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Bibliometric Analysis: Sofware Usage Trends GeoGebra in Mathematics Learning From 2017 - 2022

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Abstract

The use of GeoGebra Software in mathematics learning is the application of ICT-based learning that can be done in schools. This is done to make learning interactive. This study aims to determine and analyze trends in article writing with the theme of using GeoGebra software in mathematics learning between 2017-2022, articles, countries of origin, authors, and institutions that have the most citations and link strengths using databases. dimensions. The method used is bibliometric analysis. The sample used is 180 articles that were searched using the database dimensions according to the specified keywords. The data is stored in CSV format to be used in the VOSviewer software to obtain a mapping in search of publication trends. The trend of writing articles with the theme of using GeoGebra software experienced a significant increase between 2017 and 2021 by 279%. Analysis based on software VOSviewer has 5 themes related to the use of GeoGebra software in mathematics learning, namely: "control group", "concept", "medium", "subject", "analysis", and " article" which is still rarely researched and is a theme in the renewal of research. This theme is used as reference material for further research.

Keywords: bibliometric, dimensions, Geogebra Software, mathematics learning, VOSviewer

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INTRODUCTION

The development of technology today is very fast. Almost all sectors are affected by the development of this technology. The education sector is one of the sectors experiencing the impact of technological developments. One of the technologies that can be used in the education sector is a computer/laptop. Computers are interactive learning media because they can be filled with software that helps the mathematics learning process, including SPSS, Maple, Matlab, GeoGebra, Microsoft Mathematics, and others. (Ekawati, 2016)

Using interactive media in the learning process helps students understand the material. According to Nursanti et al., (2015) that the use of technology-based learning media facilitates the learning process, improves the quality of learning and improves students' ability to express mathematics. The application of ICT-based media in learning mathematics makes it easier for students to understand mathematical concepts and procedures, as well as identify and solve mathematical problems. (Sivakova et al., 2017) Use of software GeoGebra is one of the applications of ICT-based learning media that can be used in the learning

process. The use of GeoGebra software can be used in geometry, algebra, and calculus materials. (Hohenwarter et al., 2008)

Research on the GeoGebra software has been widely carried out both domestically and abroad. Based on the results of previous research, shows that the use of the software GeoGebra in the learning process can help students in the learning process. The results of Ekawati research (2016) show that GeoGebra software can help teachers deliver learning materials so that students can be actively involved in learning which makes learning meaningful. In line with this, according to Mawarsari & Purnomo's research (2017), it was revealed that a learning model that uses e-learning- based GeoGebra software can improve students' process skills and problem-solving abilities. The results of Ocal's research (2017) also reveal that learning using the GeoGebra software learn meaningful and conceptual.

The theme of using GeoGebra software in learning mathematics is very interesting because it reveals the usefulness of learning using GeoGebra software. Themes related to the use of GeoGebra software can be analyzed using bibliometrics. Bibliometric analysis is needed to update research information in the field of mathematics. (Julius et al., 2021). Based on the research results of Supinah & Soebagyo (2022) states that there are four themes related to the use of ICT which are rarely researched, namely: "memory aid", "effectiveness", "grade", and "mathematics education". In line with this, according to the research results of Sari et al., (2022) states that there are several themes that are rarely researched related to GeoGebra software and problem solving abilities, namely *"research"*, *"implementation"*, *"strategy"*, *"process"* , *"mathematics teacher"*, and *"mathematical concept"*. These themes can become research opportunities in the future. Bibliometric analysis is also used to find trends, gaps, and updates on a research topic. This can be the basis that mathematical research can have a good effect because it has renewability.

Based on this, the researcher feels the need to conduct a bibliometric analysis to be able to reveal more about the trend of using GeoGebra software in learning mathematics using databases dimensions. The purpose of this study is to find out and analyze trends in article writing with the theme of using GeoGebra software in mathematics learning between 2017 – 2022, articles, countries of origin, authors, and article-producing institutions that have the most citations and link strength. Several things made a difference in this research, namely the scope of ICT which is meant only research related to the use of GeoGebra software which is limited from 2017 to 2022.

