

A Bibliometric Approach to Assessing the Potential Research on the Use of Virtual Classroom in Vocational Education

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Abstract

Education is progressing faster than at any other time in history. Educators are becoming increasingly conscious that today's learning media are developing to match future realities. Education must establish new approaches in the learning process by employing virtual classrooms and tools and technology. The virtual classroom concept offers a solution for today's and tomorrow's educational needs. To prepare for future employment, students require a holistic education that combines practical occupational skills, communication methods, and leadership development. This paper will give a bibliometric analysis of the term virtual classroom as a learning media, focusing on future research trends in vocational education. The articles were obtained with the help of the Publish or Perish software and the Scopus database. With a search period spanning 2013 to 2022, 405 articles were evaluated (9 years period). The desktop version of the Mendeley program is used to handle the references. VOS Viewer software was used to classify the articles by generating six clusters. The main keywords from the six groupings are virtual reality, e-learning, teaching, education, augmented reality, and improved classroom instruction.

Keywords

Bibliometric approach, Virtual classroom, Vocational education, Scopus, Virtual Reality.

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Submitted : Maret 24, 2024. Accepted : April 19, 2024. Published : April 26, 2024.

INTRODUCTION

The development of the learning process using information and communication technology is proliferating [1]. The role of information technology as a medium in solving problems in all fields is changing its function as an attractive, interactive, and practical virtual-based learning media [2]; [3]; [4]. It is indicated by the many forms of virtual-based learning media in education, especially in Indonesia. The use of virtual technology can already be felt in the learning process to improve the quality of the classroom [5]. As a teacher on campus, virtual technology can be used as a medium in the teaching and learning process as interactive tutorial media, teaching aids, and test equipment to be very helpful in delivering and understanding the material to students [6]. Learning media is a means that can be manipulated and can be used to influence the thoughts, feelings, concerns, and attitudes of students, thereby facilitating the learning process [7]. The utilization of learning media in the teaching and learning process can also generate motivation, develop new desires and interests, and positively affect students [8].

The basic principle of implementing a virtual classroom is distance learning. Distance education began in Boston in 1728 with the use of the post. Penn State University in 1922 conducted learning through radio, while in 1950, universities offered to learn through television [9]. In an era where the community widely owns laptops, digital devices, and the internet, online learning can be done affordably and accessed anywhere with free time flexibility. However, the definition of online learning is not clearly defined. Some literature can specify it by the terms virtual, digital, online, remote, distance and e-learning. These terms can be used to describe virtual classroom learning media broadly. In this case, the internet and technology can connect teachers and students who are geographically separated [10]. The implementation of virtual learning can vary in its performance (tutorials, discussions, groups, webcasting) according to the configuration of existing resources [11]; [12]. Combining traditional learning and online lectures is also possible because the blended model is prevalent these days.

Virtual reality (VR) is an advanced technology invention that can provide real-world simulations into the virtual world [13]; [14]. Meanwhile, the virtual classroom is a simulated classroom environment using a head-mounted display (HDM). Visual and sound stimuli can provide students with experience in the learning process [15]. There have been many studies with virtual classroom objects using VR by conducting controlled experiments with a high level of validity in various fields of science. For example, the development of virtual classrooms to correct the decline in students' attention in the class and assess the progress of students' learning processes [16]; [17]. In addition, in the last few years, virtual classrooms can be used for teachers and prospective teachers to provide virtual classrooms close to actual classes to improve teaching practice skills [18].

This study aims to investigate the development of research on virtual classrooms in education, especially vocational education. Based on the authors' knowledge, no bibliometric analysis has been conducted to analyse the topic of the virtual classroom. Furthermore, this study was undertaken to provide relevant bibliometric analysis of the literature from the Scopus database to answer the following questions: (1) Research topics about are the trends in virtual classroom topics; and (2) What are the trending topics for further research in the future?

Virtual classroom learning is defined as a learning and teaching method that includes presenting material, graphics, simulations, evaluations, and feedback as outlined in interactive multimedia learning that uses Internet connections to deliver virtual-based material and guidance [19]. Virtual Class Learning is also defined as a form of distance learning that is carried out via the internet virtually in cyberspace [20]; [21]. Virtual Class Learning makes it easy for users to get a lot of material from the internet and is based on virtual interactively between lecturers and students [22]. The advantages of this virtual classroom are high mobility, low price, and more interactivity (between users/students, users/students with programs, and users/students with other resource persons/assistant lecturers) [23].

