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Trends in Mathematical Literacy and Numeracy Research Based on Bibliometric Analysis of Scopus Articles from 2014 to 2024

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Abstract

This study aims to analyze trends in mathematical literacy and numeracy research using a bibliometric approach based on publication data from Scopus during the period 2014–2024. The method used is bibliometric analysis with PRISMA stages, including identification, selection, eligibility, and inclusion of relevant articles. Data were analyzed using VOSviewer software to map author collaborations, publication distribution by year, research types, and emerging topic trends. The results show a significant increase in the number of publications over the past decade, with quantitative research dominating (39%) and qualitative research (30%). Authors such as Vince Geiger, Ratu Ilma Indra Putri, and Zulkardi were the main contributors to this topic. Keyword analysis produced five main clusters, namely numeracy teaching, integrated mathematical literacy, mathematics education in elementary schools, numeracy assessment development, and adult numeracy literacy. These findings provide an overview of the global development of mathematical literacy and numeracy, which is relevant to Indonesia's education policies, particularly the strengthening of numeracy competencies in the National Assessment. Further research is recommended to expand the focus on adult numeracy literacy, the integration of financial literacy, and the development of contextual assessment instruments that are appropriate to local cultures.

Keywords: mathematical literacy, numeracy, bibliometric analysis, VOSviewer

Abstrak

Penelitian ini bertujuan untuk menganalisis tren penelitian literasi matematis dan numerasi dengan menggunakan pendekatan bibliometrik berbasis data publikasi pada Scopus selama periode 2014–2024. Metode yang digunakan adalah analisis bibliometrik dengan tahapan PRISMA, mencakup identifikasi, seleksi, kelayakan, dan inklusi artikel yang relevan. Data dianalisis menggunakan perangkat lunak VOSviewer untuk memetakan kolaborasi penulis, distribusi publikasi per tahun, jenis penelitian, serta tren topik yang muncul. Hasil penelitian menunjukkan peningkatan signifikan jumlah publikasi pada dekade terakhir, dengan dominasi penelitian kuantitatif (39%) dan kualitatif (30%). Penulis seperti Vince Geiger, Ratu Ilma Indra Putri, dan Zulkardi menjadi kontributor utama dalam topik ini. Analisis kata kunci menghasilkan lima klaster utama, yaitu pengajaran numerasi, literasi matematis terintegrasi, pendidikan matematika di sekolah dasar, pengembangan asesmen numerasi, dan literasi numerasi orang dewasa. Temuan ini memberikan gambaran perkembangan literasi matematis dan numerasi secara global sekaligus relevan dengan kebijakan pendidikan di Indonesia, khususnya penguatan kompetensi numerasi dalam Asesmen Nasional. Penelitian selanjutnya disarankan untuk memperluas fokus pada literasi numerasi orang dewasa, integrasi literasi finansial, serta pengembangan instrumen asesmen kontekstual yang sesuai dengan budaya lokal.

Kata kunci: literasi matematis, numerasi, analisis bibliometrik, VOSviewer

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INTRODUCTION

Mathematical literacy and numeracy are two fundamental competencies that are extremely important in 21st-century education (Gorman et al., 2023). Mathematical literacy is defined as an individual's ability to formulate, use, and interpret mathematics in various contexts, while numeracy encompasses the ability to understand and use numbers in everyday life (Karaali et al., 2016; OECD, 2019). Both of these skills are the primary focus of various international assessments such as the

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Programme for International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMSS) (Hiller et al., 2022; Mullis et al., 2020). Good literacy and numeracy achievements have been proven to contribute to enhancing human resource competitiveness in various countries (Gorman et al., 2023; Grotlüschen et al., 2020). Therefore, research mapping the development of mathematical literacy and numeracy studies is urgently needed as a basis for formulating data-driven education policies.

In Indonesia, mathematical literacy and numeracy are part of the priorities for educational development, especially after the implementation of the National Assessment by the Ministry of Education, Culture, Research, and Technology (Muniasari et al., 2024). This assessment measures students' literacy and numeracy skills to map the quality of education nationally (Indonesia, 2021). Many national-level studies focus on learning strategies or evaluating student achievement in literacy and numeracy (Farokhah et al., 2024; Prabowo et al., 2023). However, studies identifying global trends in publications in this field are still rare. Yet, such information is crucial for assessing the position of national research within the international research landscape.

