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Research productivity on science learning: a bibliometric study international from 2013 to 2023

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ABSTRACT

This research focuses on evaluating research productivity in the realm of science learning using various bibliometric indicators. A total of 4,942 scientific publications were taken from the Scopus database from the period 2013–2023, applying related keyword searches. The result is presented in graphical form. Studies also use VOSviewer and Biblioshiny tools through R to evaluate network visualizations and find the most prolific authors, number of publications and citations, country representatives, organizational and university contributions, publishers, and frequently appearing words. The results reveal a growing trend in total publications in the past 10 years of research. Out of a total of 4,942 scientific publications, NA NA is one of the most prolific authors. The USA and China are the most productive countries when it comes to publishing research in the field. The University of California, National Taiwan Normal University, and Purdue University are reported to be the top three productive organizations in the field of science learning. The study also looked at collaboration and cooperation between authors, countries, and organizations in visualization analysis. The results of the word that often appears are reported to be that science, education, learning, and effects have maximum link strength.

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1. INTRODUCTION

Education is one of the frontlines of each country. Quality education produces a quality country because the quality of the country is determined by future generations [1], [2]. One of the efforts is to improve the quality of education. The quality of education in the era of Society 5.0 is currently based on technology and big data [3]. Technology that is very significant in its development makes it easier for education to be widely spread and makes it easier to find references [4], [5]. Some of the references relied on at this point are scientific articles [6], [7]. Scientific articles are produced from various studies. The benefits of scientific one of the main benefits of scientific articles are that they help researchers publish the results of their research so that they can be accessed and utilized by other researchers around the world [8], [9]. One way of analyzing scientific articles is through bibliometrics [10], [11].

A bibliometric study is the study of the quantity and quality of scientific publications using bibliographic data that can measure the impact and influence of an article or journal on the scientific community [12], [13]. Bibliometric studies are often conducted using bibliographic data from scientific databases, such as Web of Science, Scopus, or Google Scholar, to measure the performance and impact of scientific publications [14]. Several researchers have previously conducted bibliometric studies in the Journal Science & Technology Libraries on science for the 2013-2022 period, including Analysis for Science Librarians [15], [16], Introduction to Altmetrics for Science [17], Profiles in Science for Science Librarians [18], Reviews of Science for Science Librarians [19], Analysis for Science Librarians of the Nobel Prize in Physics [20], Analysis for Science Librarians of the Nobel Prize in Physiology or Medicine [21], Analysis for Science Librarians of the Nobel Prize in Chemistry [22], and Science Librarians Seeking to Serve their Students [23]. Some of these studies have shown the importance of studying science. Science is one of the benchmarks in PISA assessments worldwide. PISA is the OECD International Student Assessment Program [24]. PISA measures the ability of 15-year-olds to use their reading, math, and science knowledge and skills to deal with real-life challenges. Science learning starts in elementary school and continues through high school [25], [26]. This shows the importance of applying scientific learning in everyday life [27].

Science learning is the process of acquiring knowledge, skills, and understanding of science that involves observation, experimentation, and analysis [28], [29]. Science learning aims to develop students' abilities in problem-solving, critical thinking, and data analysis [30]–[32]. In addition, science education teaches students to use the scientific method to solve problems and collect data [33]. Students also learn how to create hypotheses and test those hypotheses with the proper scientific method [34], [35]. During the science learning process, students learn about various science concepts, such as physics, chemistry, and biology [36], [37]. Students learn about the structure and function of objects in the universe, living beings, and how living beings interact with their environment [30], [32], [38]. Students learn about biodiversity, solar systems, chemical processes, and more [39]. In addition, science learning can also help students understand the role of technology in everyday life. Students can learn about information technology, medical technology, energy technology, and environmental technology [40]–[43]. Students can also learn about the social, economic, and environmental impacts of technology and the process of managing those technologies responsibly [5], [32].