Virtual classrooms use multiple media to recreate a physical classroom's structure and a learning experience [24]. The virtual classroom is a unique application of social learning [25]. So-cial learning involves understanding by interacting with other people [26]; [27]; [28]. The virtual classroom is needed to help teachers adapt to the learning carried out by students, provide community and special rules required by students, make learning in the classroom more familiar, and students have a high understanding. Learning can be done actively and free/flexible.

Educators are now using virtual classrooms to imitate a centuries-old teaching process precisely as they would in a traditional classroom [29]. Although the technology exists to allow virtual classrooms to expand beyond conventional (face-to-face) educational settings

and include practices that are not possible in a traditional classroom, this is not the case. It will likely take a few more years to become a common practice for virtual classrooms. Introducing new technology into a subject with established procedures and traditions is common.

METHOD

This research uses the bibliometric analysis method. This method effectively provides dataset information that policymakers, researchers, and other stakeholders can use to improve the quality of research [30]. The articles analysed in this study were taken from the Scopus database. Scopus was chosen because it is one of the complete journal databases and has high credibility in providing information on scientific research articles. The research was conducted using an online search from December 23, 2021, to January 12, 2022, with the keyword "Virtual Classroom" according to "title, keywords, and abstract."

This study adopted the bibliometric analysis of [31], which consists of (1) defining search keywords; (2) initial search results; (3) refinement of the search results; (4) compiling the initial data statistics; and (5) data analysis. Articles obtained from the Scopus database are downloaded in RIS format. Furthermore, to visualize and analyze trends in bibliometric form, VOSviewer software is used [32]. VOSviewer can display publication maps, author country distribution maps, journal maps based on co-citation, and keyword maps based on shared networks [33]; [34].

Defining Author Contributions

The search for articles used in the analysis was carried out from December 2021 to January 2022 using the keyword "virtual classroom", as shown in Table 1. The search process uses the Scopus database to collect data. Search the Scopus database only for articles from the journal with a period of 1972-2022. When defining the year, it starts from 1950, but the first article that appears is 1972, so the time range is 1972-2022.

Table 1. Initial Search Result

Initial search	Limit to					Number of Article
	Year	Search initial	Source type	Subject area	Keywords	
1	1972-2022	Virtual Classroom	All	All	All	7690

Initial Search

During the initial search, the researcher provided a limit from 1972 to 2022 according to step 3.1. The initial search found 7690 with no filters on source type, subject area, and keywords. It is done to find out the results of the initial investigation of articles with the initial search "virtual classroom." Table 2 displays the top ten articles containing the term "virtual classroom" based on the initial examination.

Table 2. Top Ten Unrefined Search Results From Scopus Database

Author/s	Title of the article	Publication year
Hones, G.H., Ryba, R.H.	Why not a geography of education?	1972
Wood, KW.	An investigation of CAI teaching methods in an electronics course	1982

Hiltz, Starr Roxanne	Virtual Classroom: Explorations of an online interactive learning space	1984
van Dam, Andries	Electronic classroom: Explorations of an online interactive learning space	1984
Hiltz, S.R.	The "Virtual Classroom": Using Computer-Mediated Communication for University Teaching	1986
Maxim, B.R., Elenbogen, .S.	Teaching Programming Algorithms Aided by Computer Graphics	1987
Meeks, Brock N.	A quiet revolution: Online education becomes a real alternative.	1988
Hiltz, S.R.	Collaborative learning in a virtual classroom: Highlights of findings.	1988
Silverman, B.G., Chang, J.S., Feggos, K.	Blackboard System Generator (BSG): An Alternative Distributed Problem-solving Paradigm	1989
Hoffman Maginnis, Barbara	Computer conferencing at the University of Arizona	1989

Refinement of the Search Results

This stage is done by doing several times the filtering that has been obtained at the initial search stage. Screening of the criteria is carried out for several things, namely the search year range, source type, subject area, and keywords. The results obtained are shown in [Table 3](#).

