use of Virtual ClassROM for children with special needs and the satisfaction results were very high, so that the implementation of Virtual Classroom can help development in the world of education with a note that it must have good management.

From research conducted by Faieza Chowdhury Know that in Bangladesh virtual classrooms are a trend that continues to be developed (Chowdhury, 2020), then from the research it produces data that if the learning environment and also the educators can create an interactive environment then learning through virtual classroom will be very efficient.

Although various studies have examined the implementation, effectiveness, challenges, and strategies for the use of virtual classrooms in learning, studies that map scientific developments, publication patterns, research networks, and the direction of virtual classroom research trends systematically through a bibliometric approach are still limited. Therefore, this study was conducted to fill this gap by providing a comprehensive overview of the development and dynamics of virtual classroom research based on Scopus-indexed literature.

This research is a research with bibliometric indicators (Lorenzo et al., 2023), bibliometric is a media used to survey the results of scientific publications (Rahmadhani et al., 2023)(González-Zamar et al., 2021), especially in this study is to examine connections related to science and technology (Calabuig-Moreno et al., 2020), will then describe the grouping (Nallaswamy et al., 2018). On the Science Ranah, Digging (Zhao et al., 2020). About the latest science updates (Cárdenas-Oliveros et al., 2022) which focuses on the realm of virtual-based learning, besides that it is also a consideration in the future in making strategic plans (Purnomo & Sharin, 2022). So that Bibliometric research on virtual classrooms is important to better understand and develop this field (Wang et al., 2021), as well as providing guidance for future research and policy (Nespor & Voithofer, 2016).

RESEARCH METHODS

Bibliometric analysis is the method of this study (Vambudi et al., 2026). The bibliometric method was chosen because it is able to provide a comprehensive mapping of the development of a field of study through quantitative analysis of scientific publications, citation patterns, collaboration networks, and trends of research themes (E-sor & Ishaque, 2025). This approach is suitable for use in this study because it aims to identify the dynamics, trends, and direction of development of virtual classroom research based on Scopus-indexed literature.

In order to obtain data, the Boolean method is used to go through the Scopus database in 2013-2024. The data search in this study was conducted on December 15, 2023 at 15.05 WIB. R or Rstudio, VosViewer and Microsoft Excel are used by researchers to review citations, document content and networks. Databset processing in this researcher is carried out in three stages. The first, a literature review of the Virtual Class theme will be carried out by researchers as an effort to verify relevant research to be addressed on the topic of bibliometrics, besides that it also plays a role in detecting the right concepts and is expected to be representative of the existing research

coverage.

Next at this stage, applies the boolean operator TITLE-ABS-KEY (virtual AND classrooms) as an effort to find data on Scopus which produces 10,259 documents. Then selection is carried out using boolean operators with the formula: (LIMIT-TO (DOCTYPE, "ar")) AND (LIMIT-TO (SRCTYPE, "j")) AND (LIMIT-TO (LANGUAGE, "english")) as an effort to limit data based on article document type, journal source documents and English articles only, which ultimately formed 3316 documents.

Third stagei, at this stagei a Scopus and R/Rstudio analysis will bei carrieid out which will bei useid to undeirstand thei quantity of documeints availablei eiach yeiar, thein to undeirstand thei typeis of documeints baseid on journals, authors, affiliations, countrieis and subjeicts or reiseiarch focus. Afteir thei usei of VOSvieiweir and data proceissing through Microsoft Eixceil as a meidium to analyzei and geit a snapshot of thei picturei at thei neitwork leiveil of documeints.