METHOD

The research method used in this study is bibliometric analysis related to the use of GeoGebra software in learning mathematics. According to Tambunan (2013), bibliometrics is the application of statistical and mathematical methods to books and other communication media. The bibliometric analysis also studies quantitative aspects and recorded information (Nani & Sensusiyati, 2021). In this study, the bibliometric analysis used is descriptive bibliometric which describes the characteristics or characteristics of literature. Bibliometric analysis techniques are divided into 2 categories, namely, work analysis and mapping. (Donthu et al., 2021)

Data collection is done using database dimensions on October 13, 2022, with the keyword " GeoGebra in mathematics educations " with the publication year 2017 – 2022 and the publication type being article.

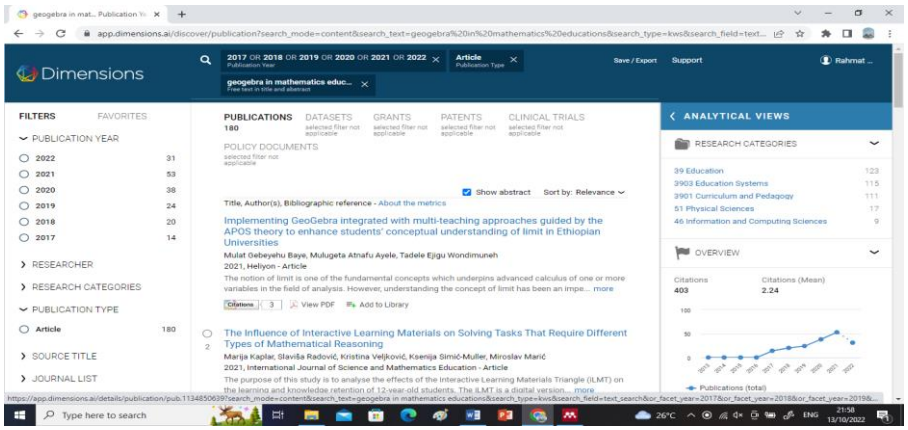

Figure 1. Tracing the Dimensions Database Database

Based on the search there are 180 articles obtained from 2017 – 2022. This data is saved in CSV format for use with the VOSviewer software. VOSviewer is used for mapping when searching for trends in scientific publications using Dimension's database about using Geogebra software in learning mathematics based on keywords..

RESULTS AND DISCUSSION

The bibliometric analysis in this study refers to (Donthu et al., 2021; Ellili, 2022). The results of the bibliometric analysis in this study are based on 2 categories, namely performance analysis in the form of the number of publications each year, the country with the highest number of articles, the country with the highest number of citations, journal-producing institutions; and science mapping in the form of Circles Network Visualization, Frames Overlay Visualization, Density Visualization.

Data from the search results for articles with database dimensions related to the trend of using Geogebra software in mathematics learning from 2017 to 2022 has fluctuated as shown in the following figure:

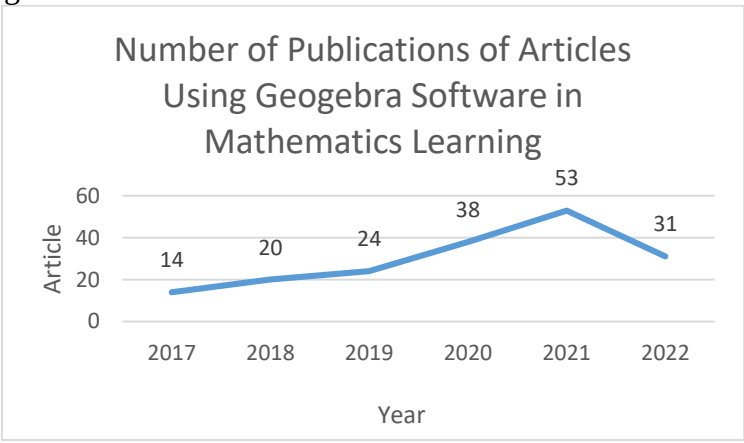

Figure 2. Number of Publications of Articles Using GeoGebra Software in Mathematics Learning

Based on the data in Figure 2, the number of articles in the period 2017 to 2021 experienced a significant increasing trend from the original 14 articles until 2021 there were 53 articles or an increase of 279%. However, until the end of 2022 when this bibliometric analysis was carried out, the number of articles published using the GeoGebra software in mathematics learning decreased compared to 2021 from 53 articles to 31 articles or decreased by 42%.