Science learning can also help students acquire practical skills such as observing, experimenting, and measuring [44]. Students learn to conduct experiments correctly, observe the results, and analyze the data obtained [45], [46]. Students learn how to work with science tools and technologies used in laboratories, such as microscopes, pipettes, and scales [47], [48]. In addition to practical skills, science learning also helps students build social skills such as cooperation, communication, and leadership [49]–[52]. In the process of learning science, students often work in groups that require the ability to cooperate and communicate with others. Students also learn how to effectively present the results of their research and discuss their findings with others [53], [54]. In addition, science learning can help students build curiosity and interest in science [55]–[57]. When students learn about science concepts and conduct experiments, they can develop a deep interest in a particular topic [58]. This can open up opportunities for careers in science and technology and inspire students to become qualified scientists in the future [59]. The importance and many benefits derived from science learning make bibliometric research on science learning necessary to be carried out internationally [15], [40]. A bibliometric analysis is employed to gauge the comparative influence of a particular subject area, utilizing various standards to examine published data [60]–[62]. The current research utilized VOS viewer and Biblioshiny via R programming to examine research data, aiming to assess the research output within the field of digital evidence within the extensive Scopus index database.

Earlier studies focused on bibliometrics within physics, chemistry, science librarianship, and an introduction to altmetrics for science. In contrast, this study delved into analyzing research data spanning from 2013 to 2023, employing VOS viewer and Biblioshiny via R programming to scrutinize research performance within the domain of digital evidence across the extensive Scopus index database. The study's objectives encompass: i) investigating the yearly output of scientific literature in science education concerning total publications (TP) and total citations (TC) shared; ii) identifying prominent authors, prolific sources, and active organizations within the scientific education realm; and iii) utilizing VOSviewer and Biblioshiny in R to comprehend bibliometric network visualizations, encompassing citation patterns of documents and nations, country co-authorship, cocitation of references, and keyword co-occurrence analysis within the digital evidence field.

2. METHOD

2.1. Data sources

We opted to utilize Scopus.com as our primary data source for the search. Scopus encompasses an extensive array of academic journals within the natural sciences and stands out as one of the most reputable databases for bibliometric investigations. Moreover, it offers reference files in diverse formats, directly catering to the requirements of bibliometric software. The data extracted from the Scopus database for this study, spanning from 2013 to 2023, on the topic of science learning, has been widely employed by numerous researchers for bibliometric inquiries [13], [14], [60]–[62]. Data is collected from various types of publications, such as articles, conference papers, reviews, book chapters, books, conference reviews, and editorial notes and letters available on Scopus.

2.2. Search strategy

The included bibliography must be a genuine article or review. Researchers perform bibliographic searches independently and download bibliometric data in plain text format. The search strategy is set as follows: TS (topic)=(*science leaning* AND *Language=English*). A total of 24,945 publications were found as final results based on the filter, A total of 4,942 publications were selected as the final dataset for subsequent analysis, following the exclusion of document types such as editorial material, corrections, conference proceedings, and correspondence. A bibliographic search and data retrieval were performed on February 13, 2023, to mitigate any potential bias stemming from database updates. This study uses VOSviewer to study network relationships and visualizations, as this tool is widely used in visualization evaluation in bibliometric studies [13], [14]. Based on the preliminary results obtained, we applied the PRISMA methodology [63] to refine our search as presented in Figure 1. This helps to systematically include relevant documents and exclude those that are outside the scope of our research.