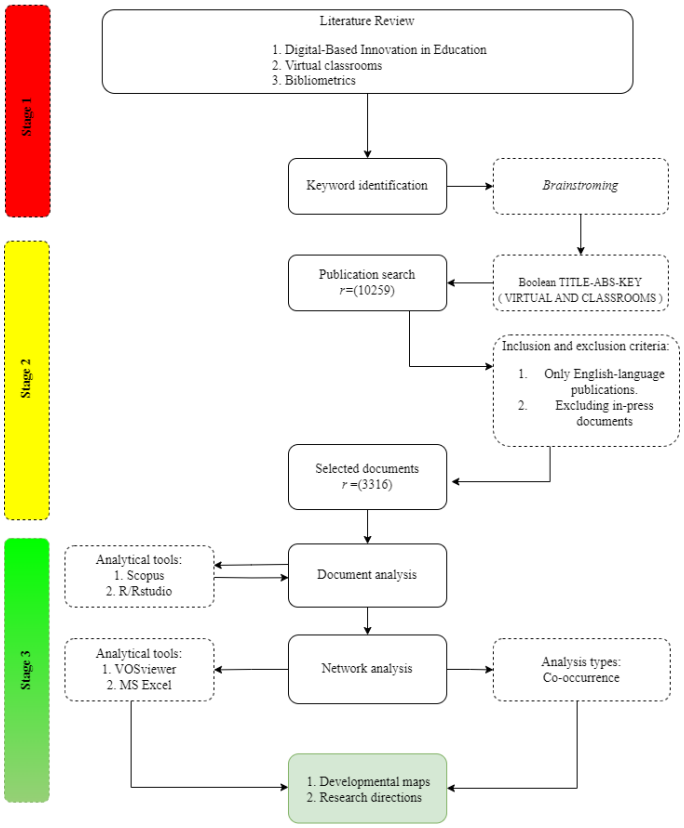

FIGURE 1. Research Procedure

RESULTS AND DISCUSSION

Document Analysis

Table 1 is the main data information taken from Bib-Shy, that there are 3316 documents in its collection over a period of 43 years. The more than three thousand documents include authors with a total of 9796, single authors with 569 and as many as 16.07% of authors who work in the international scope, then also includes 125194 studies where the most citations per document is 1204.

Table 1. Key Information About Data

Description	Results
MAIN INFORMATION ABOUT DATA	
Timespan	2013:2024
Sources (Journals, Books, etc)	1373
Documents	3316
Annual Growth Rate %	-29,3
Document Average Age	3,08
Average citations per doc	12,04
References	125194
DOCUMENT CONTENTS	
Keywords Plus (ID)	6321
Author's Keywords (DE)	7808
AUTHORS	
Authors	9796
Authors of single-authored docs	569
AUTHORS COLLABORATION	
Single-authored docs	600
Co-Authors by Doc	3,34
International co-authorships %	16,07
DOCUMENT TYPES	
Article	3316

Figure 2 provides information regarding the progress of publication of the Virtual Class theme from year to year. Research related to Virtual Classrom began to appear in 1972, but from the year of its appearance until 1994 the publication of research documents related to Virtual Classroom stagnated, only then from 1995 to 2014 experienced a fairly consistent increase. However, from 2013 to 2018 publications related to Virtual Classroom fluctuated, only then in 2019 to 2023 experienced a consistent increase and experienced the highest peak of publications in 2022 to 2023.

