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Global Research Trends of Mathematics Literacy in Elementary School: A Bibliometric Analysis

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ABSTRACT

This study aims to analysis global research trends of mathematics literacy in elementary schools through bibliometric using VOSviewer software with Publish or Perish. We conducted bibliometric analysis in this research. The data was collected using a manager reference application, namely Publish or Perish sourced by Google Scholar. Publish or Perish software was used to conduct a literature review of mathematics literacy in elementary school topics. The keywords used in collecting data are mathematics literacy, elementary school, and mathematics education. The article publications used were published from 2014 to 2024. The results revealed that 998 relevant articles were published in the range of 2014 to 2024. The research trends based on the publication of research on mathematics literacy in elementary schools have fluctuated from 2014 to 2017. However, since 2017 research publications on mathematics literacy in elementary school have drastically decreased (sequentially 154,121, 97, 61, 44, 21, 14, 12 publications per year). Based on the mapping results, the connection between mathematics literacy and elementary school can not be seen clearly. In conclusion, the research publication on mathematics literacy in elementary school is still limited to research and has a big chance to conduct future research, so that it can have a higher impact on research novelty.

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1. INTRODUCTION

Mathematics literacy can be defined as an individual ability to formulate, use, and interpret mathematics in various contexts to understand the role of mathematics in the world and the future and to make judgments and decisions. Mathematics literacy fosters students to solve problems related to various contexts in life according to mathematical principles (Hayati & Kamid, 2019). Through mathematics literacy, students are prepared to reflect on mathematical logic to be used in their lives, community, and society, so mathematics literacy is an important ability for students, especially in elementary school.

Many previous studies have been conducted about mathematics literacy in elementary school, including the mathematics literacy achievement of elementary school students (Harahap *et al*., 2022; Putra *et al*., 2021; Rakhmawati & Mustadi, 2022), research about the difficulty of mathematics literacy of elementary school students (Rakhmawati & Mustadi, 2022; Putra *et al*., 2021), and research improving mathematics literacy through learning approach (Faozi *et al*., 2020; Wigati *et al*., 2020; Firdaus *et al*., 2017; Kurnila *et al*., 2022).

Based on several previous studies regarding significance test statistics, there has been no research that analyzes research trends regarding mathematics literacy in elementary school using a bibliometric analysis approach assisted by mapping visualization. The development of research trends in mathematics literacy can be analyzed using some of these techniques. A bibliometric is an analysis method of research data by analyzing article publications in some sources at a certain period. Research using bibliometric analysis has been conducted in many studies, especially about mathematics learning. The previous research including bibliometric mapping of the studies in the field of mathematics education (Ozkaya, 2018), bibliometric mapping on artificial intelligence in mathematics education (Hwang & Tu, 2021), and bibliometric analysis on augmented reality in mathematics education (Karakus *et al*., 2019).

However, research on bibliometric analysis of mathematics literacy in elementary school has not been carried out, especially to describe the development of the research using the VOSviewer application. Therefore, this research aims to analyze global research trends of mathematics literacy in elementary schools through bibliometric using VOSviewer software with Publish or Perish. This research can be a reference to conduct and determine the research themes for future research, especially related to mathematics literacy. The novelties in this research are (i) this study analyzes the research trends on mathematics literacy in elementary school through bibliometric analysis, (ii) this study finds the next future research.

2. METHOD

In this study, bibliometric analysis was conducted by analyzing the article data based on research from publications published in Google Scholar-indexed journals. The data was collected using a manager reference application, namely Publish or Perish. Publish or Perish software was used to conduct a literature review of mathematics literacy in elementary school topics. The keywords used in collecting data are mathematics literacy, elementary school, and mathematics education. The article publications used were published from 2014 to 2024. The data was obtained in April 2024. The articles that have been collected are then exported into two file types: research information systems (.ris) and comma-separated value format (*.csv). VOSviewer is aimed at visualizing and evaluating trends using bibliometric maps. VOSviewer was used to describe 3 variations of mapping publications, consisting of network visualization, density visualization, and overlay visualization based on the network (co-citation) between existing items.

