Trends in Elementary School Statistical Literacy Research: A Bibliometric Analysis

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Abstract

Statistical literacy is an essential skill that is increasingly important in the information age, where the ability to understand, analyze, and interpret statistical data is an integral part of primary to secondary education. Amid technological developments and increasingly widespread access to data, statistical literacy is key in helping individuals make decisions based on strong evidence. This research aims to determine the research development on elementary school statistical literacy. The method used in this research is the bibliometric analysis method. The results of computational mapping, and interpreting the findings from the search results, obtained 200 articles from search results on Google Scholar using Publish or Perish that were relevant to elementary school statistical literacy from 2014 to 2024. The research results show that research on elementary school statistical literacy is minimal. From article analysis using VOSviewer, the development of publications related to statistical literacy from 2014 to 2024, out of 200 publications pertaining to statistical literacy, there are 6 publications. From these results, it can be concluded that studies on elementary school statistical literacy research are still limited. This means that research on this topic has a great opportunity to be carried out in the future to provide novelty in research.

Keywords: Literacy, Statistical literacy, Bibliometry

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1. Introduction

Statistical literacy is the ability to understand information in everyday life based on statistical data, the ability to answer problems well based on existing data in various ways, and obtain results that are not much different (Maryati, 2017). Statistical literacy ability can also be interpreted as the ability to understand the statistical process as a whole and apply this understanding to real problems by providing criticism, evaluation, and generalization related to data description, data organization, data representation, as well as data analysis and interpretation (Wulansari et al., 2019). Another definition states statistical literacy as high-level skills such as communicating, interpreting, and critically evaluating statistical data (Ziegler & Garfield, 2018). Apart from that, there are several definitions of statistical literacy, namely a reasoning method that combines ideas to understand statistical data, make interpretations, and draw conclusions (Budayasa & Juniati, 2018). Based on the opinion above, it can be concluded that statistical literacy is the ability to understand data, process data, and apply statistical understanding in everyday life. Therefore, we need to obtain clear information about data, especially data used in research that develops from natural science education (Chen et al., 2021).

On the other hand, bibliometric analysis has now proven to be an effective tool in studying research phenomena and progress in various research fields and contributes to providing an updated perspective on research limitations and trends (Chen, 2004; Wang & Ho, 2010; Sinha, 2012; Zhuang et al., 2013). Searching for certain topics that have great opportunities for research and searching for references that are most widely used in certain fields can be done using VOSviewer in bibliometric analysis (Nandiyanto et al., 2020). Many studies have been conducted in the field of education (Al Hussaeni et al., 2023); Febriandi, 2020; Febriandi et al., 2023), one

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of which is research in the field of statistics in elementary school mathematics lessons. Statistical literacy is very basic in elementary school mathematics learning. However, bibliometric reviews of self-directed learning and mathematical literacy are still limited, especially in analyzing research trends in the last ten years, where self-directed learning and mathematical literacy are in great demand.

Research related to statistical literacy at the elementary school level has experienced rapid development in recent years, reflecting increased attention to the development of critical and analytical thinking skills from an early age. However, despite its importance, this research is often fragmented and lacks global integration. Bibliometric analysis is therefore a very useful tool for understanding trends in statistical literacy research, including the identification of key themes, patterns of author collaboration, as well as the most active areas in the field.

Therefore, through bibliometric analysis, this research aims to provide a comprehensive picture of research trends in statistical literacy at the elementary school level. It is hoped that the results of this study can help educators, researchers, and policymakers in designing more effective and data-based learning programs while encouraging further research that can enrich the field of statistical literacy at the basic education level.

2. Literature Review

Statistical literacy is a general concept whose definition has changed over time along with developments and changes in technological times (Berndt et al.; Setiawan, 2019). Statistical literacy is one of the competencies that everyone must have to face the era of the Industrial Revolution 4.0 (Setiawan, 2019). Statistical literacy is an important skill in facing global challenges related to problem-solving and decision-making that require an understanding of data and statistics (Alman et al., 2024). At a higher level, reasoning and thinking enable critical evaluation of procedural and statistical problems. Based on the suggested definition, statistical literacy is used for the needs of scientific activities. They describe statistical literacy as the use and interpretation of statistical numbers in the context of science, which is a working definition for research (Maryati & Priatna, 2018).

