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Bibliometric Analysis using Vos viewer with Publish or Perish of Mathematical Proficiency

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ABSTRACT

The purpose of this research is to find out the development of research on mathematical proficiency. The method used in this study uses a bibliometric approach based on mathematical proficiency analysis assisted by VOSviewer, based on searches from the Google Scholar database, and the title of the article is used as a guide in the search process which is obtained from the keyword "Mathematical Proficiency". From the search results, 999 articles were obtained from search results on Google Scholar using Publish or Perish (PoP) that were relevant to the mathematical proficiency from the last 5 years (2020-2024). The results showed a decline in research related to mathematical proficiency. From the analysis of articles using VOSviewer, the number of publications related to mathematical proficiency has decreased each year from 347 publications in 2020, 271 publications in 2021, 205 publications in 2022, 134 publications in 2023, and 42 publications in 2024. The conclusions of this study provide an appropriate reference for further research regarding "mathematical proficiency".

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1. INTRODUCTION

Mathematical proficiency refers to an individual's ability to understand, apply, and communicate mathematical concepts effectively in a variety of contexts. As stated by the National Research Council (2001) (see in <https://nap.nationalacademies.org/catalog/9822/adding-it-up-helping-children-learn-mathematics>), mathematical proficiency includes a deep understanding of mathematical concepts, the ability to solve problems using appropriate strategies, and the ability to communicate clearly and precisely in a mathematical context. Thus, mathematical skills become an important foundation in developing analytical, critical, and creative abilities needed in various scientific fields and everyday life.

Previous research on mathematical proficiency has provided valuable insight into understanding the complexity of the development of mathematical abilities at various levels of education and cultural contexts. According to literature, "research results also show the importance of interactive learning approaches, providing constructive feedback, and the use of technology in improving students' mathematical proficiency" (Philipp, 2007). In addition, other literature highlights the relationship between mathematical proficiency academic achievement, and career success in various fields. By building on these findings, future research is expected to make further contributions to the development of effective learning strategies to improve mathematical proficiency among students. Bibliometric analysis regarding mathematical proficiency is needed to identify trends, patterns, and research developments in this field as well as to evaluate the contribution and impact of various studies conducted (Verschaffel *et al.*, 2020).

Based on several previous studies regarding mathematical proficiency, there has been no research that analyzes research trends regarding mathematical proficiency using a bibliometric analysis approach assisted by mapping visualization. As stated by Jones *et al.* (2020), "bibliometric analysis provides deep insight into trends, research focus, and contributions of researchers in understanding and improving mathematical proficiency". Thus, this research aims to analyze research trends regarding mathematical proficiency using bibliometric analysis methods assisted by mapping analysis. This research also analyzes the development of research and the development of the number of citations in research on mathematical proficiency. This research uses visualization mapping to determine keywords for discussion in research regarding mathematical proficiency.

2. METHOD

The method used in this research is bibliometric analysis. There are several stages in bibliometric analysis, including collecting article data which is the first step in conducting literature research using bibliometric analysis. At this stage, published research documents related to the topic of "mathematical proficiency" are collected. The article data used is article data indexed by Google Scholar in 2020-2024. Article data is collected via the Publish or Perish application. The results of collecting article data using Publish or Perish produced 999 articles for analysis. The collected research article data is saved in (*.csv) format so that it can be analyzed using Microsoft Excel software, and (*.ris) format so that it can be analyzed and visualized using the VOSviewer application. After data collection, article data was filtered to see the completeness of its components (such as year). Next, the article data was analyzed using Ms. Excel and visualized using VOSviewer.

3. RESULTS AND DISCUSSION

3.1. Development of Mathematical Proficiency Publication 2020-2024

Table 1 shows the annual research report "Mathematical Proficiency" which has been published in national and international journals. Based on the data, it is known that the total documents found over the last 5 years were 999 documents. Details of the number of research documents regarding "Mathematical Proficiency", namely in 2020 there were 347 documents, in 2021 there were 271 documents, in 2022 there were 205 documents, in 2023 there were 134 documents, and in 2024 there were 42 documents.