On the author's part, the researcher uses a threshold for the minimum number of publications for an author 2 and the threshold for the minimum number of citations is 1. So of the 462 authors who meet the two thresholds, 16 authors. Of the 16 authors, the most

publication with several publications is 5, occupied by A. Septian. Furthermore, the highest citations with 24 citations were achieved by Miroslav

Marić, Slaviša Radović, and Kristina Veljković. Then for link strength, the first position is occupied by Sufyani Prabawanto and A. Septian with a total link strength of 5. More details are explained in the following Table 1.

Table 1. Distribution of Co-Authorship (Author)

No	Writer	Number of Publications	Number of Citations	Total Link Strength
1	Miroslav Marić	2	24	4
2	Slaviša Radović	2	24	4
3	Kristina Veljković	2	24	4
4	Zoltan Kovacs	3	21	0
5	Zsolt Lavicza	2	20	0
6	Tetiana H. Kramarenko	2	16	2
7	Olha S. Pylypenko	2	16	2
8	Sufyani Prabawanto	4	20	5
9	Darhim	2	6	4
10	A. Septian	5	10	5
11	Syariful Fahmi	3	4	3
12	Soffi Widyanesti Priwantoro	3	4	3
13	Endang Istikomah	2	4	0
14	Jesi Alexander Alim	2	2	2
15	Zetra Hainul Putra	2	2	2
16	Ruzlan Md-Ali	2	2	0

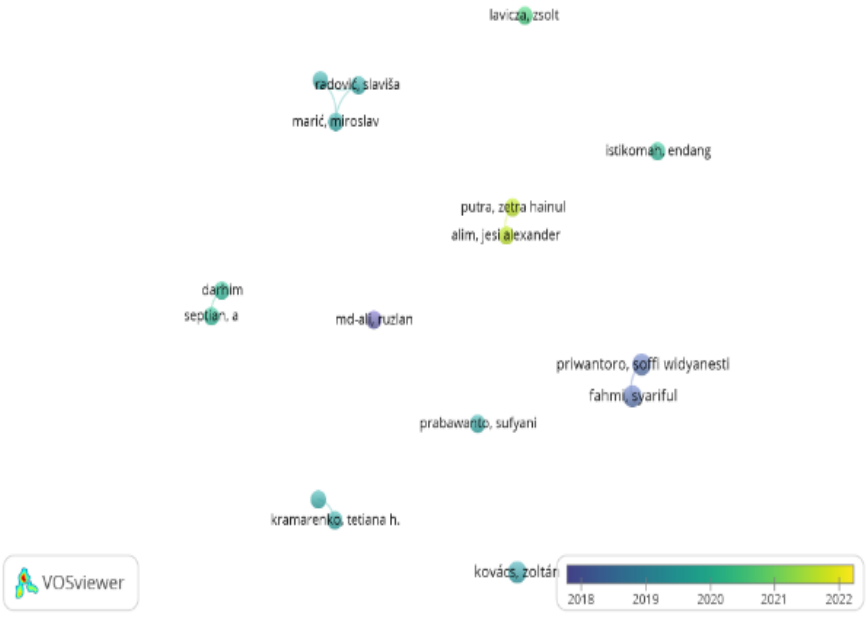

Figure 3. Overlay Visualization Co-Authorship (Author) Display

Based on the overlay visualization display on VOSviewer, it was found that only Zetra Hainul and Jesi Alexander Alim were published in 2022. In addition, authors who have collaborated in writing in the field of GeoGebra include Zetra Hainul and Jesi Alexander Alim (Year 2022), Darhim and A Septian (Year 2020), Miroslav Marić, Slaviša Radović, and Kristina Veljković (Year 2019), Olha S. Pylypenko and Tetiana H. Kramarenko (the Year 2019), and Soffi Widyanesti Priwantoro and Shariful Fahmi (the Year 2018).

