

Bibliometric Analysis of the Role of Language in Mathematics Learning Communication on Student Learning Outcomes

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ABSTRAK

Matematika adalah pelajaran yang bersifat abstrak sehingga dianggap menjadi pelajaran yang sulit bagi sebagian peserta didik maupun mahasiswa. Bahasa merupakan alat komunikasi manusia. Penggunaan bahasa yang tersusun dengan baik dan tepat akan memudahkan lawan bicara memahami apa yang disampaikan, hal ini juga berlaku dalam pembelajaran. Tingkat pemahaman peserta didik terhadap materi yang disampaikan oleh pendidik menjadi faktor utama yang dapat mempengaruhi hasil belajar peserta didik. Metode yang digunakan dalam penelitian ini adalah metode analisis bibliometrik. Analisis bibliometrik merupakan suatu metode penelitian yang digunakan peneliti untuk mencari informasi seluas-luasnya terkait dengan kata kunci pada penelitian yang akan dilakukan. Adapun tujuan dari penelitian ini, antara lain: (1) Untuk mengetahui trend mengenai penelitian bahasa dalam komunikasi pembelajaran matematika. (2) Untuk mengetahui besar peluang penelitian lanjutan mengenai topik bahasa dalam komunikasi pembelajaran matematika. Peneliti menemukan bahwa sudah banyak penelitian dengan kata kunci "*mathematics*", namun masih sedikit penelitian yang berkaitan dengan *mathematics learning*, *outcomes mathematics* dan *quality*. Hal tersebut dapat menjadi peluang bagi penelitian selanjutnya untuk melakukan penelitian dengan ketiga kata kunci tersebut.

Kata kunci : bahasa, hasil belajar, analisis bibliometrik

ABSTRACT

Mathematics is an abstract subject so it is considered a difficult subject for some students and students. Language is a human communication tool. The use of language that is well structured and precise will make it easier for the interlocutor to understand what is being conveyed, this also applies in learning. The level of students' understanding of the material presented by educators is the main factor that can affect student learning outcomes. The method used in this research is bibliometric analysis method. Bibliometric analysis is a research method used by researchers to find the widest possible information related to keywords in the research to be carried out. The objectives of this research are, among others: (1) To find out trends regarding language research in mathematics learning communication. (2) To find out the great opportunities for further research on the topic of language in mathematics learning communication. The researcher found that there have been many studies with the keyword "mathematics", but there is still little research related to mathematics learning, mathematics outcomes and quality. This can be an opportunity for further research to conduct research on these three keywords.

Keywords : language, learning outcomes, bibliometric analysis

INTRODUCTION

Learning is an activity that is systematically designed and delivered using appropriate language to students so that the learning process can be conducted effectively to achieve the desired learning objectives. In the school environment, the teacher is the one who designs the learning activities that take place in the classroom. The teacher plays a crucial role in the teaching and learning process, especially in delivering the subject matter. One of the essential aspects in delivering material is the teacher's ability to use language effectively.

According to Wicaksono (2016), language becomes a core element in learning activities because, essentially, the learning process focuses on encouraging students to participate actively. Language is defined as a skill that humans must possess to communicate with one another.

Language plays a vital role in learning communication. The relationship between language use and mathematics learning outcomes is evident (Abedi and Lord, 2010). Learning becomes more engaging and motivating for students when teachers use language that is easy for them to understand (Ramadania, Wulandari, and Nahlini, 2018).

In mathematics learning, mathematical communication occurs between teachers and students, learning resources (such as books) and students, and among students themselves. In mathematics, communication holds an important function. The communication process helps form meaning and permanence of ideas and enables those ideas to be shared publicly (NCTM, 2000). Research by Muh Rizal concluded that there are four functions of communication in learning based on the existing framework: social communication, expressive communication, ritual communication, and instrumental function (Masdul, 2018).

According to Alfirahmadita and Maarif, communication is a fundamental part of the teaching (delivering mathematics materials) and learning (acquiring mathematics materials) process (Alfirahmadita and Maarif, 2020). Before teaching students, teachers must understand the learning objectives to be achieved and what students can or cannot comprehend. According to Wisman, communication plays a significant role in education (Wisman, 2017). Teachers must understand supporting elements in the learning process such as methods, strategies, and potential barriers in communication to ensure that learning communication runs smoothly.