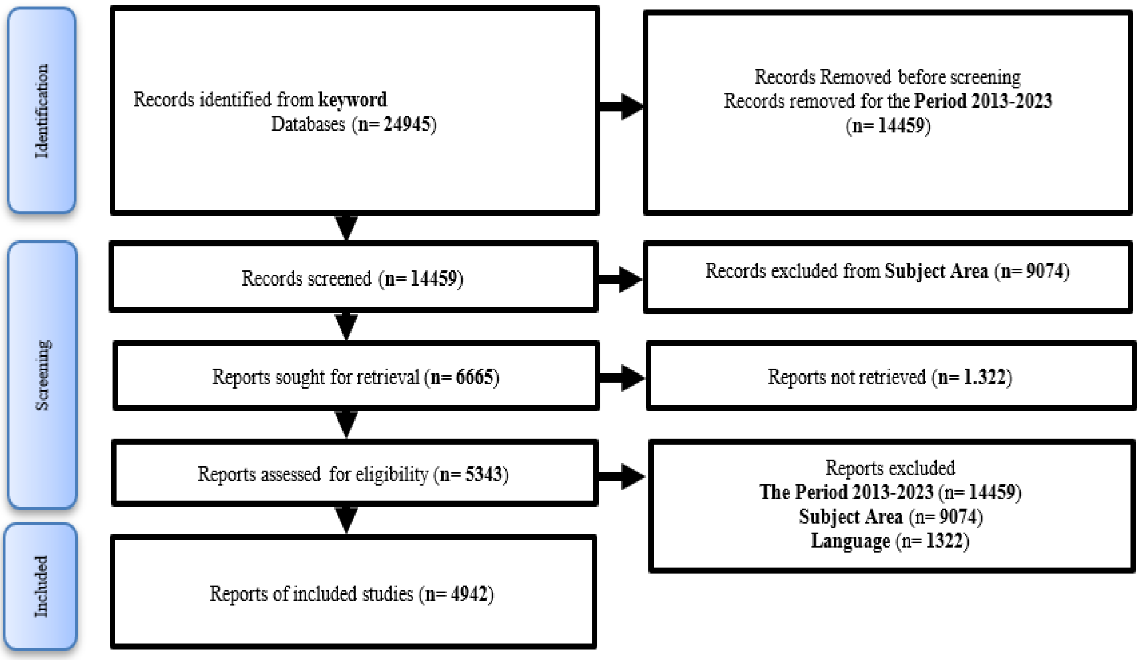

Figure 1. PRISMA flowchart for recording the relevant papers from the above searches [64]

2.3. Data collection and analysis techniques

Bibliometric metrics of publications are condensed, encompassing publication counts, sources, authors, affiliations, countries, commonly occurring terms, and collaborations. A publication is categorized as a multi-country publication (MCP), indicating collaboration between authors from at least two countries, while a single-country publication (SCP) denotes intra-country collaboration. We conduct an exhaustive bibliometric analysis using VOSviewer (version 1.6.19), bibliometrics based on R software (version 4.2.2), and an online analytics platform (bibliometric).

3. RESULTS AND DISCUSSION

3.1. Distribution of the most prolific authors

The current study considers 4,942 scientific publications. Figure 2 illustrates the outcomes regarding the top 10 most productive authors within the realm of science learning, along with their contribution to the overall publication count. According to the TP figures, the top 10 authors with the highest productivity have each published a minimum of 13 papers in this domain. It was observed that the highest article was published by NA NA, followed by Wang X, Li X, Li Y, and Liu Y, Wang Y and Zhang X, Li J, Wang J, and Wang L.