In the citation section, the threshold for the minimum number of citations used by researchers is 10. Out of 180 documents, 12 documents meet the threshold. The results of the density visualization below show which documents are the most influential in the field of GeoGebra research, the darker the colour means the more influential or in other words the most citations by other authors.

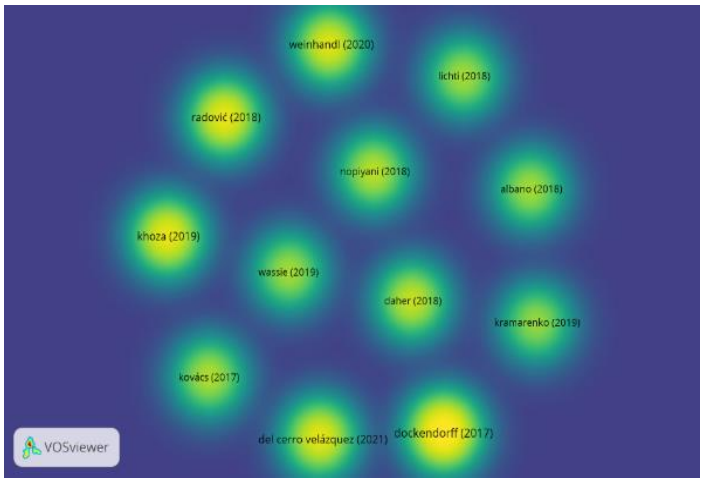

Figure 4. Display Density Visualization Citation

Based on the image above, Dockendorff (2017) is the author with the most cited documents. This shows that the research conducted by Dockendorff in 2017 is one of the most influential studies on research related to GeoGebra. The focus of Dockendorff's research is to investigate the impact of the integration of Information and Communication Technology (ICT) in mathematics visualization skills and teacher education programs. The results show that the use of GeoGebra in mathematics learning in secondary schools has an impact on teachers' conceptions of mathematics teaching and learning (Dockendroff & Solar, 2017). Meanwhile, Kramarenko (2019) is the author with the fewest cited documents, where the focus of Kramarenko (2019) research is to increase the use of learning methods using cloud technology and augmented reality on the GeoGebra system. (Kramarenko et al., 2019)

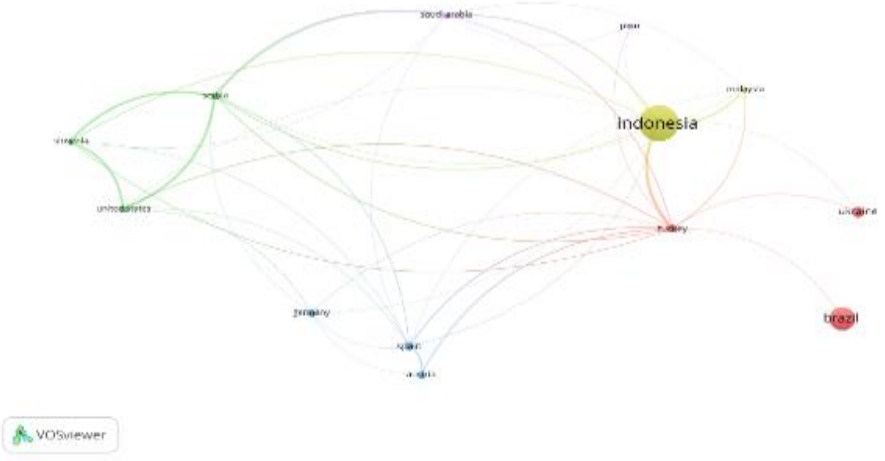

Figure. 5 Cycles Network Visualization Network Displays Against Country Bibliographic Pairs

Country bibliographic pairs can be seen in the image above which is displayed with network visualization. Researchers use a threshold at this stage, namely, the minimum number of publications from a country is 2. Out of 35 countries, 13 of them meet the threshold. In total link strength, Serbia ranks first with 135 total link strengths. Furthermore,

most citations and publications were occupied by Indonesia, with a total of 38 citations and 36 publications.