Based on the number of research documents each year, it is known that research publications regarding "Mathematical Proficiency" have decreased every year, starting from 2020 to 2024. **Figure 1** shows a graph of the decrease in the number of publications regarding "Mathematical Proficiency" more clearly. Over the last 5 years, the highest number of research on this topic occurred in 2020 with 347 documents and the lowest number in 2024 with 42 documents. The decrease in the number of documents occurs consistently every year, the highest decrease is between 2023 and 2024, namely a decrease in the number of documents by 92 documents.

Research on mathematical proficiency plays an important role in the development of mathematics education and a broad understanding of mathematical concepts. As stated by [Hiebert and Stigler \(2017\)](#), "A deep understanding of mathematical proficiency is the key to preparing students with the skills needed to face the challenges of the 21st century." Research on mathematical proficiency can provide a better view of effective learning strategies, enable better curriculum development, and provide a basis for appropriate educational interventions to improve students' mathematical abilities. Therefore, this research was conducted to describe the process of reviewing literature regarding mathematical proficiency for various purposes.

Table 1. Annual report research on "Mathematical Proficiency".

Year	Documents	Percentages (%)
2020	347	34.73
2021	271	27.13
2022	205	20.52
2023	134	13.41
2024	42	4.21
Total	999	100

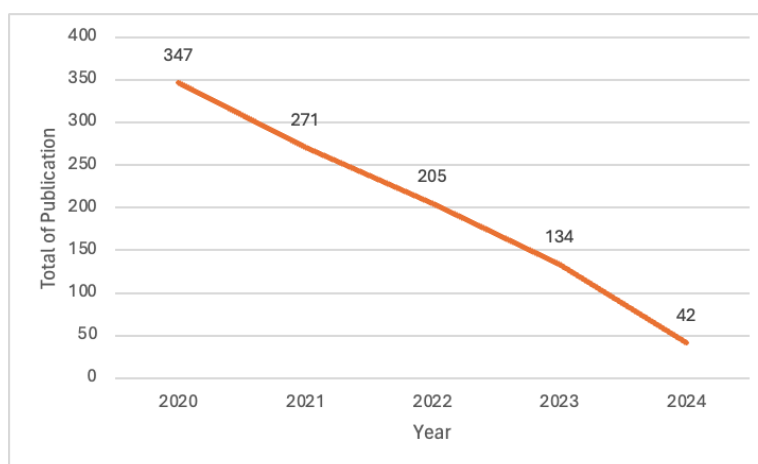


Figure 1. Annual report of publications.

3.2. Trend of Mathematical Proficiency Research Citation 2020-2024

In this research, 20 articles regarding mathematical proficiency were presented which had the highest number of citations. **Table 2** presents some metadata from articles with the highest number of citations. Based on **Table 2**, it is known that there are many articles with the title "Correlates of exam performance in an introductory statistics course: Basic math skills along with self-reported psychological/behavioral and demographic variables" written by [Rabin et al. \(2021\)](#) it is the most frequently cited article with a total of 2231 cited. Based on the data in **Table 1**, it is known that the articles published regarding mathematical proficiency with the highest number of citations came from 2020 with 6 articles, 2021 with 9 articles, 2022 with 1 article, 2023 with 3 articles, and 2024 with 1 article.

Table 2. Mathematical proficiency articles with the most citations.