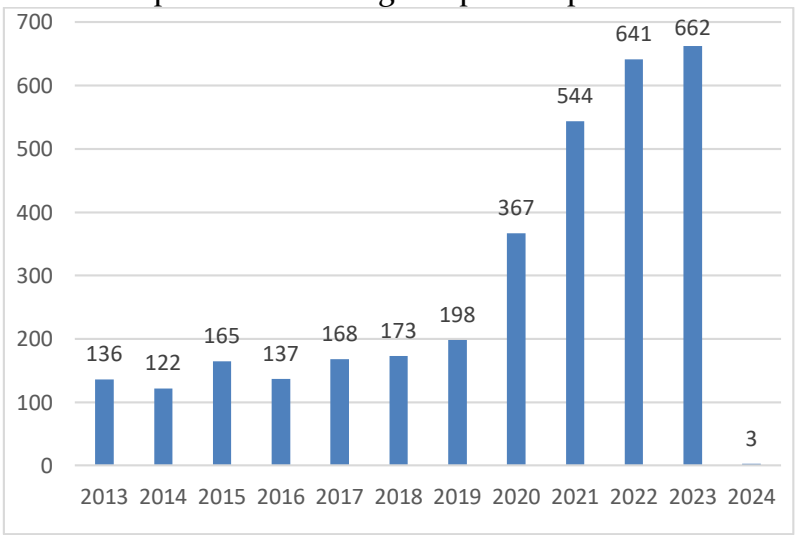

Figure 2. Documents by Year

Figure 3 provides information that there are 10 authors who have high influence in publishing research on Virtual Classroom, namely Hwang, G.J. leads with 9 publications, followed by Boleh Achuthan, K. and Jong, M.S.Y. with the same number of publications with 8 documents. Then the third most influential author is Higuera-Trujillo, J.L. and Llinares, C. with a total of 7 document publications, followed by four authors who both published 6 documents namely Birt, J., Dede, C., Diwakar, S., Makransky, G. and finally Cowling, M with 5 publication documents.

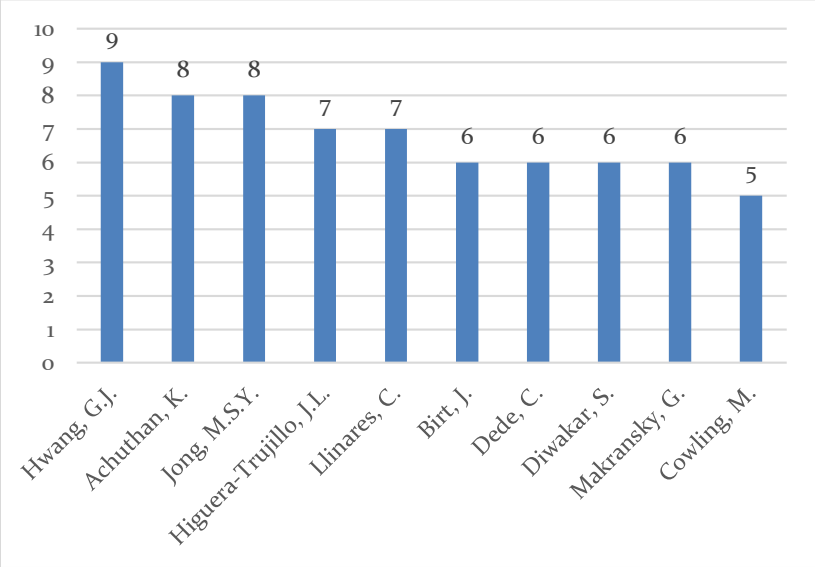

Figure 3. Most Relevant Author Documents

Figure 4 provides information that there are 10 affiliates who have high influence in publishing research on Virtual Classroom. Where the University of Florida is the leading affiliate with 24 documents.. The second is University of Toronto with the publication of 20 documents. Continued by the same 3 universities published 18 documents, namely The Ohio State University, Purdue University, and Universidad de Sevilla. Then followed by three universities namely National Taiwan Normal University, National Taiwan University of Secience and Technology and Tecnologico de Monterrey with 17 publication documents. Then the last is the University Tecnologico de Monterry and Clemson University with the publication of 15 documents.