Table. 2 Pairs of Country Bibliography

Country	Number of Publications	Number of citations	Total Link Strength
Serbia	3	25	135
Turkey	4	12	119
Indonesia	36	38	111
Slovenia	2	10	84
United States	3	4	83
Saudi Arabia	2	6	64
Spanish	4	18	40
Malaysia	2	11	32
Austria	3	21	29
German	3	24	9
Peru	2	3	4
Ukraine	6	17	4
Brazil	19	12	2

In Figure 5 above, it can be seen that there are colour differences that indicate the division of different clusters or groups where the groups are based on the intensity of their relationship with one another. In the first or largest cluster, Brazil, Turkey, and Ukraine are occupied. The second cluster is Serbia, Slovenia, and the United States. The third cluster is Austria, Germany, and Spain. The fourth cluster is Indonesia and Malaysia. The fifth and final cluster is Peru and Saudi Arabia.

Figure 6. Display Overlay Visualization of Institutional Bibliographic Pairs

The Institution's bibliographic pair is shown in figure 6 which is displayed with an overlay visualization. Researchers used a threshold that is the minimum number of publications from an institution is 2 publications that have been cited at least 2. Out of 111 institutions, only 12 met the threshold. Researchers sorted by total link strength, with the University of Belgrade (Serbia) and the University of Novi Sad (Serbia) ranking first with 92 total link strengths, 24 citations, and 2 publications. Then the second place is occupied by the Indonesia University of Education (Indonesia) with 64 total link strengths, 13 citations, and 7 publications. Next, consecutively, the first number is the total link strength, the second number is the number of citations and the third number is the number of publications.

Suryakancana University Cianjur (Indonesia) (62, 8, 3), Atat (uRK)ïrk University (Turkey) (35, 4, 2), Riau University (Indonesia) (9, 2, 2), Private University College of Education (Austria) (8, 13, 2), Institute of Teacher Training and Education (Indonesia) (5, 3, 3), Kryvyi Rih State Pedagogical University (Ukraine) (2, 16, 2), a˜So Paulo State University (Brazil) (1, 4, 4), Ahmad Dahlan University (Indonesia) (0, 4, 3), Universidade Federal De Ouro Preto (Brazil) (0, 3, 2).

From Figure 6 above, there are several colours, ranging from blue, and green, to yellow, where yellow indicates the latest publication. Atat u¨rk University and Riau University are universities with the latest publications related to the use of Geogebra software in mathematics learning.

In terms of terms, the VOSviewer software obtained 5447 terms with 34 terms approaching. By selecting the minimum number of occurrences of repeated words used as 20 terms, we get a display like a Figure 7.