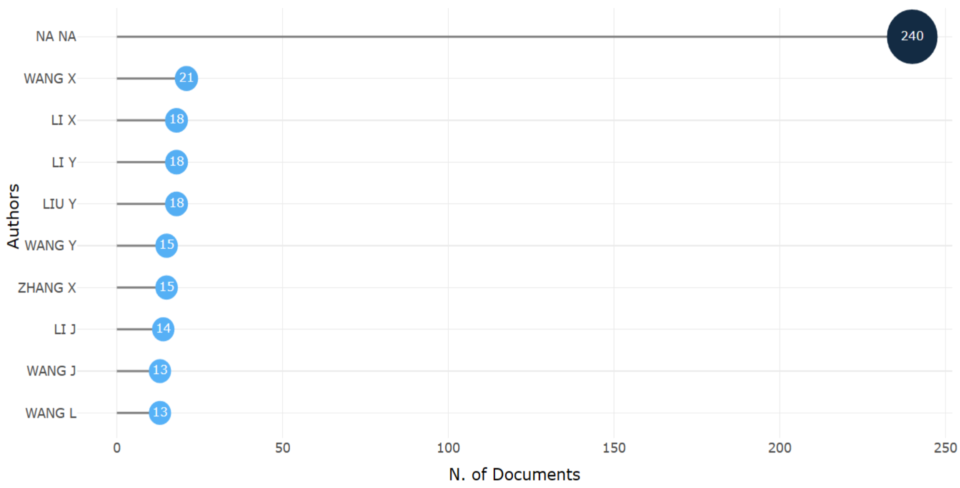

Figure 2. The distribution of the 10 most prolific authors

3.2. Distribution of the large production of scientific documents and citations per country

The current study considers 4,942 scientific publications. Figure 3 shows 20 countries with a large number of documents published in chronological order. The number of documents and countries, from highest to lowest, are the USA (more than 900 documents), China and Turkey (more than 300 and less than 900 documents), Germany, Spain, the United Kingdom, Australia, Korea, Canada, the Netherlands, Brazil, Malaysia, Iran, Indonesia, Italy, South Africa, Sweden, Japan, and Portugal (less than 300 documents). Figure 3 depicts a large number of documents with the colors blue and red. The red color indicates MCP (multiple countries publication) and the blue color is SCP. In MCP, the superior country is China over the USA. While in SCP, the most superior country is the USA compared to China. In general, most publications are in the US, and the lowest publication position is in Portugal. They utilize geographical distribution search aids to identify the prevalence of publications within a specific country. Excerpts from documents highlight their visibility and importance as academic reference materials, with documents accruing more citations being regarded as more influential within a given topic [65], [66].

Figure 4 relates to Figure 3, which shows 20 productive countries in science learning publications. Figure 4 reveals the 10 countries that have the most citations. The countries in question are the USA (27,138 citations), China (5,476 citations), Germany (4,749 citations), the United Kingdom (3,389 citations), Turkey (3,318 citations), Spain (2,890 citations), the Netherlands (2,832 citations), Canada (2,312 citations), Australia (2,168 citations), and Sweden (1,278 citations). The country that excels in citations is the USA, while the lowest is Sweden. Although Sweden has the third-lowest number of documents, it has more citations than Korea. The second indicator examined and presented was the evolution of source documents associated with the specified keywords. Over time, there has been a steady rise in the diversity of backgrounds within the context of disaster education. The number of documents linked to these keywords exhibited consistent growth, extending until December 2021. Another interesting fact is that Sweden has the third lowest number of documents, it has more citations than Korea. Indonesia ranked 14th in terms of the highest number of published documents but did not feature among the top ten countries with the most citations. It's important to note that the number of citations does not always directly correlate with the number of documents originating from a specific country. This discrepancy arises because not all documents from a country are referenced by other researchers.

3.3. Distribution of highly productive institutions

Figure 5 shows the top 10 most productive institutions identified based on a minimum total of 40 research articles published in the science learning domain. Highly productive institutions with several publications include the University of California (108 articles), which leads in the domain of science learning, followed by the National Taiwan Normal University (67 articles), Purdue University (62 articles), the University of Michigan, Stanford University, Michigan State University, the University of Toronto, Arizona State University, Notre Dame, and Beijing Normal University (less than 60 articles). The University of California is in the USA, which corresponds to the country that has the highest number of publications and citations (Figures 3 and 4). Another fact found is that universities in Indonesia are not included in the category of 10 productive countries in terms of science learning publications. This is a recommendation in the next publication so that science education needs to be considered and researched more.