Table 3. Refinement Search Result

Refine search	Limit to					Number of Article
	Year	Search initial	Source type	Subject area	Keywords	
1	1972-2022	Virtual Classroom	Journal	All	All	3404
2	2013-2022	Virtual Classroom	Journal	All	All	2381
3	2013-2022	Virtual Classroom	Journal	social sciences, computer sciences, engineering, art and humanities, psychology	All	2035
4	2013-2022	Virtual Classroom	Journal	social sciences, computer sciences, engineering	virtual reality, education, virtual classroom, engineering education.	559

In [Table 4](#), the number of papers in the initial search results is 2000, not 7690, and this is because the Publish or Perish software can only read data from the Scopus database as much as 2000 documents. Hence, the results are not detailed enough but can represent metric data compared with refinement search results. From [Table 3](#), the result is 405 articles which will be continued at the next stage for analysis. The references of the articles met the requirements of the screening criteria in the last nine years.

Table 4. Comparison Metric Between Initial And Refinement Results

Metric data	Initial search results	Refinement search results
Query	Journal, virtual classroom	Journal, virtual classroom from 2013-2022
Source	RIS/RefManager from Scopus	RIS/RefManager from Scopus
Papers	2000	405
Citations	18729	5647
Years	29	9
Cites_Year	645.83	627.44
Cites_Paper	9.36	13.94
Cites_Author	8669.25	2077.80
Papers_Author	951.40	174.00
Authors_Paper	3.00	3.28
h_index	59	35
g_index	98	65
hc_index	42	37
hI_index	20.01	8.81
hI_norm	39	19
AWCR	2911.80	1506.65
AW_index	53.96	38.82
AWCRpA	1226.68	533.41
e_index	66.00	47.74
hm_index	42.31	20.97
QueryDate	22/03/2022 16:36	22/03/2022 16:21
Cites_Author_Year	298.93	230.86
hI_annual	1.34	2.11
h_coverage	41.8	62.1
g_coverage	51.5	76.7
star_count	45	33
year_first	1993	2013
year_last	2022	2022
ECC	18729	5647
acc1	651	229
acc2	377	164
acc5	137	80
acc20	13	10
hA	18	15

Compiling the Initial Data Statistics

After filtering, the search results are then downloaded and entered the Mendeley reference manager in RIS format. This step loads all critical information with these articles, including title, author's name, abstract, keywords, year of publication, volume, edition, and pages. It can be classified based on the year of publication source and publisher. From a query that used a maximum period, 7690 articles were obtained, while 405 journal articles were from 2013 to 2022.

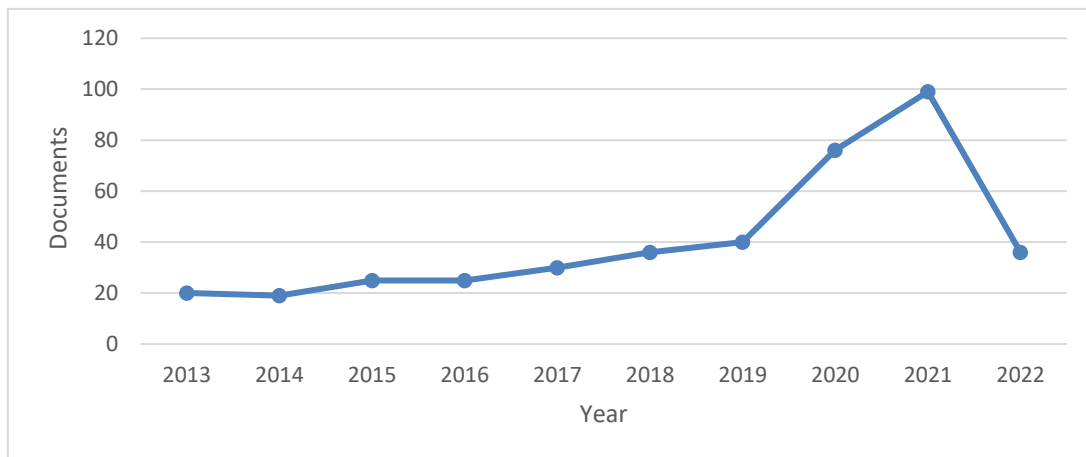


Figure 1. Documents By Year

Figure 1 shows that the keyword virtual classroom research development has increased yearly. In 2013 there were 21 articles, although, in 2014, it decreased to 19 articles, there was a significant increase in the following year. Until 2021, there will be 98 articles. From 2022 until March, there were 36 articles. It shows that there are still many potentials that can be developed from the topic of virtual classrooms. Figure 2 shows the top 10 journals that publish articles about virtual classrooms. The first rank was the journal Computers and Education with 26 articles, followed by the International Journal of Emerging Technologies in Learning with 19 articles.