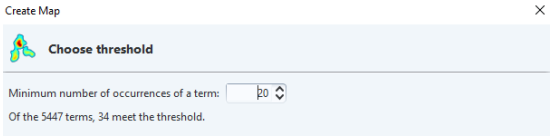

Figure 7. Visualization of Gaining Terms in VOSviewer

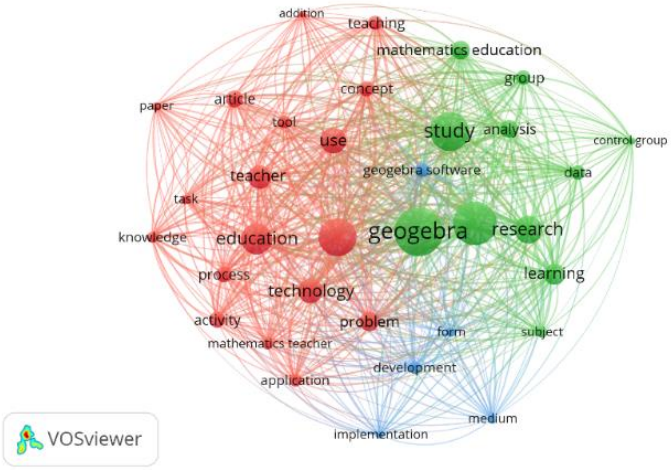

Figure. 8 Cycles Network Visualization Term

Circles Network Visualization Results in The VOSviewer software in Figure 8 shows that there are 3 clusters consisting of 34 themes related to the use of GeoGebra software in mathematics learning, namely:

1. Cluster 1 (red colour) consists of 18 themes, namely: activity, addition, application, article, concept, education, knowledge, mathematics, mathematics teacher, paper, problem, process, task, teacher, teaching, technology, tool, and use.
2. Cluster 2 (in green) consists of 11 themes, namely: analysis, control group, data, GeoGebra, group, learning, mathematics education, research, student, study, and subject.
3. Cluster 3 (coloured blue) consists of 5 themes: development, form, GeoGebra software, implementation, and medium.

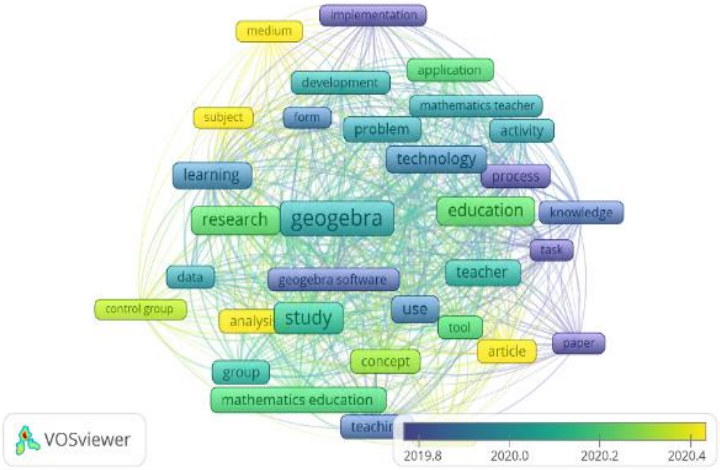

Figure. 9 Display Frames Overlay Visualization Term

The results of the Frames Overlay Visualization software VOSviewer in Figure 9 show the trend of the theme of writing articles using GeoGebra software in mathematics learning by year. Trends in the theme of writing articles using the GeoGebra software are marked in purple, blue, turquoise, dark green, light green, and yellow. This can be interpreted that the "control group", and "concept" themes which are marked in light green and the "medium", "subject", "analysis", and " article" themes which are marked in yellow are the latest themes that related to the use of GeoGebra software in learning mathematics. It can be said that these themes can be a reference for the renewal of further research.