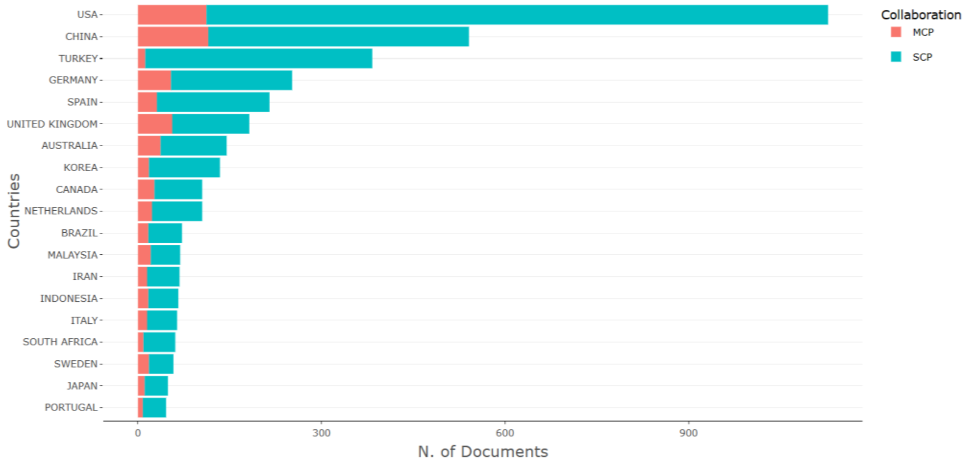

Figure 3. Country-wise scientific production

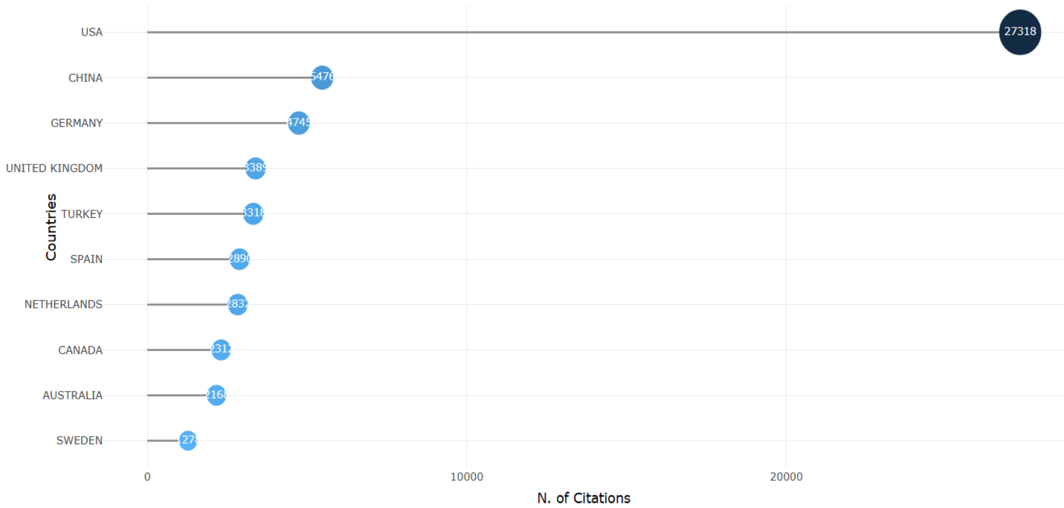

Figure 4. The relationship of the state with the multiplicity of citations

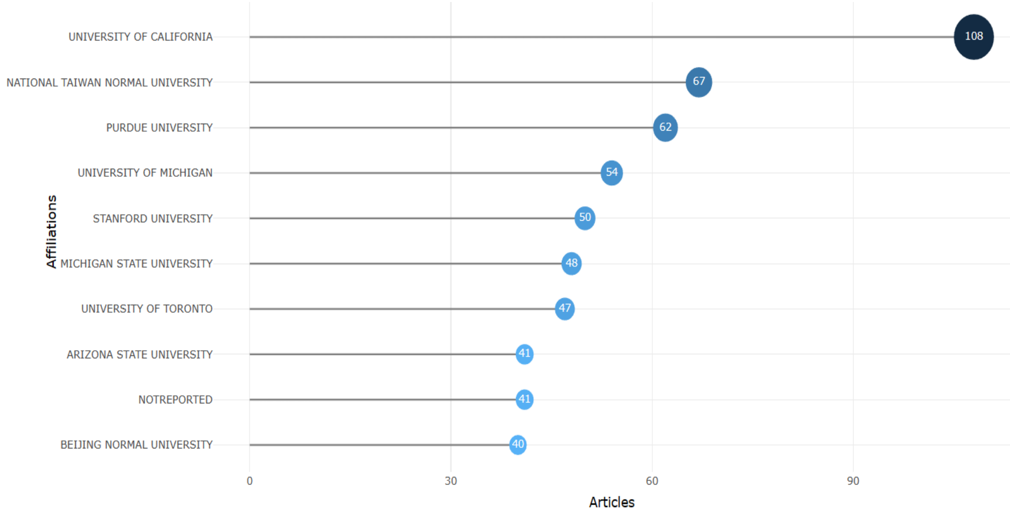

Figure 5. Most relevant affiliations

3.4. The most relevant publication source

The top 10 most productive publication sources are identified based on a minimum of 59 total research documents published in the science learning domain. Figure 6 shows highly productive sources of publication based on the number of publications. The most prolific source in the science learning domain is the Journal Computer and Education (120 documents); the journal is indexed in Q1. Furthermore, the Journal PLOS One (120 documents) indexes Q1. The top two journal sources from the USA correspond to the country that has the highest number of affiliates, publications, and citations (Figures 3, 4, and 5). The tenth place of publication sources in the Journal Research in Education Journals from the Netherlands is indexed in Q1. According to Figure 4, the United States leads with the highest number of article publications, surpassing 68 other countries with a total of 45 articles. Figure 5 illustrates the citation count of documents originating from the United States.