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3. RESULTS AND DISCUSSION

3.1. Development of Statistical Significance Test Publications 2013-2023

Table 1 shows the annual report on research on "Mathematics Literacy in Elementary School" which has been published in national and international journals. Based on **Table 1**, the data can be seen that the number of publications on mathematics literacy in elementary school is 998 articles from 2014-2024. In 2014, the number of publications was 140 articles. In 2015 the number of publications was 153 articles. In 2016, the number of publications was 151. In 2017 the number of publications was 154 articles. In 2018 there were 121 articles, in 2019 there were 97 articles, in 2020 there were 61 articles, in 2021 there were 44 articles, and in 2022 there were 21 articles. In 2023 there were 14 articles and in 2024 there were 12 articles. Based on the number of publications, it indicates that research trends on mathematics literacy in elementary school have fluctuated in the last 10 years (2014-2024).

Figure 1 describes the research trends of mathematics literacy in elementary schools through article publications from 2014 to 2024. From 2014 to 2017, the research trends were shown by volatile graphics. It can be seen that the publication of research on mathematics literacy in elementary school has fluctuated from 2014 to 2017. Since 2017, research on mathematics literacy in elementary schools has drastically decreased. According to data, research trends on mathematics literacy in elementary school are volatile and it has decreased from 2017 until now.

Table 1. Annual report research on "mathematics literacy in elementary school".

Year	Documents	Percentages (%)
2014	140	14.03
2015	183	18.34
2016	151	15.13
2017	154	12.12
2018	121	9.71
2019	97	6.11
2020	61	4.40
2021	44	2.10
2022	21	1.40
2023	14	1.20
2024	12	1.20
Total	**998**	**100**

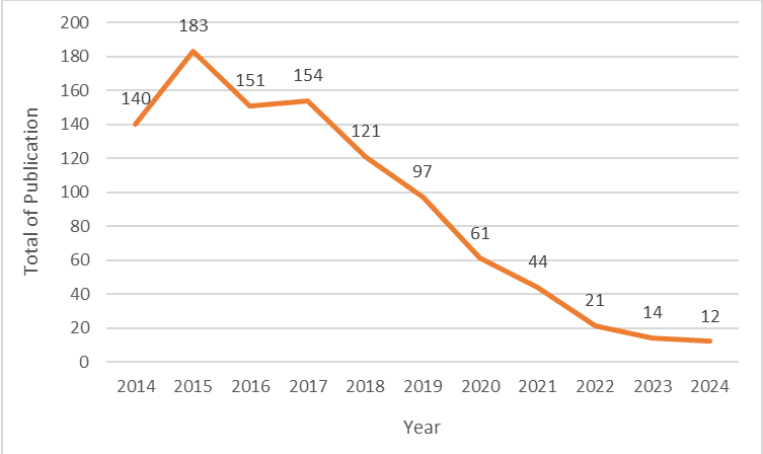

Figure 1. Research developments regarding "Statistical significance".

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3.2. Trend of Mathematics Literacy in Elementary School Research Citations 2014-2024

In this research, 20 articles were presented regarding mathematics literacy in elementary schools that have the highest number of citations. The 20 best articles are sorted from the number of citations. Based on the results, the number of article citations is 141328. The number of citations per year is 14132.80, the number of citations per article is 141.33, the average author in the articles used is 2.78, all articles have an average h-index is 181, and the g-index is 291. **Table 2** presents some metadata from articles with the highest number of citations. Based on **Table 2**, it is known that articles with the title " Learning to think mathematically: Problem-solving, metacognition, and sense-making in mathematics (Reprint)" written by Schoenfeld in 2016 are articles about mathematical thinking that are most frequently cited. total 7632 cited. Schoenfeld (2016) describes mathematical thinking and problem-solving.

Table 2. Difference mathematics literacy in elementary school articles with the most citations.