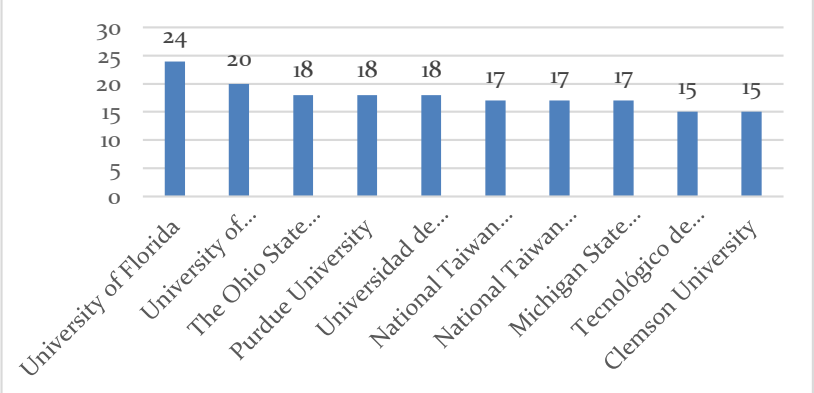

Figure 4. Documents by Affiliation

Figure 5 provides information about publications by country with the theme Virtual Classroom.The United States leads publications with 1046 documents. Followed by China which has a very wide gap with the United States which is 267 documents. Then there is Spain which only has 7 publication differences with China, which is 260 publication documents.

Asian countries dominate with 4 countries, while European countries occupy the second after Asian. So it is clear that countries on the Asian continent have a higher interest in conducthing research on Virtual Classroom.

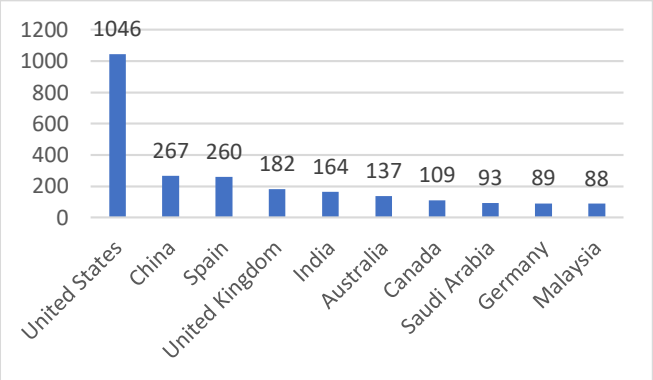

Figure 5. Documents by Country

Figure 6 contains 3 supervised components; journal name, author name and subject used. The three units are then connected by interconnected gray plot lines. Based on the name of the journal, in each journal it appears which authors contribute most often to its distribution, especially those on the topic of Virtual Classroom.

The approximate plot shows how large the distribution is with respect to the topic. Based on the picture above, there are 15 journals. The journal that has spread the most research on the subject of Virtual Classroom is Virtual Reality which is displayed in dull reddish colors and is attributed to several creators such as Huang Y, Hwang g-j, Jong MS-Y, and Wang-Q.

Based on the image above, there are 20 creators. The size of the bar chart shows how much of the distributed research comes from each creator. Among the 10 creators who composed prominent articles on the subject of Virtual Classrooms are Huang Y, Hwang g-j, Liu Y, Birt J, Kumar A, Wang Y, Wang I, Jr, Jong ms-j, and Diwakar S.

In the third component, each research subject is associated with a creator who writes a package on ICT proficiency points. From the results of the examination, there were 16 slogans for ICT Virtual Reality and Making Progress in Educational Classes. It seems that this word is closely related to ICT literacy.