No.	Cites	Title	Year	Cites Per Year	Cites Per Author	Ref
1	2231	Correlates of exam performance in an introductory statistics course: Basic math skills along with self-reported psychological/behavioral and demographic variables	2021	743.67	558	Rabin et al. (2021)
2	476	Characteristics of effective teaching of mathematics: A view from the West	2023	476.00	238	Anthony and Walshaw (2023)
3	457	Modelling the long-run learning impact of the Covid-19 learning shock: Actions to (more than) mitigate loss	2021	152.33	457	Kaffenberger (2021)
4	311	Parent-child information frictions and human capital investment: Evidence from a field experiment	2021	103.67	311	Bergman (2021)
5	194	Learning to teach through mathematical problem posing: Theoretical considerations, methodology, and directions for future research	2020	48.50	97	Cai & Hwang (2020)
6	166	Tablets and apps for promoting robotics, mathematics, STEM education, and literacy in early childhood education	2020	41.50	55	Dorouka et al. (2020)
7	157	"I can math!": Reducing math anxiety and increasing math self-efficacy using a mindfulness and growth mindset-based intervention in first-year students	2021	52.33	79	Samuel & Warmer (2021)
8	146	Building back better to avert a learning catastrophe: Estimating learning loss from COVID-19 school shutdowns in Africa and facilitating short-term and long ...	2021	48.67	29	Angrist et al. (2021)
9	140	Effects of digital game-based STEM education on students' learning achievement: a meta-analysis	2022	70.00	28	Wang et al. (2022)
10	135	Mathematics anxiety among STEM and social sciences students: the roles of mathematics self-efficacy, and deep and surface approach to learning	2020	33.75	34	Rozgonjuk et al. (2020)

Table 2 (Continue). Mathematical proficiency articles with the most citations.

No.	Cites	Title	Year	Cites Per Year	Cites Per Author	Ref
11	125	Opportunity in crisis: The role of universal design for learning in educational redesign.	2020	31.25	42	Basham <i>et al.</i> (2020)
12	124	Representation in teaching and learning mathematics.	2021	41.33	124	Mainali (2021)
13	120	Cultural beliefs and equity in educational institutions: exploring the social and philosophical notions of ability groupings in teaching and learning of mathematics	2023	120.00	60	Alam & Mohanty (2023)
14	120	The Importance Of Integrating Mathematical Literacy In The Primary Education Curriculum: A Literature Review	2024	120.00	24	Sitopu <i>et al.</i> (2024)
15	115	The Impact of Teaching by Using STEM Approach in The Development of Creative Thinking and Mathematical Achievement Among the Students of The Fourth ...	2021	38.33	38	Jawad <i>et al.</i> (2021)
16	113	Multilevel mixed methods research designs: Advancing a refined definition	2020	28.25	57	Headley & Clark (2020)
17	111	Digital game-based learning in a Shanghai primary-school mathematics class: A case study	2020	27.75	28	Deng <i>et al.</i> (2020)
18	106	Gender differences in mathematics self-concept across the world: An exploration of student and parent data of TIMSS 2015	2021	35.33	35	Rodrigues <i>et al.</i> (2021)
19	106	ChatGPT: A revolutionary tool for teaching and learning mathematics	2023	106.00	27	Wardat <i>et al.</i> (2023)
20	105	English language learners, self-efficacy, and the achievement gap: Understanding the relationship between academic and social-emotional growth	2021	35.00	53	Soland & Sandilos (2021)

3.3. Visualization of Research Data Mapping of Mathematical Proficiency Research

Data mapped using VOSviewer produces 3 forms of visualization, namely network visualization in **Figure 2**, overlay visualization in **Figure 3**, and density visualization in **Figure 4**. Network visualization shows terms generated from the abstract and keywords that are considered appropriate to the keywords used at the time of data collection it was divided into 6 clusters with a total of 97 items. Each item has a different link, total link strength, and occurrence. Overall, based on network visualization, the total link strength is 8393 while the total number of links is 2620. The following is a more detailed explanation of each cluster:

- i) Cluster 1 which is marked in red consists of 23 items, namely belief, case, classroom, education, experience, factor, mathematical proficiency, mathematical thinking, mathematics, mathematics classroom, mathematics education, mathematics instructions, mathematics teacher, opportunity, perception, proficiency, reasoning, strand, success, teacher, teaching, teaching mathematics, and technology.

there are the same number of items). Terms that are often used both as keywords and as abstracts in research articles related to keywords such as mathematics and proficiency.

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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