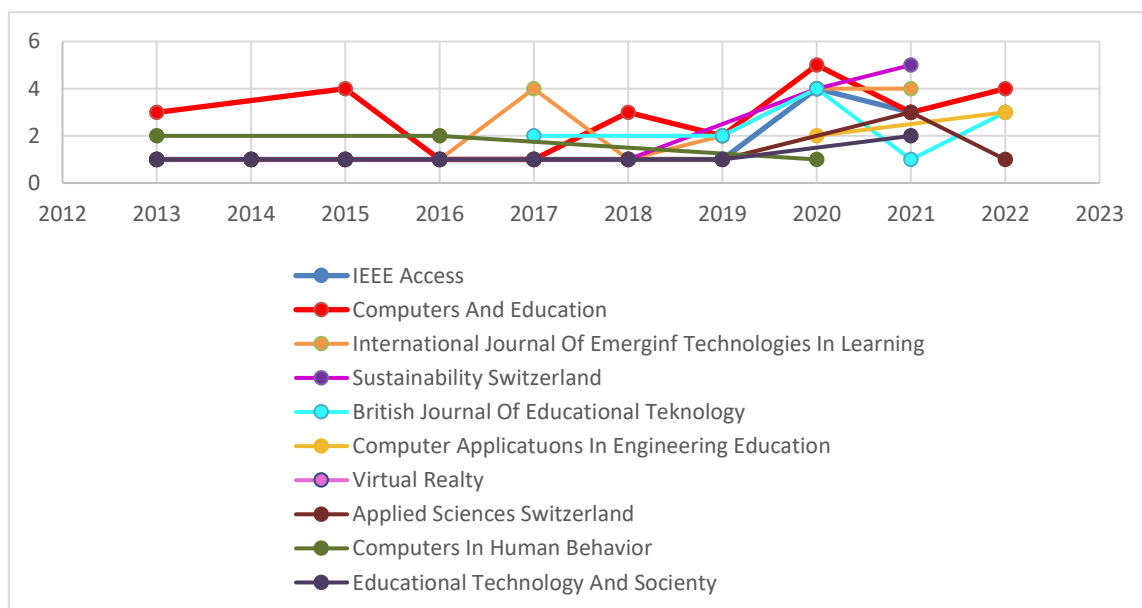


Figure 2. Documents Per Year By Source

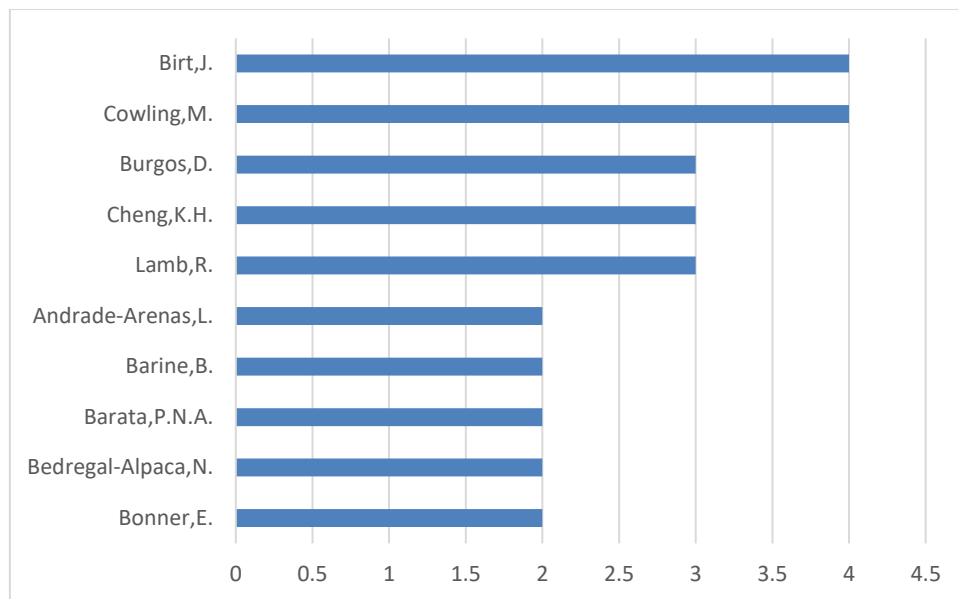


Figure 3. Documents by author

According to Figure 3, James Birt and Michael Cowling are the authors with the highest number of articles, namely four articles. It was followed by Daniel Burgos, Kun-Hung Cheng, and Richard Lamb, who produced three articles. It can be a challenge for other researchers to create articles with this theme from this data.