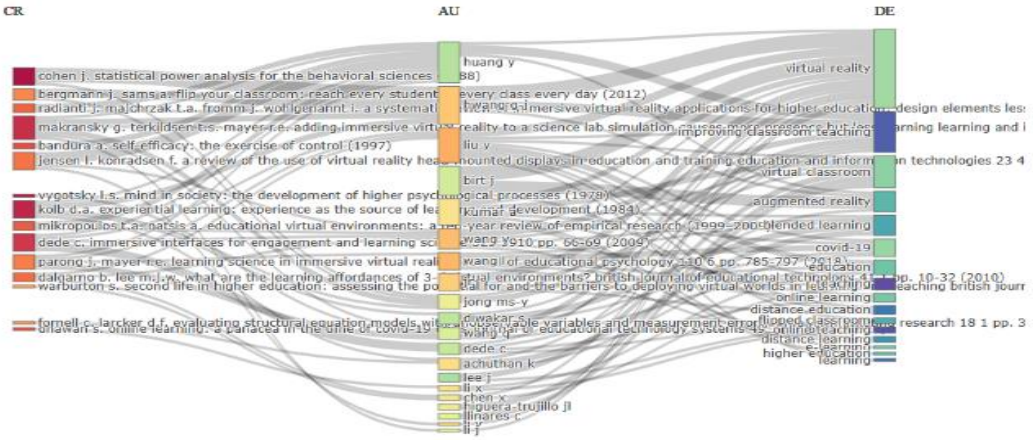

Figure 6. Three-Field Plot *Corresponding Author's Countries*

Figure 7 explains that from the SCP (Single Country Publication) side or from the MCP (Multiple County Publication) side, the USA, China and Spain have the highest number of author countries. Based on data in the continent category, the Asian continent dominates with a total of 10 countries, then the second place is the European continent with 4 countries.

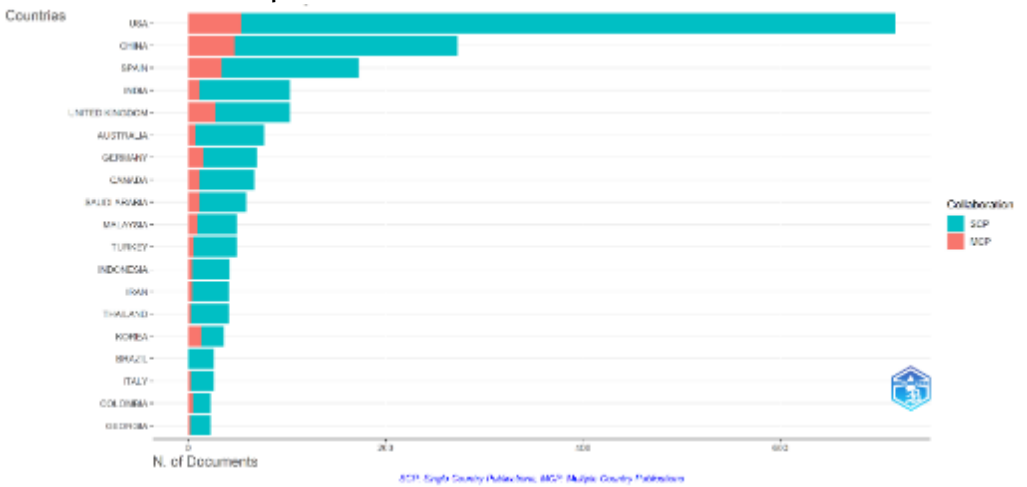

Figure 7. Corresponding Author's Countries *Most Global Cited Document*

Table 2 provides information about the papers with the largest total citation (TC) is "HANUS MD, 2015, COMPUT EDUC" with 1011 citations. Meanwhile, the paper that has the largest TC per Year is "CHICK RC, 2020, J SURG EDUC" with 151 citations per year.

Based on these data, it can be stated that TC (total citations) tends to affect TC per Year (citations per year). In general, papers that have a larger TC also tend to have a significant TC per year. Although it is not always true that papers with large TCs necessarily have a higher TC per year than others, and vice versa.

Table 2. Most Global Cited Document

Paper	Total Citations	TC per Year	Normalized TC
HANUS MD, 2015, COMPUT EDUC	1011	112,33	39,65
CHICK RC, 2020, J SURG EDUC	604	151,00	33,16

MARTÍN-GUTIÉRREZ J, 2017, EURASIA J MATH SCI TECHNOL EDUC	426	60,86	19,72
SACKS R, 2013, CONSTR MANAGE ECON	409	37,18	15,16
BUJAK KR, 2013, COMPUT EDUC	335	30,45	12,42
KAMARAINEN AM, 2013, COMPUT EDUC	334	30,36	12,38
AGUDO-PEREGRINA ÁF, 2014, COMPUT HUM BEHAV	300	30,00	11,37
MARKOWITZ DM, 2018, FRONT PSYCHOL	218	36,33	13,05
JOHNSON-GLENBERG MC, 2014, J EDUC PSYCHOL	204	20,40	7,73
DE JONG T, 2014, SMART LEARN ABOUT	201	20,10	7,62