Bibliometric analysis is an appropriate method for mapping research trends and identifying developments in specific topics quantitatively (Alghar & Rizqiyah, 2024; Wirzal et al., 2022). This method is used to analyze publication metadata such as the number of publications per year, productive authors, inter-researcher collaboration, target journals, and frequently used keywords (Donthu et al., 2021). The results of bibliometric analysis can help researchers and policymakers understand the direction of development in a particular field of study (Farokhah et al., 2024). In the context of mathematical literacy and numeracy, bibliometrics can provide an overview of popular topics and areas that are still rarely researched.

Previous studies have shown that mathematical literacy has become a major concern for researchers in various countries, both in the context of primary, secondary, and higher education (Genc & Erbas, 2019; Goos et al., 2013; Hidayatulloh et al., 2021). These studies typically focus on students' ability to solve contextual problems, the integration of technology in learning, or the development of assessment tools (Ozkale & Ozdemir Erdogan, 2020; Yim, 2024). Meanwhile, numeracy is more often studied in relation to financial education, statistics, or understanding number concepts in daily life (Bolstad, 2021; Geiger et al., 2015). Although mathematical literacy and numeracy are closely related, studies combining both within a single analytical framework remain limited. This indicates a need for research integrating both concepts.

In addition, many literacy and numeracy studies are case studies or limited to specific regions. For example, some studies only examine mathematical literacy skills without linking them to global trends (Forgasz et al., 2024; Hidayatulloh et al., 2025; Purnomo et al., 2022). This situation results in insights that are often partial and fail to fully represent the overall development of research. Bibliometric analysis based on international publication data, such as Scopus, enables the identification of a broader research landscape. This is important for understanding the extent of Indonesian researchers'

contributions to the discourse on mathematical literacy and numeracy.

Previous studies using bibliometric analysis in the field of mathematics education generally only highlight one aspect, such as mathematical literacy alone or numeracy alone (Farokhah et al., 2024; Wirzal et al., 2022). This narrow approach has left the conceptual relationship between the two under-explored. However, a comprehensive understanding of mathematical literacy and numeracy can strengthen learning design, assessment, and educational policy. Therefore, this study aims to bridge this gap by analyzing both themes.

The time frame used in this study is 2014–2024. This period was chosen because it covers research developments over the past decade, including significant changes resulting from the digital revolution and the post-COVID-19 pandemic (Fauzi, 2022). These changes have influenced teaching, assessment, and research methods in the fields of literacy and numeracy (Yim, 2024). With a long time frame, this analysis can identify long-term patterns as well as fluctuations that occur during certain periods. This provides a richer picture than analyses with a narrow time frame. .

In addition to analyzing publication trends, bibliometric analysis research also maps frequently used keywords and emerging potential new topics (Donthu et al., 2021). Keyword co-occurrence analysis can reveal connections between topics, as well as areas that have not received much attention from researchers (Durmaz, 2023). For example, terms such as “financial literacy” or “artificial intelligence” may appear in the context of mathematical and numeracy literacy, but have not been a primary focus. Identifying this potential is important for guiding future research.

Based on the previous description, this study aims to map trends in mathematical literacy and numeracy research in Scopus-indexed publications from 2014 to 2024. This analysis covers annual publication trends, journal quartile levels, author collaboration, keyword distribution, and potential new topics. The results are expected to contribute to the development of scientific knowledge in the field of mathematics education and serve as a reference for researchers, educators, and policymakers. This study addresses the gap in bibliometric studies focused on mathematical literacy and numeracy.

METHODS

This study uses a bibliometric approach with PRISMA to select and analyze publications. The data source was obtained from the Scopus database in the form of Research Information Systems (.ris) files downloaded in August 2025. The time range analyzed was 2014–2024 to ensure data currency and cover long-term trends. The inclusion criteria for this study include: (1) articles published in Scopus-indexed journals, (2) discussing mathematical literacy, numeracy, or both, (3) written in English or Indonesian, and (4) having complete metadata containing article information. Exclusion criteria include: (1) documents in the form of proceedings, editorials, book chapters, or conference papers; (2) articles outside the 2014–2024 timeframe; and (3) articles irrelevant to the theme. Inclusion and exclusion criteria are presented in Table 1.