3.5. Number of articles each year

The five most prolific countries of publication from 2013 to 2023. The USA country leads in the most articles published every year until the last 3 years when every year 3,000 articles are published. It has published over 3,000 articles in 2023, which is still in February. Germany, Spain, and Turkey from 2013–2023 published less than 1,000 articles. In the past two years, China has published more than 1,000 articles. This shows that the topic of science learning is very interesting to be discussed in various countries, both at the elementary, junior high, high school to college levels. Another fact finding, Indonesia has not entered the 5 productive countries based on the most articles in the last 10 years.

3.6. The most frequent words

This study uses a word that often appears for network visualization in science learning. Analysis of frequently appearing words provides current research trends. Figure 7 illustrates the co-emergence of a word that often appears using bibliophily. Studies in bibliophily set a maximum of 10 frequently occurring words. The top three keywords are science, education, and learning. Figure 8 shows Figure 7 using the VOSviewer tool. This study set a limit of at least 20 words that often appear to create visualizations. Based on the treemap in the science learning publication, it is shown that education has the highest percentage because learning is one of the important components of education. The next percentage is students who have an important role as subjects in science learning.

This study used a word that often appears for network visualization in science learning. Analysis of frequently occurring words provides current research trends. This analysis was done by measuring the co-occurrence of keyword pairs [67]. Most words appear as science, practice, and effect. Red indicates older data, yellow indicates new data and green indicates newer data. The oldest data is from 2013 and the latest in 2023. Based on the tree map in science learning publications obtained from bibliophily, it is shown that education has the highest percentage because learning is one of the important components of education. The next percentage is students who have an important role as a subject in science learning.