No	Cites	Title	Year	Cites Per Year	Cites Per Author	Ref
1	7632	Learning to think mathematically: Problem solving, metacognition, and sense making in mathematics (Reprint)	2016	954.00.00	7632	Schoenfeld (2016)
2	1771	Defining computational thinking for mathematics and science classrooms	2016	221.38.00	354	Weintrop *et al*. (2016)
3	1232	STEM education K-12: Perspectives on integration	2016	154.00.00	1232	English (2016)
4	1141	Teacher collaboration in instructional teams and student achievement	2015	126.78	285	Ronfeldt *et al*. (2015)
5	945	Teachers' perception of STEM integration and education: a systematic literature review	2019	189.00.00	473	Margot & Kettler (2019)
6	837	Cooperative learning: Review of research and practice	2016	104.63	837	Gillies (2016)
7	830	Effects of physical activity on executive functions, attention and academic performance in preadolescent children: a meta-analysis	2018	138.33.00	208	De Greeff *et al*. (2018)
8	826	A theoretical and empirical analysis of the roles of instructional leadership, teacher collaboration, and collective efficacy beliefs in support of student learning	2015	91.78	207	Goddard *et al*. (2015)
9	809	Teaching scientific practices: Meeting the challenge of change	2014	80.90	809	Osborne (2014)
10	790	How science, technology, engineering, and mathematics (STEM) project-based learning (PBL) affects high, middle, and low achievers differently: The impact of	2015	87.78	263	Han *et al*. (2015)

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Table 2 (Continue). Difference mathematics literacy in elementary school articles with the most citations.

No	Cites	Title	Year	Cites Per Year	Cites Per Author	Ref
11	695	Parental involvement and adolescents' educational success: The roles of prior achievement and socioeconomic status	2016	86.88	232	Benner *et al.* (2016)
12	660	Formal and informal home learning activities in relation to children's early numeracy and literacy skills: The development of a home numeracy model	2014	66.00.00	220	Skwarchuck *et al*. (2014)
13	625	Relations of different types of numerical magnitude representations to each other and to mathematics achievement	2014	62.50.00	156	Fazio *et al*. (2014)
14	623	School governance, teacher incentives, and pupil–teacher ratios: Experimental evidence from Kenyan primary schools	2015	69.22.00	208	Duflo *et al*. (2015)
15	617	A systematic literature review of 21st century skills and competencies in primary education.	2018	102.83	617	Chalkiadaki (2018)
16	609	Does leadership matter? Examining the relationship among transformational leadership, school climate, and student achievement.	2015	67.67	203	Allen *et al*. (2015)
17	595	Faculty trust in the principal: An essential ingredient in high-performing schools	2015	66.11.00	298	Tschannen-Moran & Gareis (2015)
18	584	A meta-analysis of mathematics and working memory: Moderating effects of working memory domain, type of mathematics skill, and sample characteristics.	2016	73.00.00	146	Peng *et al*. (2016)
19	545	Tablet use in schools: A critical review of the evidence for learning outcomes	2016	68.13.00	182	Haßler *et al*. (2016)
20	544	The effect of school closures on standardized student test outcomes	2022	272.00.00	272	Maldonado & Witte (2022)

3.3. Visualization of Research Data Mapping of Statistical Significance Test Research

Data mapped using VOSviewer produces 3 forms of visualization, namely network visualization (**Figure 2**), overlay visualization (**Figure 3**), and density visualization (**Figure 4**). The topic area of mathematics literacy in elementary school is analyzed using computational mapping. In this study, the computational mapping used VOSviewer. The results showed computational mapping of 134 items. The items are divided into 6 clusters, as follows.

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i) Cluster 1 marked in red consists of 44 items, namely ability, academic achievement, academic performance, achievement, activity, association, child, difficulty, disability, effect, elementary school child, elementary school student, factor, grade, implication, importance, influence, intervention, level, math, math achievement, math anxiety, mathematics achievement, mathematics performance, mathematics skill, memory, meta-analysis, middle school, model, performance, present study, primary school, quality, reading, relation, role, sample, score, skill, study, systematic review, time, and writing.