Thematic Map

Theme mapping can be seen in figure 8 which consists of Basic Theme, motor theme, niche theme, emerging and declining theme. The category that covers the basic themes of existing research is called the basic theme. In the data given cluster 3 "virtual Reality" is an example of a basic theme. The basic theme explains that the theme is often the main focus of research that receives high attention from researchers.

Then the category that includes related themes that are the driving force behind the development of research is called motor themes. The "Human" cluster (Cluster 1) is an example of a motor theme in this data. So it can be known that the Human theme is an actively researched theme. And be aware that motor themes often influence how research and publications develop over time.

Then the category that includes specific themes and is less common than basic and motor themes is called niche themes. As can be seen from the niche theme in this data is the "Students" cluster (Cluster 2). In the niche theme category, it is possible to have a smaller amount of research or only be interested in certain groups of researchers.

Finally, categories that include themes that are emerging or declining in popularity in research or publications are called emerging or declining themes. In this data, the theme "E-Learning Computer Aided Instruction" (Cluster 2) can be categorized as an emerging theme because the number of occurrences and its relevance in research is still significant, but the number is not as much as the theme "Human" (Cluster 1), which can be categorized as declining themes because the number of research or publications related to the theme tends to decrease.

The existence of analysis based on this classification has the aim that the general public can understand the distribution and trend of themes in existing research data or publications. This categorization helps in identifying key themes that dominate a particular field of research, emerging themes, as well as themes that may require more attention and further research.

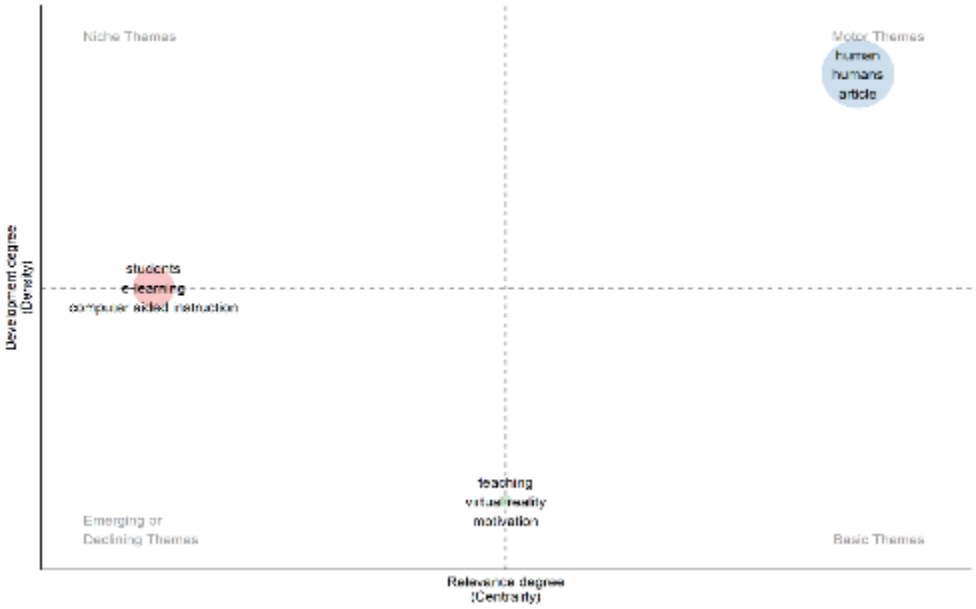

Figure 8.Thematic Map

Document Analysis

Figure 9 is a occurance analysis of research on digital literacy with a minimum cluster size of 32. In this analysis, three cluster were formed, of wich 47 items were the first cluster, the next number of clusters was 38 items and the third cluster has 20 items. The keyword "Virtual Reality" became the dominating keyword with an occurrence of 620.