Some statistical literacy learning problems include: 1) recognizing and categorizing data; 2) understanding how to collect a representative sample from the population; 3) modifying the graph to interpret the data; 4) interpreting concentration measures, location, and distribution data; 5) understand random chance; 6) understand the relationship between sample and population; 7) interpreting the relationship between two variables (Subekti & Akhsani, 2020). Meanwhile, based on previous research, several problems were encountered when teaching descriptive statistics material, including 1) difficulties in providing reasons for choosing to present data in the graphic form chosen; 2) the meaning of data presentation; and 3) difficulties in solving the problem of measuring data distribution (Habibi & Hidayat, 2020). The research results showed that the statistical literacy of prospective elementary school teacher students increased in the high, medium, and low groups after attending Educational Statistics lectures for 16 meetings (one semester) (Fardillah et al., 2019). Other factors that help improve students' statistical literacy are: (1) serving students outside class hours; (2) lecturer teaching methods; (3) duration of the meeting. The research conducted resulted in a low percentage of students' statistical literacy skills for each indicator (Salmi et al., 2019).

Research trends, especially in mathematics education, experience various changes in each era. Bibliometrics is a method for studying and analyzing large amounts of scientific data (Donthu et al., 2021). This method provides great benefits for computerized data processing and has been proven to increase the number of publications over the last few years (Ellegaard & Wallin, 2015).

Previous research using bibliometric analysis has been carried out, especially in mathematics education, such as research on bibliometric analysis in mathematics education (Özkaya, A. (2018), bibliometric analysis of learning models and methods in mathematics education (Lozada et al., 2021), analysis bibliometrics on learning media in mathematics (Santosa et al. 2021), bibliometric analysis of technology in mathematics education Hincapie et al., 2021), and bibliometric analysis of mathematical thinking Afifah & Maarif, 2021; Coban & Tezci, 2022; Supryadi, 2022). However, bibliometric reviews of statistical literacy are still very limited, especially in analyzing research trends in the last ten years. Learning statistical literacy in elementary school mathematics is in great demand. Therefore, the current research aims to analyze research trends through bibliometric analysis using VOSviewer software on elementary school statistical literacy.

3. Method

This research uses bibliometric analysis methods. Published article data are used to analyze research trends on elementary school statistical literacy. This research followed several steps: formulating research questions for bibliometric analysis, collecting research publication data on elementary school statistical literacy through the Publish or Perish application, organizing bibliometric data from publication data obtained through the Microsoft Excel application, carrying out computational mapping of bibliometric publication data through the VOSviewer application, analyzing computational mapping results, and interpreting findings. This research began by formulating the research question "What are the research trends on elementary school statistical literacy from 2014 to 2024?". Furthermore, data from published articles was collected from Google Scholar. To collect this data, the researchers used the software Publish or Perish. Through this software, we search for publication data using two keywords consisting of elementary school statistical literacy. The articles used were articles published between 2014 and 2024. Data obtained from the Publish or Perish software was exported into two types of files consisting of research information system and VOSviewer formats. Next, CSV files were organized using Microsoft Excel and categorized by year of publication. Ris files are used to analyze research trends using VOSviewer. Output files from VOSviewer and Microsoft Excel were interpreted to illustrate the findings. Detailed information regarding the use of VOSviewer is described elsewhere (Al Husaeni, & Nandiyanto, (2022); Laely Farokha et al., (2023).

4. Results

4.1 Results

Based on data collected in the Google Scholar database, 200 articles were published using the keyword statistical literacy. The number of citations for all articles published in this research is 34,128, the number of citations per year is 707.00, and the number of citations per author is 2141. There are 6 articles related to statistical literacy published. Table 1 shows some published article data categorized by year of publication related to statistical literacy and based on the highest number of citations.