Figure 4 represents the dominance of the National Taiwan Normal University in producing the term virtual classroom. Other universities contributed by making four articles, namely Iowa State University, Tecnologico de Monterrey, National Chung Hsing University, University College London, National Taiwan University of Science and Technology, Bond University, University of Science and Technology Liaoning, and the International University of La Rioja.

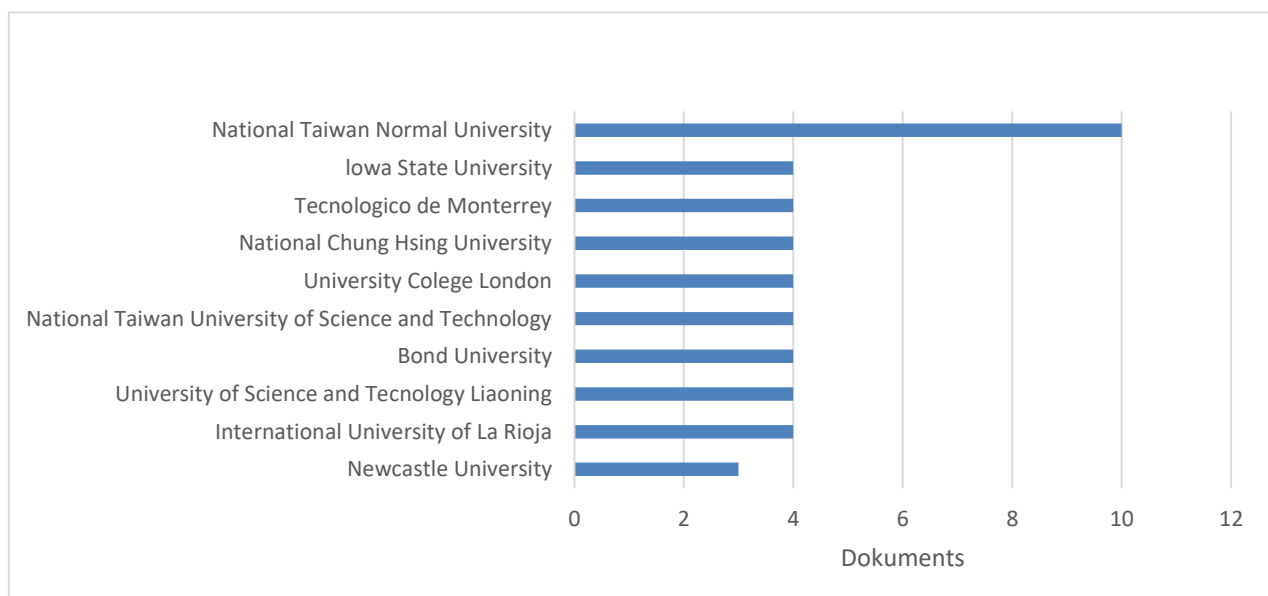


Figure 4. Documents by affiliation

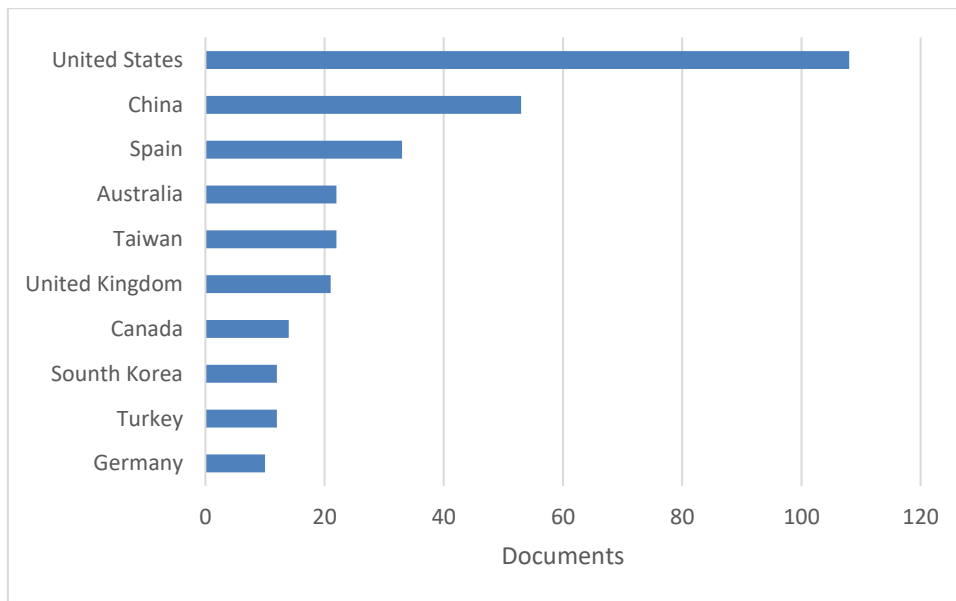


Figure 5. Documents by County or Territory

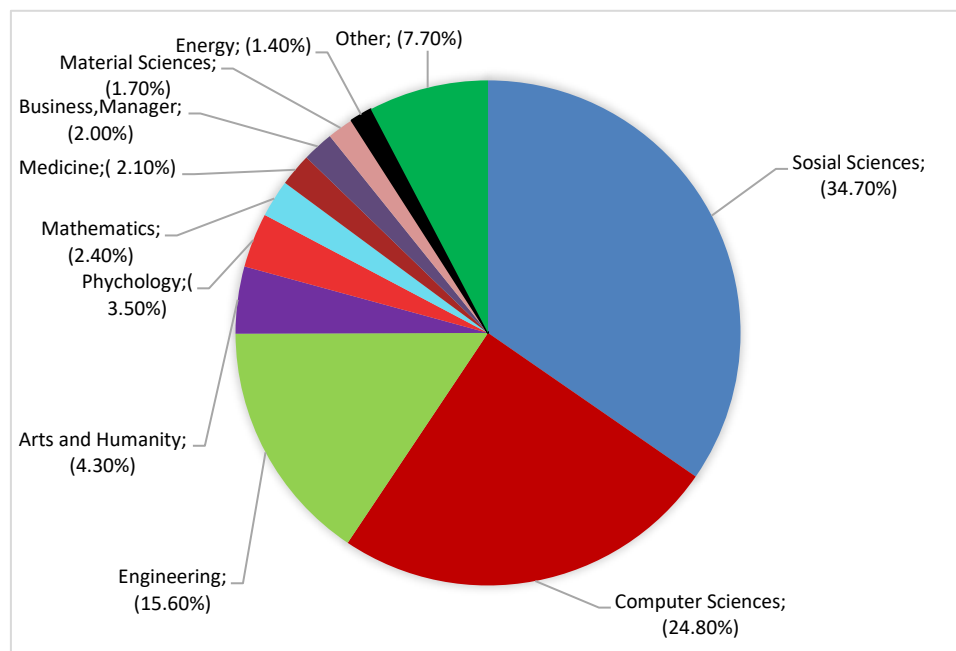


Figure 6. Documents by Subject Area

Figure 5 shows countries that contributed to research on virtual classrooms. The United States became the country with 107 documents, China with 56 papers, and Spain with 35 articles. The data obtained also show that only 1 document is produced for Indonesia, the same as for Singapore. Malaysia ranks first in the Southeast Asia Region and is followed by Thailand with four papers. Figure 6 shows the social science field with 34.7% or 281 documents—furthermore, 25.8% or 202 papers in the Scopus database from computer science. The third rank is the engineering field, 15.6% with 127 articles. From this data, it can be concluded that the social science field is the most significant contributor to research on virtual classrooms.

Data Analysis

The findings of a bibliometric analysis on the issue of virtual classrooms are presented in this research. Publish or Perish software version 8.2.3883.8074 was used for the bibliometric review in this paper. Professor Anne Wil Harzing founded Tarma Research Program Pty-Ltd Melbourne in 2006 and developed this software (Bensman 2011). Data from 7690 documents was retrieved because of data searches conducted on January 24, 2022.