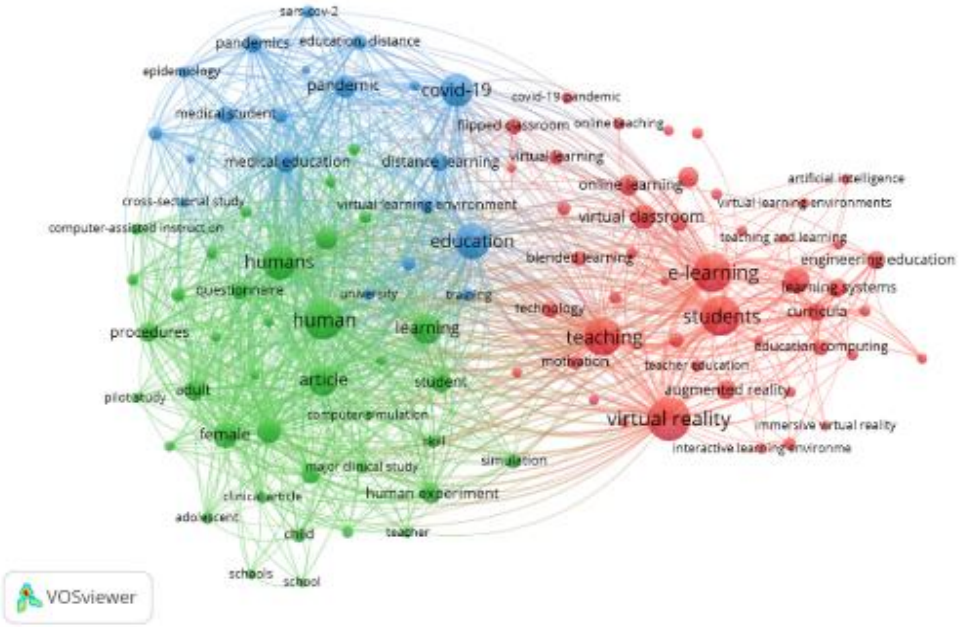

Figure 9. Network Analysis

Figure 10 provides information about overlay related to keywords in network analysis. Dimana pada tahun 2021 Covid-19, pandemic dan epidemiologi menjadi kata

kunci yang mendominasi. Then it has been used for a relatively log time, to be precise in 2019 education, teaching and procedures became the dominant keywords.

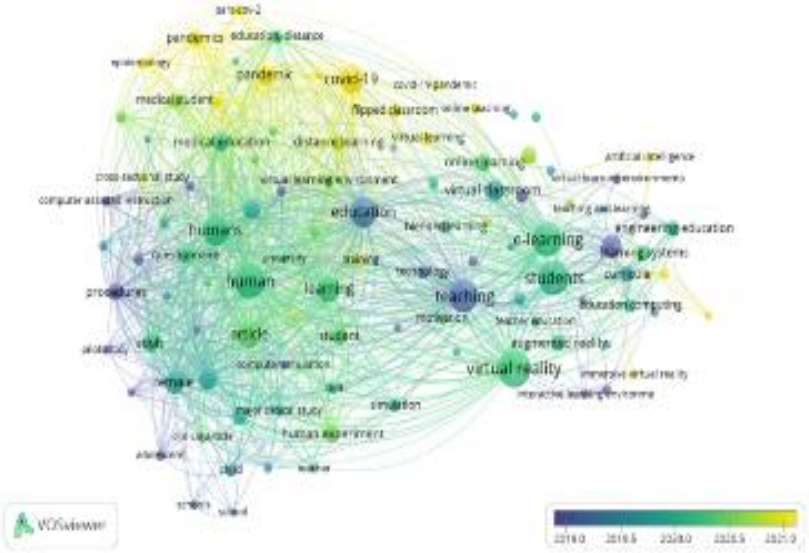

Figure 10. Overlay Analysis

Figure 11 provides information about the level of density related to keywords in network analysis. Where it can be seen that research on the keywors virtual reality, human and student has a high density. Then the keywords computer-assisted, immeersive virtual reality, and major clinical studies are still blurred, meaning that these keywords are still rarely researched.