Table 1. Inclusion-Exclusion Criteria

Inclusion	Exclusion
Data consists of articles from the Scopus database.	Data consists of articles not from the Scopus database.
Articles published between 2014 and 2024.	Articles published before 2014 or after 2024.
Research articles with titles or keywords related to literacy and numeracy.	Research articles without titles or keywords related to literacy and numeracy.
Articles presenting research on literacy and numeracy.	Articles not presenting research on literacy and numeracy.

The analysis stage was carried out through five main procedures. First, the author searched for articles on the themes of "mathematical literacy" and "numeracy" from the Scopus database using the SeForRa application. Second, data screening followed the PRISMA flow, which includes four stages: identification, screening, eligibility, and inclusion. In the identification stage, all publications matching the initial keywords were collected. The screening stage was used to remove duplicates and irrelevant articles. The eligibility stage ensured that the articles met the inclusion criteria, and the included stage produced the final data set for further analysis. Third, the downloaded files in .ris format that had gone through the PRISMA flow were then completed with their identities, including abstracts and keywords, using the Mendeley application. Fourth, the .ris data completed in the Mendeley application is then imported into VOSviewer software to visualize author collaboration networks, keyword co-occurrence, and publication distribution by country. Fifth, descriptive statistical analysis is performed to calculate the number of publications per year, top keywords, and author distribution based on productivity. The PRISMA guidelines are presented in Figure 1.

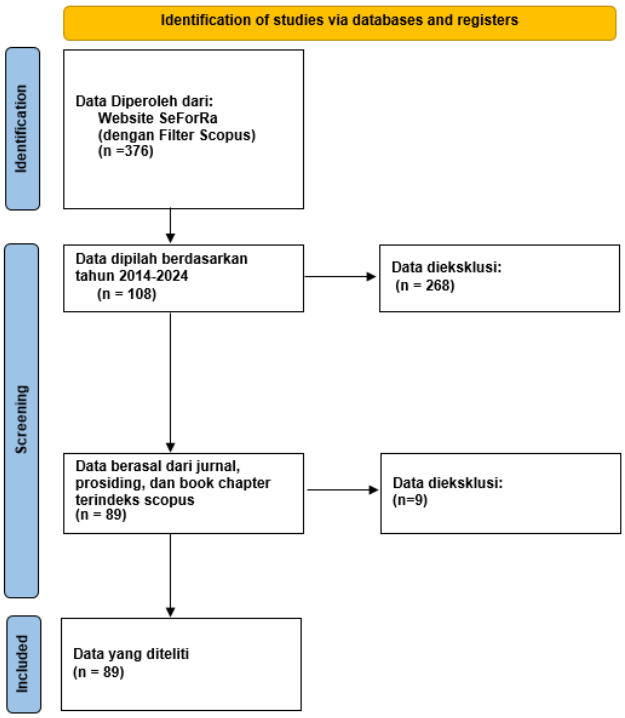

Figure 1. PRISMA flowchart for mathematical literacy and numeracy research for the period 2014–2024

RESULT AND DISCUSSION

Development of Research on Mathematical Literacy and Numeracy from 2014 to 2024

Based on the results of a search of publications in Scopus, the trend in research on mathematical literacy and numeracy in the period 2014–2024 shows fluctuating but generally increasing development (see Figure 2). Publications in the early years of the period were relatively low, averaging less than five articles per year from 2014 to 2016. From 2017 to 2019, the number of publications increased in line with the growing global attention to international assessments such as PISA and TIMSS. The peak in publications was observed in the period 2020 to 2024, with many publications more than doubling compared to previous years. This surge was driven by increased research related to online learning during and after the COVID-19 pandemic, which affected mathematical and numeracy literacy.