ii) Cluster 2 marked in green consists of 43 items, namely application, approach, article, assessment, challenge, context, country, education, engineering, example, experience, framework, goal, integration, knowledge, learning, learning mathematics, mathematical literacy, mathematics, mathematics education, mathematics literacy, mathematics teacher, mathematics teaching, paper, perspective, pisa, practice, process, research, review, school mathematics, science, science education, scientific literacy, stem, stem education, task, teacher, teaching, teaching mathematics, technology, use, view.

iii) Cluster 3 marked in blue consists of 18 items, namely algebra, analysis, attitude, case, case study, classroom, data, english, high school, learner, mathematics instruction, opportunity, participant, school, secondary school, student, subject, year.

iv) Cluster 4 marked in yellow consists of 14 items, namely anxiety, aspect, belief, course, interest, mathematical knowledge, mathematical problem, mathematics anxiety, measure, motivation, problem, relationship, self-efficacy, and strategy.

v) Cluster 5 marked in purple consists of 10 items, namely change, children, development, focus, group, instruction, kindergarten, language, literacy, and student learning.

vi) Cluster 6 marked in light blue consists of 5 items, namely effectiveness, evidence, impact, outcome, and student achievement.

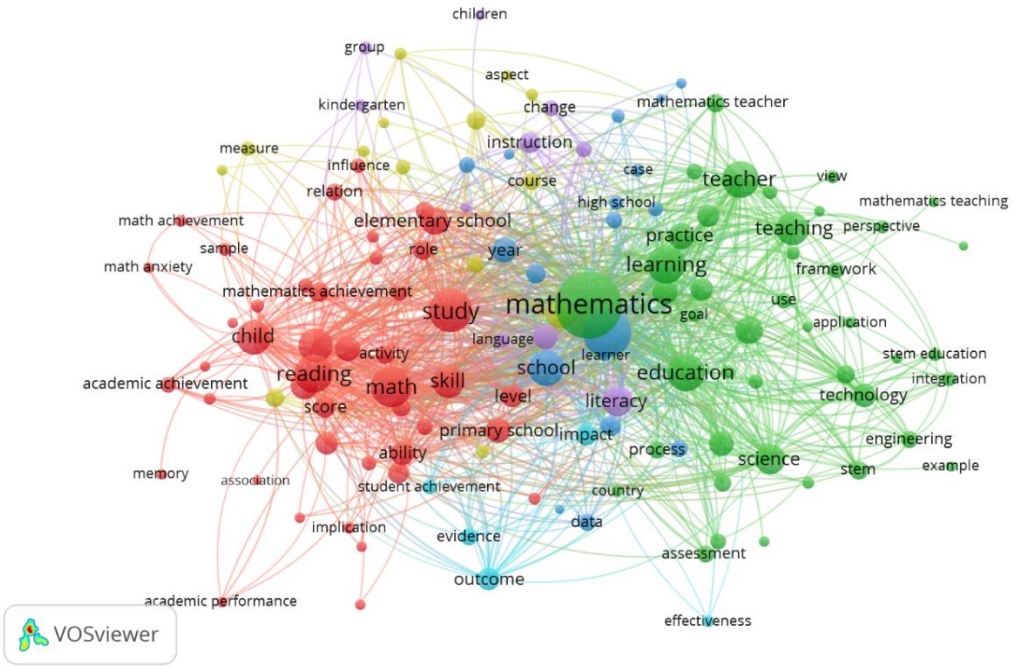

Figure 2. Network visualization based on co-occurrence of terms.