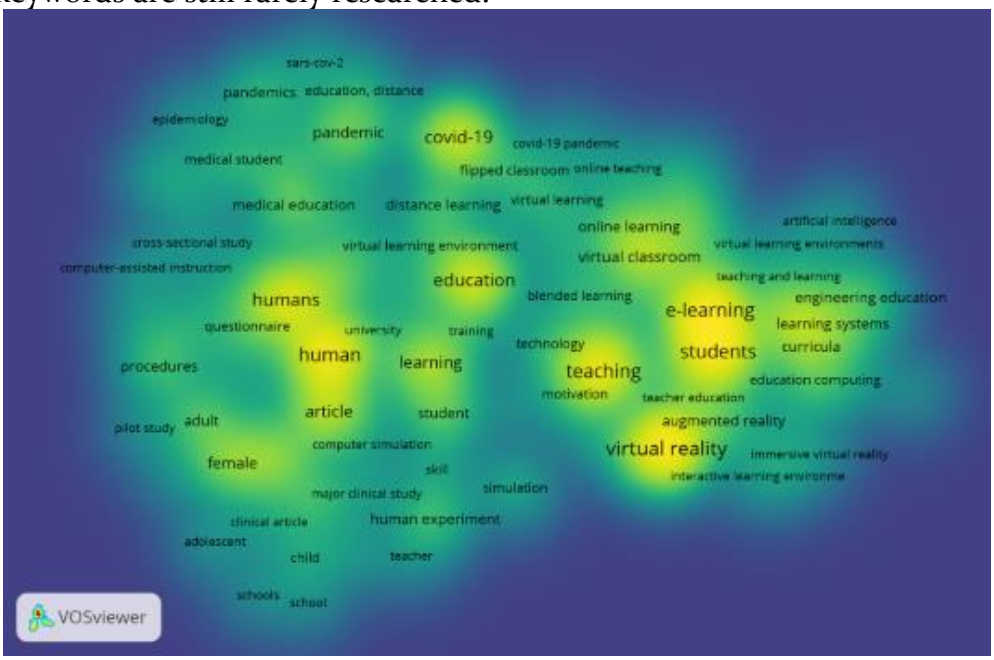

Figure 11. Analisis Density

Table 3 provides information that the keywords that frequently appear in each cluster and can represent major themes in research related to virtual classroom are virtual reality wich is the theme in the first cluster, then humans are the theme in the next cluster, and education is the theme in the third cluster.

Table 3. Total Occurrenceance

Keyword	Occurrences	Cluster
Virtual Reality	620	1
Student	506	
E-learning	498	
Teaching	463	
Computer Aided Instruction	232	
Human	526	2
Article	298	
Learning	279	
Female	205	
Curriculum	164	
Education	395	3
Covid 19	362	
Distance Learning	113	
Pandmic	176	
Medical Education	150	

CONCLUSION

2023 is the culmination of virtual classroom-themed publications. Huang Y is the most relevant author, having published 11 documents. The University of Florida is the largest publishing affiliation with 24 documents. Then with 1046 publications the Unitesstates became the country with the most publication on virtual classroom research. The United States is an MCP. HANUS MD, 2015, COMPUT EDUC is the document with the largest citations, which is 1011 citations. Virtual Reality is a basic theme in Virtual Classroom research. The dominating keyword with 5298 strengh links is Human. The keywords pandemic, Covid-19 and epidemiology are keywords with usage in 2021. Virtual Reality, Human, Education and Student are the mainstream themes found.

This study has limitations, namely only exploring datasets indexed by Scopus and only analyzing documents with English-language journal article types without considering other global indexation, languages, and document types other than articles.

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