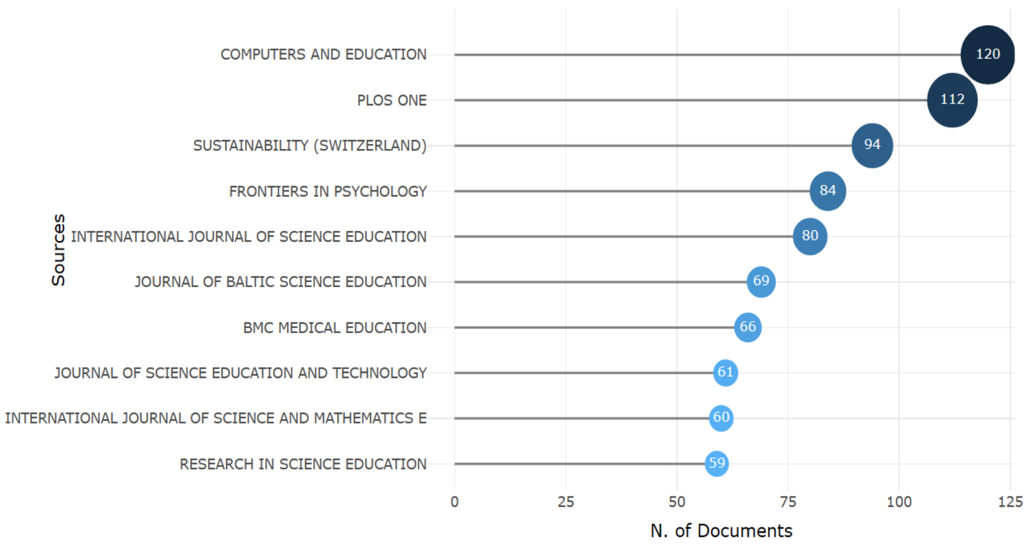

Figure 6. The most relevant publication source

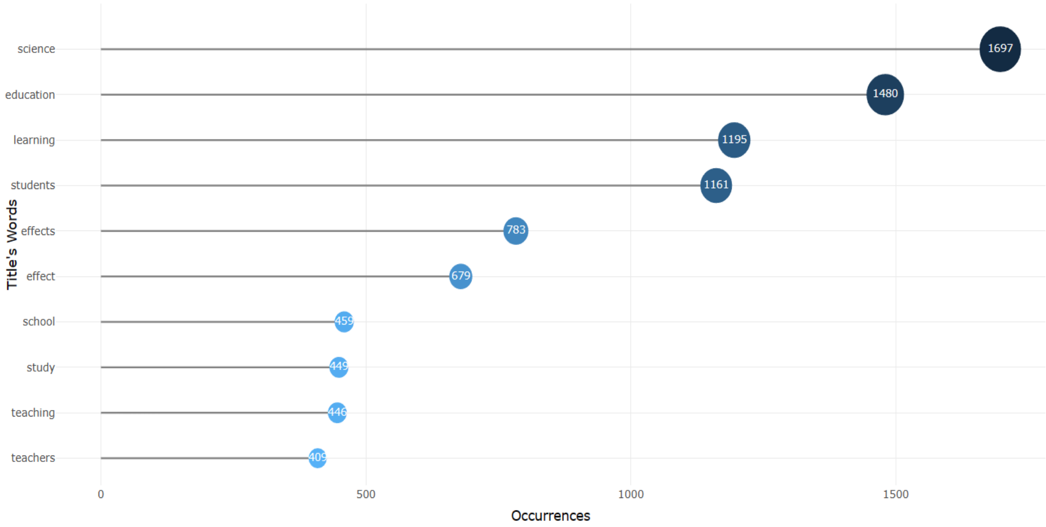

Figure 7. The most frequent words

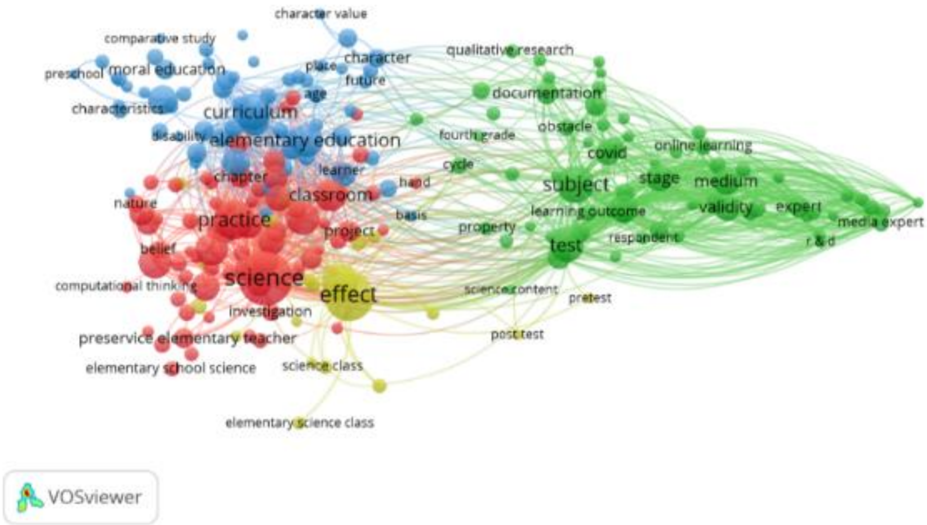

Figure 8. Visualization of co-occurrence of keywords

4. CONCLUSION

This research satisfies efforts to investigate research performance in the domain of science learning by referring to bibliometric analysis and network visualization carried out with the help of VOSviewer and Biblioshiny tools through R. Research domains are analyzed based on the most productive authors, the number of publications and citations, country representatives, organizational and university contributions, publishers, and frequently appearing words. Of the 4,942 documents taken from the most prolific author, Scopus NA NA, with a total of 240 articles, In the last ten years, the United States has produced the most publications and citations in the field of science learning. In network analysis, institutional collaboration and cooperation are also observed in the domain. The co-occurrence results of the word that often appears are useful for subsequent research. Science, education, learning, students, and effects are words that come up frequently and have maximum link power. Because this study has taken data using the Scopus bibliographic database, however, some journals from this domain are not fully covered in Scopus; therefore, further research can be done, including documents covering Scopus and the Web of Science, that can provide a clearer and more comprehensive picture of the development of science learning.

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