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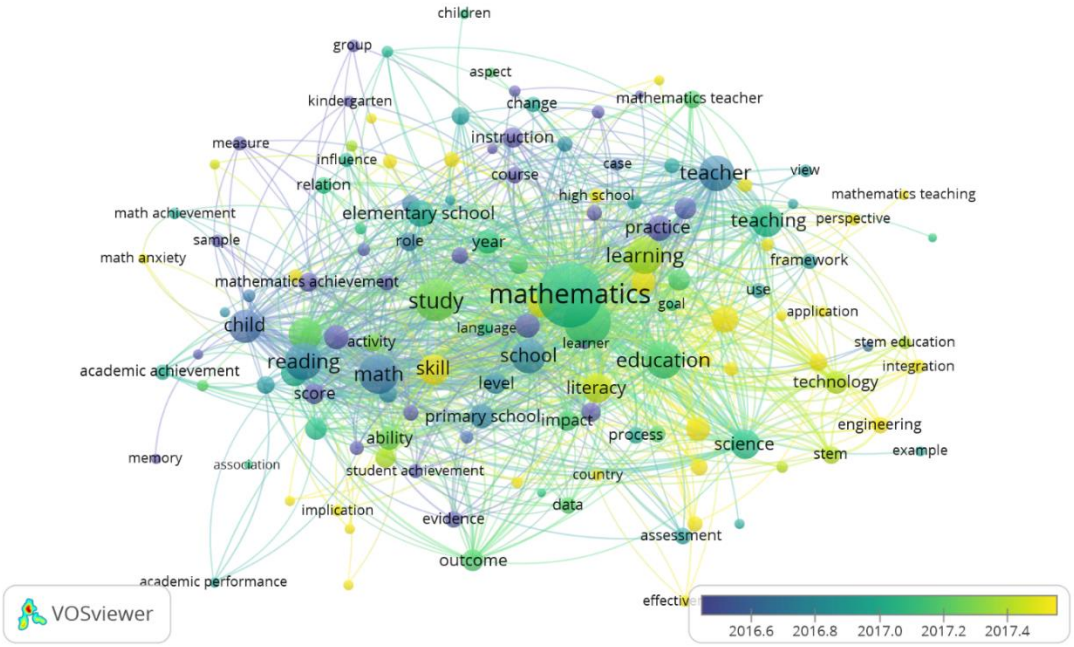

Figure 3. Overlay visualization based on co-occurrence of terms.

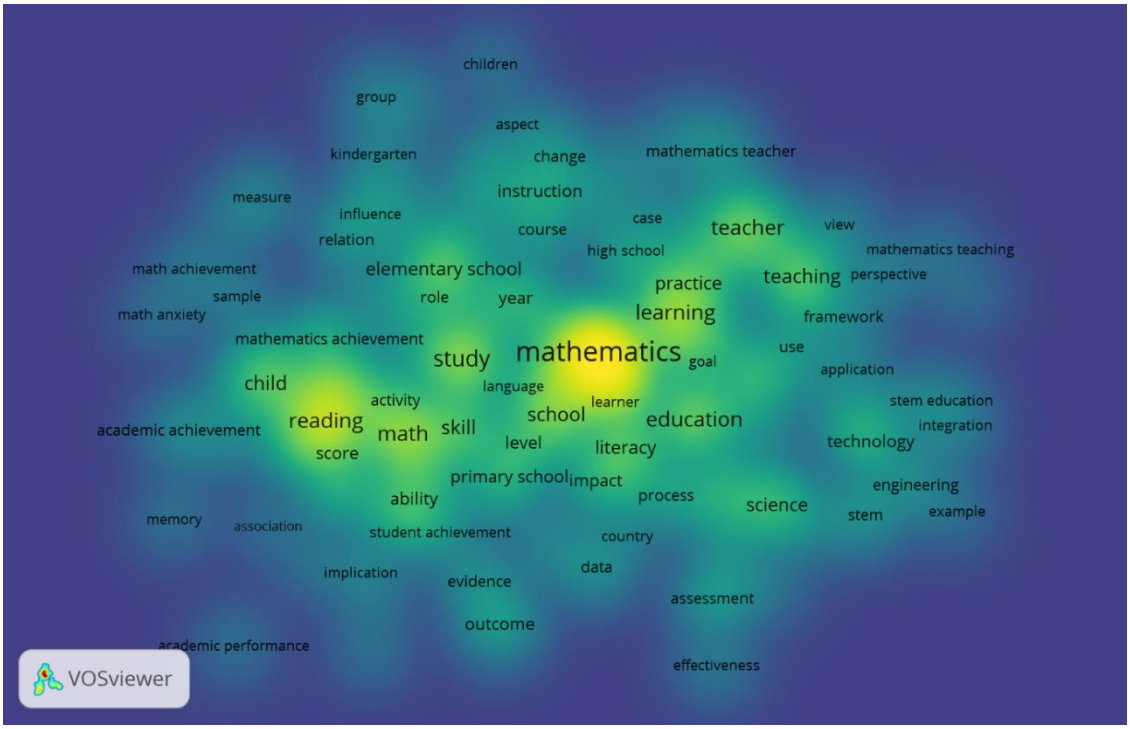

Figure 4. Density visualization based on co-occurrence of terms.