Table 1. Publications Related to Statistical Literacy

No.	Autor	Title	Year	Cites
1	J Engel	Statistical literacy for active citizenship: A call for data science education	2017	203
2	S Sharma	Definitions and models of statistical literacy: a literature review	2017	178
3	R Callingham & JM Watson	The development of statistical literacy at school	2017	104

4	LD English & JM Watson	Statistical literacy in the elementary school: Opportunities for problem posing	2015	68
5	MA Jenny, N Keller, and G Gigerenzer	Assessing minimal medical statistical literacy using the Quick Risk Test: a prospective observational study in Germany	2018	65
6	B Güven, A Baki, N Uzun, ZM Özmen, and Z Arslan	Evaluating the statistics courses in terms of the statistical literacy: Didactic pathways of pre-service mathematics teachers	2021	19

To obtain research trends, data from Google Scholar is categorized based on the year of publication. Research trends are shown in Figure 1. In 2017, there were 3 articles published in journals sourced from Google Scholar. In 2015 2018, and 2021 the number of publications remains the same, namely 1 article related to statistical literacy. Over the last 10 years, the publication of journals or articles related to statistical literacy has been very limited and there were three published articles in 2017, whereas in 2018 and 2021 there was a decrease, namely 1 publication each published and indexed by Google Scholar. There are 7 years, namely 2014, 2016, 2019, 2020, 2022, 2023, and finally 2024, experiencing a lack of publications related to statistical literacy. In contrast to 2015, in 2017 there was an increase in publications to 3 articles. However, in the following year, article publications decreased again, with a total of 1 article in 2018 and 2021. This means that from 2014 to 2024, articles published about statistical literacy experienced fluctuations. Based on data from analysis related to statistical literacy, it can be concluded that the research trend on statistical literacy will fluctuate from 2014 to 2024.