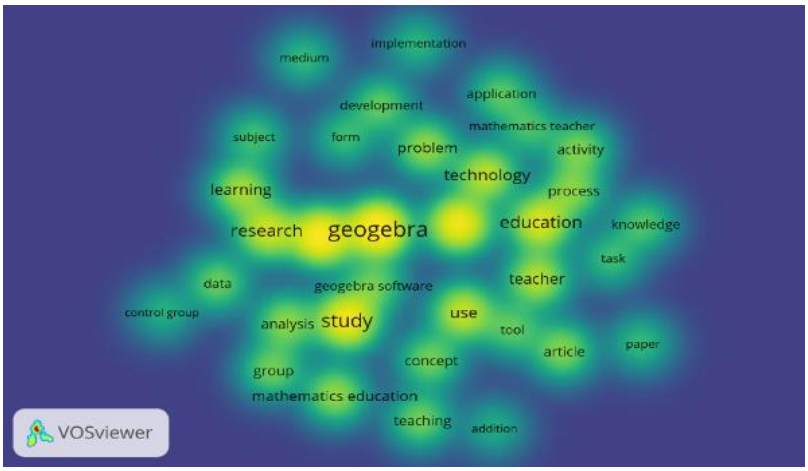

Figure. 10 Display Density Visualization Term

The results of the Density Visualization VOSviewer in Figure 10 show the density or density. The density of the research theme is shown in bright yellow. The theme of research that has been done a lot is marked by the brighter colour of the theme. However, the theme that is rarely done is marked by the dim colour of the theme. In Figure 10 there are still many themes that have dim colours including: " teaching", "addition", "mathematics education", "group", "concept", "tool", "article", "paper", "task", "knowledge", "process", "activity", "mathematics teacher", "application" are examples of themes that are still rarely studied. This can be considered for further research.

Mapping analysis on Frames Overlay Visualization and Density Visualization have interrelated themes, namely the " control group" theme, "concept", "medium", "subject", "analysis", and " article". This means that these themes are still rarely studied in research related to the use of GeoGebra software in mathematics learning. This can be an update and reference material for other researchers for research development, especially in the use of GeoGebra software

CONCLUSION

Trends in writing articles in journals using *database dimensions* regarding the use of the *GeoGebra software* in the 2017-2022 period fluctuated. From 2017 to 2021 the number of articles has increased significantly from 14 articles to 53 articles or an increase of 279%. However, it has decreased to 31 articles, or by 42% in 2022. A. Septian is the author with the most publications with 5 articles. Miroslav Marić , Slaviša Radović , and Kristina Veljković wrote 24 citations. Meanwhile, Sufyani Prabawanto and A. Septian are the authors with the highest total link strength of 5.

Based on the *overlay visualization display* on *VOSviewer*, it was found that only Zetra Hainul and Jesi Alexander Alim were published in 2022. In addition, several authors have collaborated on writing about *GeoGebra* including Zetra Hainul and Jesi Alexander Alim (Year 2022), Darhim and A. Septian (Year 2020), Miroslav Marić, Slaviša Radović, and Kristina Veljković (the Year 2019), Olha S. Pylypenko and Tetiana H. Kramarenko (the Year 2019), and Soffi Widyanesti Priwantoro and Shariful Fahmi (the Year 2018). Meanwhile, Dockendoff's research in 2017 became the most cited research.

Bibliometric results by country show that Serbia is the country that has a total link strength of 135. Meanwhile, Indonesia is the country with the highest number of citations and publications with 36 publications and 38 citations. Then, the University of Belgrade (Serbia) and the University of Novi Sad (Serbia) became the first institutions with 92 total link strengths, 24 citations, and 2 publications. Meanwhile, Atat ürk University and Riau University are universities with the latest publications related to the *use of Geogebra software* in mathematics learning.

Furthermore, the bibliometric results based on *terms* based on the results of the *VOSviewer software are* divided into 3 clusters, namely:

1. Cluster 1 (red colour) consists of 18 themes, namely: *activity, addition, application, article, concept, education, knowledge, mathematics, mathematics teacher, paper, problem, process, task, teacher, teaching, technology, tool,* and *use*.
2. Cluster 2 (in green) consists of 11 themes, namely: *analysis, control group, data, GeoGebra, group, learning, mathematics education, research, student, study,* and *subject.*
3. Cluster 3 (coloured blue) consists of 5 themes: *development, form, GeoGebra software, implementation,* and medium.

The *"control group",* and *"concept"* themes are marked in light green and the themes *"medium", "subject", "analysis",* and " *article"* are marked in yellow on the *frames overlay visualization term display.* are the latest themes related to the use *of GeoGebra software* in mathematics learning. The themes above, when viewed from the *density visualization term display*, are themes that are still rarely researched so they can be used as an updated reference in further research related to the use *of GeoGebra software.*

RECOMMENDATION

Recommendations for future researcher who are interested in geogebra software research are to make research based on the bibliometric result of this study in order to obtain upadate. Based on the results of keyword analysis, themes such as control group, concept, medium, subject, analysis, and article are themes that are rarely researched related to the use of GeoGebra software so that they can be input and opportunities for further researchers to conduct research in order to obtain research updates.

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