Figure 2 shows the connections between terms through the clusters related to the research topic of mathematics literacy in elementary school. Based on **Figure 2**, the research on mathematics literacy in elementary school generally can be divided into 3 aspects, such as mathematics literacy, elementary school, and mathematics education. The mathematics literacy term is included in cluster 2 with 99 links total, 360 total link strength, and 66 occurrences. Second, the elementary school term is included in cluster 1 with 111 links total, 505 total link strength, and 88 occurrences. Third, the mathematics education term is included in cluster 2 with 111 links total, 455 total link strength, and 87 occurrences.

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Moreover, **Figure 3** describes the overlay visualization in research on mathematics literacy in elementary school. **Figure 3** shows that research about mathematics literacy, elementary school, and mathematics education was carried out from 2014 to 2024. However, research on mathematics literacy in elementary school is still limited from 2014 to 2024. **Figure 4** describes the density visualization. Density visualization refers to the term that appears based on the brighter yellow color. Based on **Figure 4**, it can be seen that research related to the term mathematics literacy, elementary school, and mathematics education has a high number of studies. Next, **Figure 5** shows the network visualization of the mathematical literacy term.

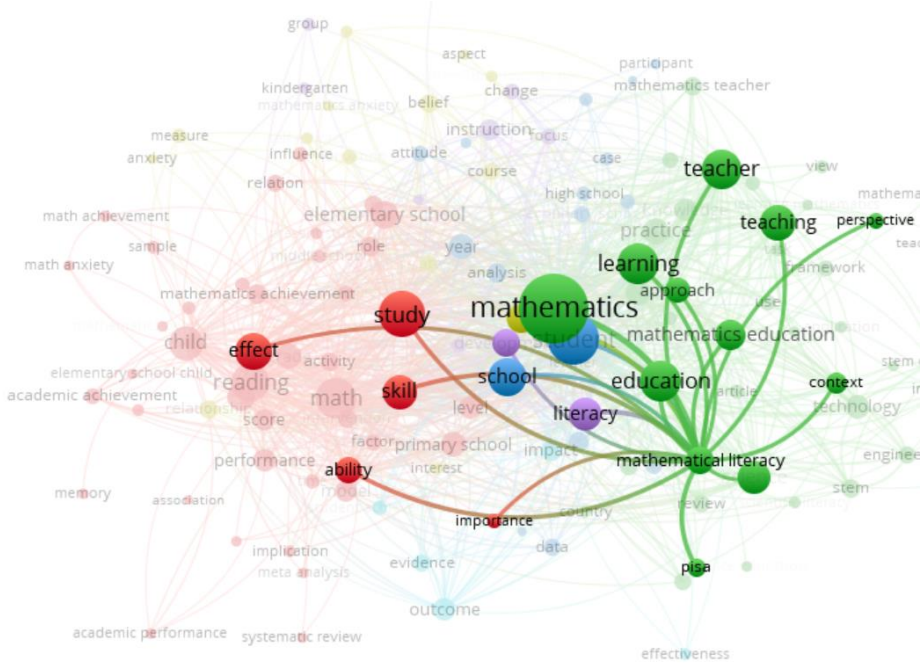

Figure 5. Network visualization of the term of mathematical literacy.

Based on **Figure 5**, mathematical literacy is associated with other terms. Based on the mapping results, the mathematical literacy term has 99 links and is connected to 43 terms. Meanwhile, **Figure 6** shows the connection between the terms relating to elementary school.