According to Garret in Sembiring (2013), learning is a process carried out over a period of time through practice or experience, which results in a change in an individual's behavior and how they respond to situations. Learning is a process that leads to changes in individuals after gaining knowledge or experience during the learning process. Zakky (2020) stated that learning outcomes refer to changes in a student's ability after undergoing a learning activity, which may involve cognitive, affective, and psychomotor domains—developed through experience and not just limited to one domain. Students' learning outcomes can be used as evaluation tools for both students and teachers. The use of good language facilitates communication in learning, which in turn affects students' learning outcomes.

Mathematics is considered an abstract subject, which is why many students perceive it as difficult (Putih, Marhadi, and Alpusari, n.d.). Therefore, effective communication between teachers and students is essential in the mathematics learning process. With strong interaction, students can discover both structured and abstract concepts, either independently or with teacher guidance. The appropriate use of language in mathematics learning communication requires further literature review to deepen the understanding of how language in mathematical communication correlates with students' learning outcomes. Based on this, the research problems are formulated as follows:

a. What are the research trends regarding the use of language in mathematics learning communication? b. Is there potential for further research on the topic of language in mathematics learning communication?. Based on the research problems, the objectives of this study are (1) To identify research trends regarding the use of language in mathematics learning communication. (2) To explore the potential for further research on the topic of language in mathematics learning communication.

METHOD

This research uses a bibliometric analysis method. Bibliometric analysis is a research method that allows researchers to explore as much information as possible from previous articles or journals (Herawati, Utami, and Karlina, 2022). Bibliometrics involves quantitative analysis related to certain characteristics of publications or literature, such as authors, publication information, cited sources, and others (Ali, 2018). This method is widely used in scientific research and is supported by rapid technological and internet development (Merigó and Yang, 2017).

This study used article and journal data from 1985 to 2022 sourced from Google Scholar using keywords related to “learning outcomes,” “language in mathematics,” and “mathematics education.” The data were collected using the Publish or Perish software. This research adopted the five-step bibliometric analysis method proposed by Fahimnia (Setyaningsih, Indarti, and Jie, 2018), which includes: defining keywords, initial search results, refining search results, initial data statistics compilation, and data analysis. Below are the descriptions of these steps:

1. Defining Keywords

Data collection was conducted in April 2022 using the keywords “learning outcomes; language in mathematics; mathematics education.” The data were gathered using the Publish or Perish software with the Google Scholar database.

2. Initial Search Results

In the first search, no time range was set, but the search was limited to 1,000 results. The results ranged from 1985 to 2022, yielding various types of documents such as articles, journals, and books, totaling 370 entries. Detailed information is provided in the table below:

Table 1. Metric Data from Initial Search Results

Metric	Search Results
Publication Year	1985–2022
Citation Years	37 (1985–2022)
Papers	370
Citations	2948
Cites/year	79.68
Cites/paper	7.97
Authors/paper	1.95
h-index	22
g-index	52
hI-norm	14
hI-annual	0.38
hA-index	8

3. Refining Search Results

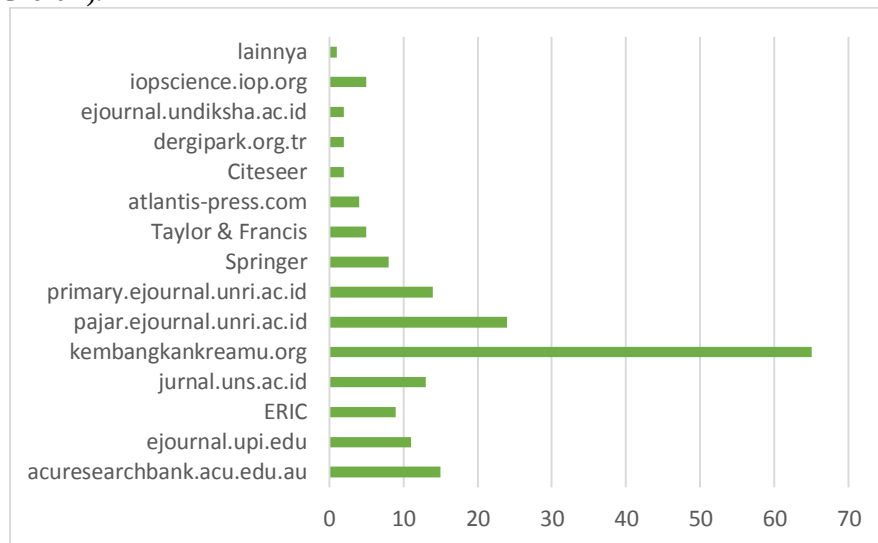
The refinement process involved selecting or filtering the data. The researcher categorized the data into two parts: those to be excluded and those to be retained. The selection criteria included: data being articles or journals, relevance to the research topic, and publication on a credible platform. This filtering resulted in 291 articles from the original 370. Details are provided below:

Table 2. Filtered Data Results

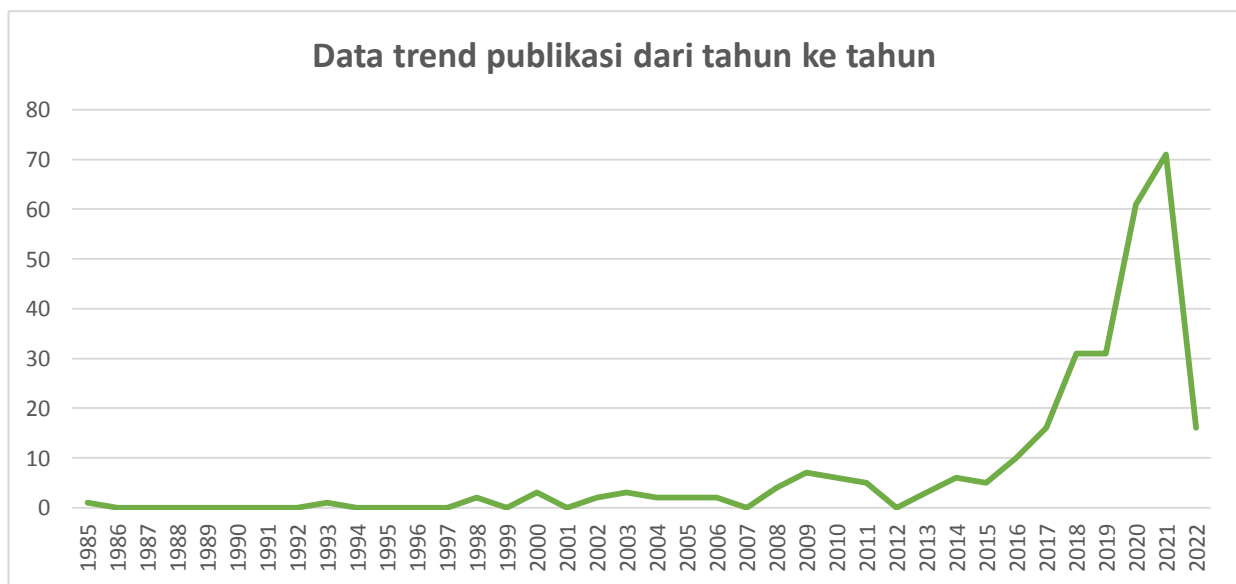
Filter Criteria	Number of Articles
Book-type entries	17
Irrelevant titles	57
Unknown publisher	5
Remaining articles	291

The filtered data were saved in RIS and CSV formats. The data were then analyzed and categorized by publication year and source. From the initial search using Publish or Perish, 370 entries were retrieved from 1985–2022. The most frequent publishers for articles matching the keywords were JP2D, followed by Jurnal PAJAR and Primary e-Journal. The number of

publications increased over the years, particularly from 2019 to 2021. The following charts illustrate the most common article publishers (Chart 1) and the trend of publications over the years (Chart 2).



Graphics 1. Frequency of Article Publication



Grapichs 2. Trend Data Publication

After collecting data using the Publish or Perish software, the next step is to analyze the data using VOSviewer software. The analysis with VOSviewer visualizes the data—comprising 291 articles and journals—into a map of item/keyword distributions in image form.

RESULTS AND DISCUSSION

The findings indicate that the refined set of articles and journals has had a substantial impact on citation-related metric data. The table below presents the five most cited articles or journals published between 1985 and 2022.