Furthermore, following modifications, the results were 405 papers with 5647 cites/year, a decrease of 69.84 percent from 18279 cites/year based on the metric data in [Table 3](#). This research indicates that, compared to other journals, publications with a strong reputation have the most significant influence on citations. It is also accompanied by evidence of a change in the h-index from 59 to 35. [Table 3](#) contains the complete findings of the metric data comparison.

RESULT AND DISCUSSION

The findings of the keyword analysis serve as the foundation for mapping the critical or unique terms found in specific articles. Mapping is a method for identifying knowledge items and their configuration, dynamics, interdependencies, and interconnections. Knowledge mapping is used in technology management to define research programs, make decisions about technological activities, build the knowledge base structure, and create education and training programs, among other things. Science mapping is a method of visualizing a science subject related to bibliometrics. It is accomplished by generating a landscape map that can display science-related themes [\[35\]](#); [\[36\]](#).

VOS Viewer software can display the results of bibliometric mapping in 3 different types of views, namely: (1) network visualization, (2) visualization overlays, and (3) density visualization. After analyzing using VOS Viewer from the term virtual classroom, it can be divided into 6 clusters that show a relationship between one topic and another topic in the study.

Cluster 1 in red, consists of 30 topics: adolescent, adult, article, assessment, child, controlled study, covid-19, curriculum, distance learning, education, distance, female, flipped classroom, human, human experiment, humans, learning, major clinical study, male, medical education, medical student, nursing education, pandemic, procedures, psychology, questionnaire, skills, student, technology, and virtual learning environment. From cluster 1, the keywords education, learning, human, and article have a close relationship in this cluster.

Cluster 2, in Green, consists of 27 topics: architectural design, classroom, classroom teaching, colleges and universities, curricula, design, engineering education, head-mounted display, immersive, immersive virtual reality, multimedia system, pedagogy, physical education, science, and technology, surveys, teachers, teaching, teaching modes, teaching platform, technology acceptance, virtual environment, virtual learning environment, virtual reality, virtual reality technology, visualization, VR technology. In cluster 2, virtual reality is very dominant, marked by the largest circle, then teaching, engineering education, and virtual reality become a close relationship in this cluster.

Cluster 3 in Blue consists of 22 topics: academic performance, blended learning, collaborative learning, computer-aided instruction, control group, distance education, e-learning, educational technology, experimental groups, information management, internet, laboratories, learning, and teachings, learning management systems, learning processes, learning systems, online education, online education, software testing students, virtual classrooms, virtual laboratories. In cluster 3, e-learning, virtual classrooms, students, and computer-aided instruction have an eating relationship.

Cluster 4, in Yellow, consists of 20 topics: augmented and virtual realities, augmented and virtual reality, classroom environment, classroom management, human-computer interaction, human-computer interfaces, human-computer interface, improving classroom teaching, interactive learning environment, interactive learning environments, learning environments, media in education, motivation, secondary education, serious games, simulations, simulations, teacher education, teaching/learning strategies, and teaching/learning strategies. In cluster 4, improving classroom and interactive learning environment has a very close relationship.

Cluster 5, in purple, consists of 17 topics: 3D printing, augmented reality, education computing, emerging technologies, experiential learning, higher education, interactive computer graphics, mixed reality, mobile learning, Moodle, personal training, social presence, teaching-learning process, three-dimensional computer graphics, university students, user experience, and virtual worlds. In cluster 5, augmented reality and education computing appear to be very dominant and close relationships.

Cluster 6 in blue sea consists of 5 topics: artificial intelligence, classroom learning, online learning, teaching, and learning. With so few issues appearing in cluster 6, the opportunity to develop related research themes is still very wide open.