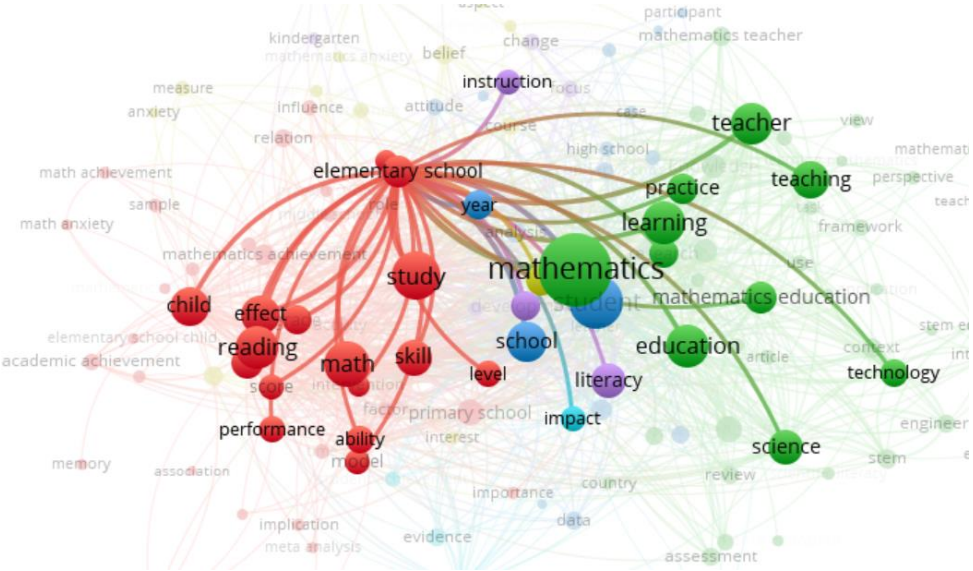

Figure 6. Network the term of elementary school.

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Based on **Figure 6**, the elementary school has 111 links and 44 connecting terms. It can be seen that research with the elementary school is more focused on mathematics education, learning, instruction, teacher, etc. According to the link and connection between mathematics literacy and elementary school, the relationship between both of them cannot be seen clearly. It can be concluded that the research publication on mathematics literacy in elementary school is still limited to research and has a big chance to conduct future research so that it can have a higher impact on research novelty.

Currently, mathematical literacy is one of the focuses in the development of PISA (Program for International Student Assessment) questions, which are an international standardized test used to measure the achievement of students' mathematical abilities. Mathematical literacy is meant to highlight mathematical skills and understanding that are useful in future life, this ability does not only refer to simple mathematics involved in direct activities such as shopping but includes the use of mathematics in high-level technical professions. Through mathematics literacy, a person will be able to reflect on mathematical logic to be used in his life, his community, and society (Karakus *et al*. 2019). This mathematical ability is the provision of basic abilities for students, especially in elementary schools.

To achieve educational goals that refer to the contents of the 2013 curriculum, it is necessary to have mathematics literacy in the process of learning mathematics (Kunter *et al*., 2013). Through mathematics literacy, a person will be able to do, understand, and apply mathematics in the context of everyday life and encourage critical thinking skills. Therefore, it is important to study students' mathematical literacy, especially in elementary schools. This result has implications for mathematics education for empowering mathematics literacy in elementary school students. For future research, it is a big chance to conduct the next research on mathematics literacy in elementary school so that it can have a higher impact on the research novelty.

4. CONCLUSION

This study is aimed to analysis global research trends of mathematics literacy in elementary school through bibliometric using VOSviewer software with Publish or Perish. The keywords used in collecting data are mathematics literacy, elementary school, and mathematics education. The results showed 998 relevant articles were published in the range of 2014 to 2024. The publication of research on mathematics literacy in elementary schools has fluctuated from 2014 to 2017. However, since 2017 research on mathematics literacy in elementary school has drastically decreased. Based on the mapping results, the connection between mathematics literacy and elementary school can not be seen clearly. In conclusion, the research publication on mathematics literacy in elementary school is still limited to research and has a big chance to conduct future research, so that it can have a higher impact on the research novelty.

5. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

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