Table 3. The Five Most Cited Journals

No	Author(s)	Article Title	Year	Journal Name	Citation Count
1	CC Ponitz, MM McClelland, JS Matthews, FJ Morrison	<i>A structured observation of behavioral self-regulation and its contribution to kindergarten outcomes</i>	2009	National Library of Medicine	997
2	C Titz, J Karbach	<i>Working memory and executive functions: effects of training on academic achievement</i>	2014	Springer	353
3	BM Stecher, S Barron, T Kaganoff, J Goodwin	<i>The Effects of Standards-Based Assessment on Classroom Practices: Results of the 1996–97 RAND Survey of Kentucky Teachers of Mathematics and Writing</i>	1998	ERIC	176
4	S Wang, CM Rubie-Davies, K Meissel	<i>A systematic review of the teacher expectation literature over the past 30 years</i>	2018	Taylor & Francis	86
5	DC Geary, AW Boykin, S Embretson, V Reyna, et al.	<i>Report of the task group on learning processes</i>	2008	Citeseer	76

Based on Table 3, the article by CC Ponitz, MM McClelland, JS Matthews, and FJ Morrison titled "A structured observation of behavioral self-regulation and its contribution to kindergarten outcomes" is the most cited, with 997 citations. This article was published in the *National Library of Medicine* in 2009. The second most cited article is "Working memory and executive functions: effects of training on academic achievement" by C Titz and J Karbach, published in *Springer* in 2014 with 353 citations. The next is "The Effects of Standards-Based Assessment on Classroom Practices: Results of the 1996–97 RAND Survey of Kentucky Teachers of Mathematics and Writing" by BM Stecher, S Barron, T Kaganoff, and J Goodwin, cited 176 times and published in *ERIC* in 1998.

After processing the literature data and calculating the number of citations using Publish or Perish, the researcher analyzed the data with VOSviewer. VOSviewer serves two main functions. First, it is used to construct networks of journals or scientific articles, researchers, regions or countries, and keywords. Second, it is used to visualize and explore maps. VOSviewer offers three types of visualizations: network visualization, overlay visualization, and density visualization. This study used data analysis to identify the most frequently used keywords. The following are the visualizations or map images generated in VOSviewer based on the processed data:

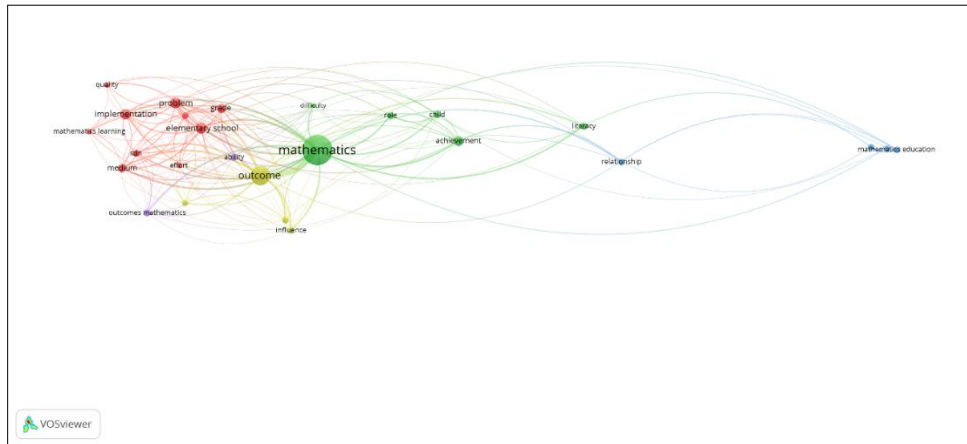


Figure 9. Network Visualization Map

Note: The five colors—red, yellow, green, purple, and blue—indicate five research clusters related to the keywords used.