The display of the results of the bibliometric analysis shows that keywords are labeled with circles with different colors. The size of the process is related to the frequency with the keyword appearing in the title and abstract. Furthermore, the frequency of occurrence affects the size of the letters and circles. The more often the keyword appears, the larger the size of the letters and circles. The density visualization display is an item (label) marked the same as the visible item. Each item point has a color that depends on the item's density at the time. It identifies that the color of a point on the map depends on the number of items associated with other items. This section is handy for obtaining an overview of the general structure of a bibliometric map by paying attention to the things that are considered essential for analysis. We can interpret the most used keywords in a publication through this worksheet. [Figure 7-9](#) results from a bibliometric analysis based on three views. The keywords that appear most often are virtual reality, e-learning, student, virtual classroom, education, engineering education, computer-aided instruction, virtual reality technology, and learning systems. This data can be seen and traced the novelty of research related to the term virtual classroom. An example is research that discusses the role of virtual reality technology in vocational education that has not been widely studied. Therefore, researchers can give their role and contribution in the development of virtual reality technology for learning, especially in vocational education. The studies that have been carried out do not specifically mention the keyword virtual classroom for vocational education. Still, there is no specific mention of the word vocational from the keywords that appear. So, indirectly, the vacancy of research on virtual classrooms for vocational education is still a lot of topics that can be researched, especially in areas that support the improvement of students' work skills.

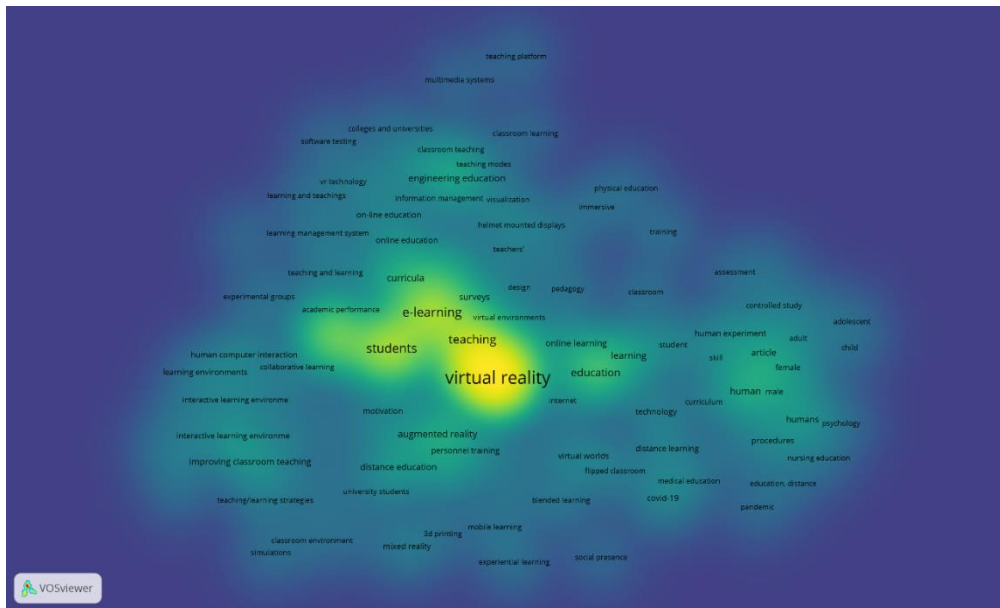


Figure 9. Density visualization

CONCLUSION AND FUTURE WORK

This study reviewed 405 articles on topics related to virtual classrooms. The articles are retrieved from the Scopus database. The search results from Scopus were then analysed using Publish or Perish software. The 405 articles obtained resulted from screening from 7690 articles obtained based on the initial search. The metric data shows 5647 citations of 405 articles, then the h-index decreases from 59 to 35. This study also provides information that articles from journals with good reputations have a dominant impact on virtual classroom research. The gaps presented in this bibliometric analysis offer excellent opportunities for future research on virtual classrooms concerning implementation in vocational education. The data obtained also show that the articles analysed have indirectly discussed the role of the virtual classroom in vocational education learning, although in detail.

Overall, research on the development of virtual classrooms using virtual reality technology is increasing. However, there is still a dominance of several countries and universities that contribute highly to producing articles. The analysis results also allow universities and developing countries to increase research on virtual classrooms, which are very open due to the covid and post-covid pandemic situations. The trend of using virtual classrooms will also continue to grow, explanations from several articles related to the post-covid case.

This research also has shortcomings due to the limitations of the Publish or Perish software which can only analyse 2000 documents from search results via Scopus. Furthermore, further research should use more article data from several sources, not only Scopus. Different software is also recommended to compare analysis results (PRISMA, Pajek, BibExcel, and CitNetExplorer).

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