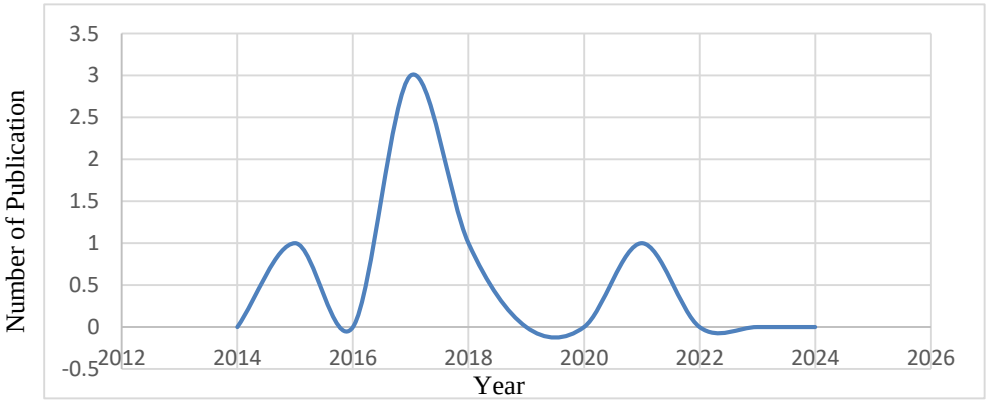

Figure 1: Trends in Statistical Literacy Research

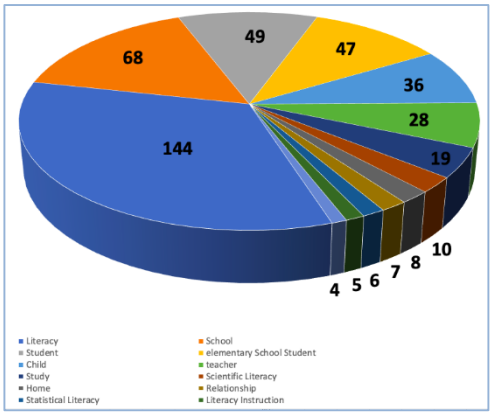

Figure 2: Trends in Statistical Literacy Research Based on Keywords

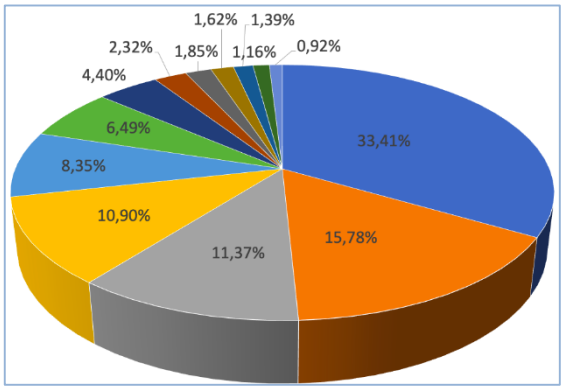

Figure 3: Presentation of Statistical Literacy Research Trends Based on Keywords

Based on the results, 194 items were found through computational mapping which were divided into 13 clusters as shown in Figure 2. Based on the categorized clusters, there was a relationship between each term. Network visualization is shown in Figures 4 and 5. Based on Figure 2, research on statistical literacy is divided into 13 aspects consisting of literacy, school, student, elementary school student, child, teacher, study, scientific literacy, home, relationship, statistical literacy, literacy instruction, and data. Literacy which is interconnected with other clusters is categorized in Cluster 1 with a total of 144 publications, cluster 2 is in the school category which is interconnected with other clusters in Cluster 2 with a total of 68 publications. Students are interconnected with other clusters in cluster 3 with a total of 49 publications. Elementary school students which is interconnected with other publications in cluster 4 with a total of 47 publications.

Child is interconnected with other publications in cluster 5 with a total of 36 publications. Teacher which is interconnected with other publications in cluster 6 with a total of 28 publications. The study is interconnected with other publications in cluster 7 with a total of 19 publications. Scientific literacy is interconnected with other publications in cluster 8 with a total of 10 publications. Home is interconnected with other publications in cluster 9 with a total of 8 publications. Relationships that are interconnected with other publications in cluster 10 with a total of 7 publications. Statistical literacy which is interconnected with other publications in cluster 11 with a total of 6 publications. Literacy Instruction is interconnected with other publications in cluster 12 with a total of 5 publications. Data that is interconnected with other publications in cluster 13 with a total of 4 publications.

Analysis of data from Google Scholar is closely related to elementary school statistical literacy based on the presentation of each cluster according to Figure 3. Research on statistical literacy is divided into 13 aspects consisting of literacy at 33.41%, school at 15.78%, student at 11.37%, elementary school student at 10.90%, child at 8.35%, teacher 6.49%, study at 4.40%, scientific literacy at 2.32%, home 1.85%, relationship 1.62%, statistical literacy 1.39%, instruction literacy 1.16%, and data 0.92. However, based on other studies, statistical literacy in the field of mathematics learning is still limited to design, and literature for implementation in the classroom is still lacking. This provides a great opportunity to research statistical literacy in mathematics learning that applies statistical literacy-based learning (Hasbola et al., 2020).

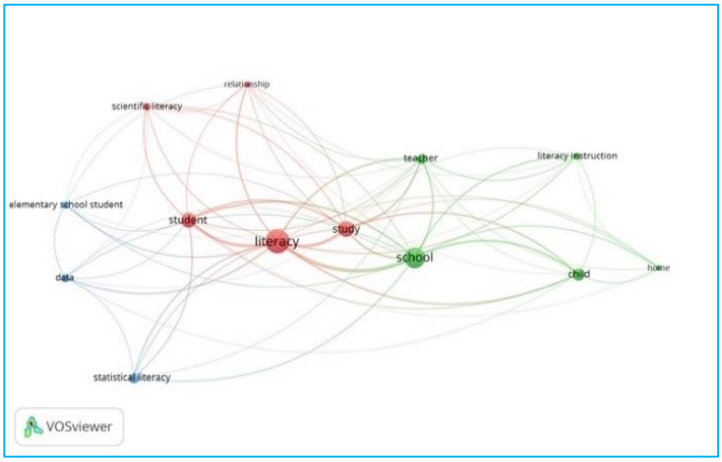

Figure 4: Cluster Visualization Using Vosviewer Network Visualization Based on Statistical Literacy Keywords