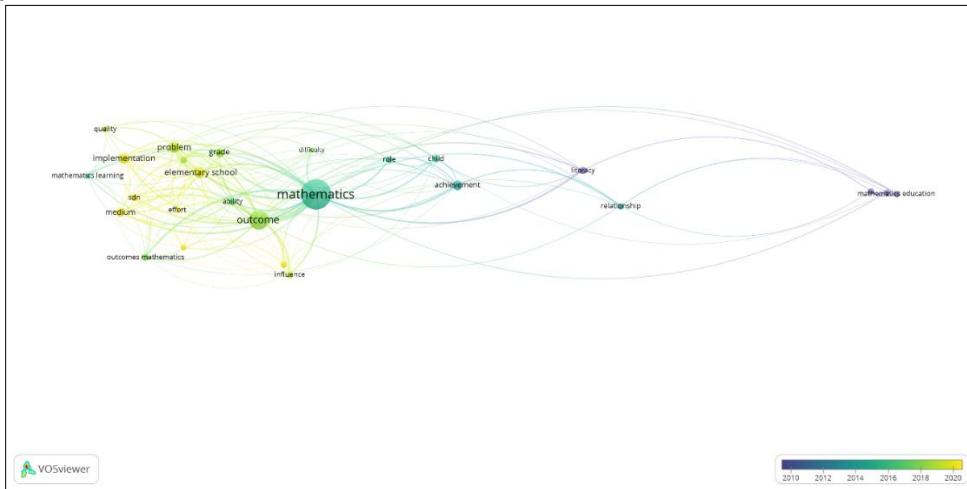


Figure 10. Overlay Visualization Map

Note: The four colors—yellow, green, blue, and purple—represent the range of publication years of the articles or journals.

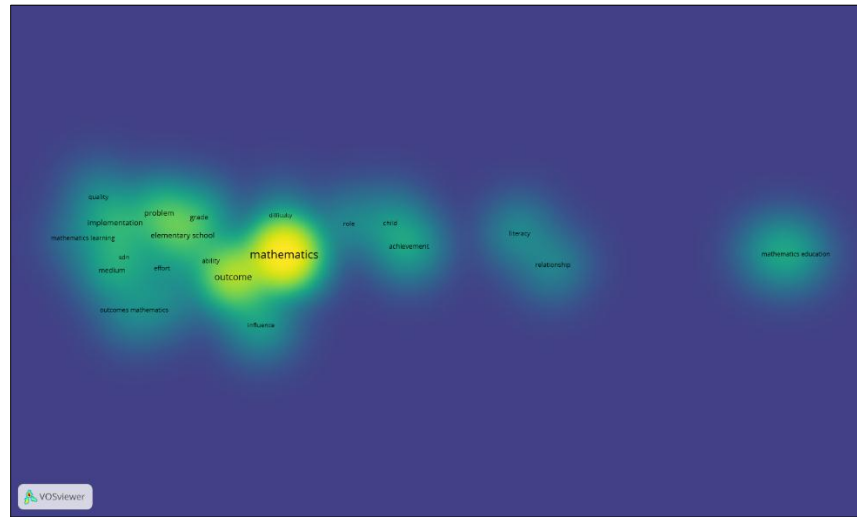


Figure 11. Density Visualization Map

Note: The largest number of items or keywords is indicated by a bright yellow color, while the smallest is shown with a pale green color.

Based on the three images above, it can be analyzed that research trends related to language in mathematics learning involve 29 popular terms, which were further filtered to retain 23 relevant terms. To identify a theme related to language in mathematics that has potential for further research, one can refer to the frequency of occurrences as shown in VOSviewer. From Figures 9 and 11, it can be seen that the term "Mathematics" has already been extensively studied, particularly between 2014 and 2016 (based on Figure 10). However, many of the other terms have relatively few occurrences, indicating that there are still opportunities or gaps for conducting further research on those items.

CONCLUSION

Bibliometric analysis is one of the scientific research methods that is useful for researchers to obtain information related to broad and richly-researched topics. Based on the results and discussion above, it can be concluded that there were 370 publications from 1985 to 2022 that used the keywords *learning outcomes*, *language in mathematics*, and *mathematics education*. This data was obtained using the Publish or Perish software with the Google Scholar database. From the initial search results, further refinement was conducted by filtering the data, resulting in a total of 291 articles and journals used in the study. In the title trend analysis, five clusters were formed. The term most frequently used in articles related to language in mathematics learning is "*mathematics*", particularly in the period between 2014 and 2016. However, there are still few discussions involving other related terms. This presents an opportunity for future research to focus on those less explored terms. Future studies could begin by exploring keywords with fewer existing publications, such as *quality*, *mathematic learning*, *outcomes mathematics*, and others. This recommendation is based on the frequency of occurrences of each term as visualized using VOSviewer.

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