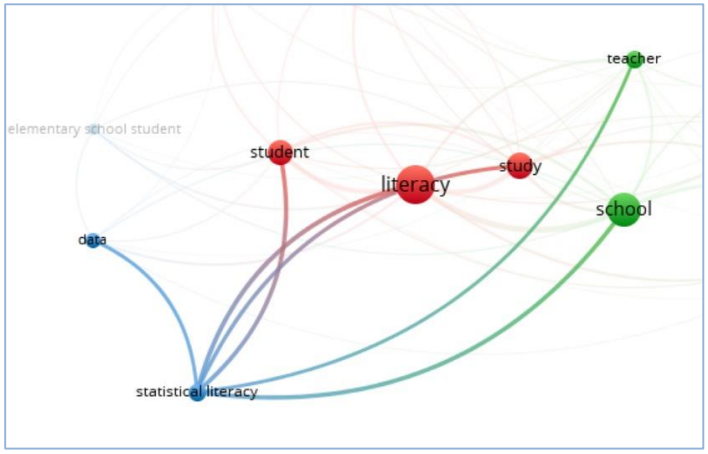

Figure 5: Cluster Visualization Using Vosviewer Network Visualization Based on Statistical Literacy Keywords

4.2 Discussion

Six articles related to statistical literacy based on year of publication, number of publications, and total citations, most of them contain statistical literacy for elementary school student learning. This finding shows that research on statistical literacy in learning achievement is the main focus of research trends from 2014 to 2024. This finding is supported by previous research which shows that there is a relationship between one research variable and another, such as literacy and mathematics, which is called mathematical literacy. Keywords are considered "content descriptors at a macroscopic level" (Chen et al., 2021) and can help clarify key research themes and research trends in elementary school statistical literacy in mathematics learning. Topics in this field can be described with keywords from publications (Chen and Tsai, 2012). Based on the type of document published, Figure 2 and Figure 3 show the publication presentation from VOS Viewer. Figure 3

lists the number of publications by document type published by presentation. Publication articles are the best format for presenting publications. This shows the great opportunities for this research to be explored and published, as well as how interesting it would be to publish in a credible conference article. Subsequent analysis with the VOS viewer, visualization, and mapping can be seen in Figures 4 and 5.

The results were generated using keywords in short display groups and abstracts from various studies on statistical literacy in mathematics learning that shapes education. With the help of bibliometric analysis, which can improve research by combining many parameters in a study, we can support future research that aims to utilize statistical literacy in data from previous studies that show that students' mathematical literacy outcomes in each category have different indicators of achievement. -different views on learning (Nurvicalesti et al., 2021; Abidin et al., 2022). Therefore, it can be concluded that research related to elementary school statistical literacy in mathematics learning is still minimal.

5. Conclusion

Based on the results and discussion, it can be concluded that from 2014 to 2024 there are fluctuations in research on elementary school statistical literacy. Only 6 articles have been published on this topic in 2015, 2017, 2018, and 2021. Of the 200 article documents, they have been released based on document type. Articles and reviews are the most frequently studied document types by document type. The VOS viewer findings in this study show 13 clusters that characterize six important current research issues in the field of statistical literacy. If we look at data from Google Scholar and VOSviewer showing interest in research into statistical literacy in elementary schools and a large number of publications in other fields of study in the near future, this means there are many opportunities for scientific literacy in areas relevant to statistical literacy to be discussed and researched more carry on.

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