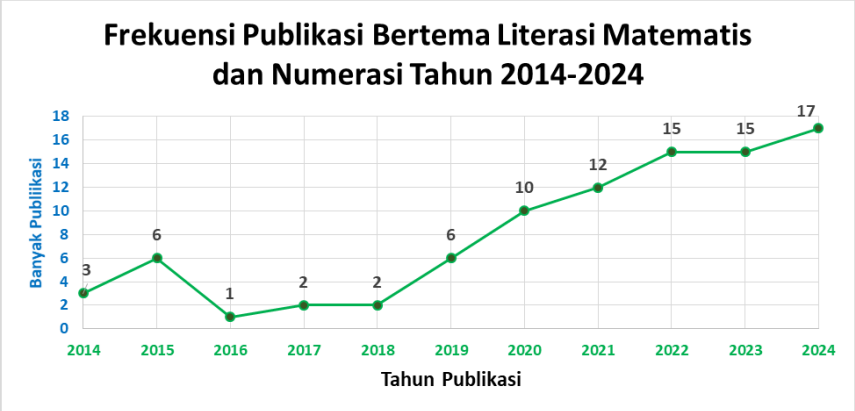

Figure 2. Frequency of Publications on Mathematical and Numeracy Literacy from 2014 to 2024

This development is in line with global trends that show increasing attention to mathematical literacy and numeracy skills as part of 21st-century skills (Forgasz et al., 2024). International studies indicate that mathematical literacy is not merely about computational skills but also encompasses critical thinking, contextual problem-solving, and interpreting data-based information (OECD, 2019). The COVID-19 pandemic accelerated this transformation by triggering innovations in technology-based learning and adaptive assessments for online learning (Fauzi & Chano, 2022; Heyd-Metzuyanim et al., 2021). The increase in publications from 2020 to 2024 was also influenced by the large number of studies investigating the impact of the pandemic on numeracy literacy outcomes at various levels of education, from elementary school to higher education (Grotlüschen et al., 2020; Heyd-Metzuyanim et al., 2021).

These findings reinforce previous reports that research on mathematical and numeracy literacy has grown rapidly in response to increasing demands for numeracy competencies across various sectors of life, including employment, citizenship, and financial literacy (Geiger et al., 2020; Graven et al., 2022). In this context, research from 2014 to 2019 primarily focused on developing concepts and measurement tools, while the period from 2020 to 2024 has seen a greater emphasis on implementing innovative learning strategies and measuring post-pandemic outcomes (Geiger et al., 2014; Shongwe, 2022). This shift in focus reflects a transition from theoretical aspects to practical implementation

relevant to global challenges.

Types of Publications and Quartile Levels in Research on Mathematical Literacy and Numeracy from 2014 to 2024

The analysis results shown in Table 2 indicate that the majority of mathematical literacy and numeracy research during the 2014–2024 period was published in the form of scientific journal articles indexed in Scopus, while the remainder consisted of international conference proceedings and book chapters. Journal articles dominate with a percentage of over 80% of total publications. In terms of journal rankings based on the Scopus quartile system, publications in Q1 journals account for the largest proportion, approximately 45% of total articles. This is followed by Q2 with approximately 30%, Q3 at 15%, and Q4 at only around 5%. The remaining 5% are publications without quartile rankings because they originate from conference proceedings or books. This distribution indicates that the topic of mathematical and numeracy literacy is a focus in reputable international journals.

Table 2. ublication type, quartile level, and quantity of publications on mathematical and numeracy literacy research from 2014 to 2024

Quartile Level	Journal/Proceedings Name	Quantity	Quartile Level	Journal/Proceedings Name	Quantity
Q2	Acta Psychologica	1	Q2	*International Journal of Instruction*	2
Pros.	*AIP Conference*	1	Q2	*International Journal of Mathematical Education in Science and Technology*	4
Q2	*Australian Journal of Education*	1	Q1	*International Journal of Science and Mathematics Education*	2
Q2	*Australian Journal of Teacher Education*	1	Q1	*International Journal of STEM Education*	1
Q2	*Canadian Journal of Science, Mathematics and Technology Education*	1	Q2	*International Review of Education*	2
Q1	*CBE Life Sciences Education*	1	Q2	*Journal of Adolescent & Adult Literacy*	1
Q2	*Cognitive Development*	1	Q4	*Journal of Education and Learning*	1
Q1	*Computer & Education*	2	Pros.	*Journal of Physics: Conference Series*	3
Q1	*Computers and Education: Artificial Intelligence*	1	Q2	*Journal on Mathematics Education*	6
Q3	*Cypriot Journal of Educational Sciences*	1	Q3	*Kasetsart Journal of Social Sciences*	1
Q1	*Early Childhood Research Quarterly*	1	Q1	*Large-scale Assessments in Education*	1
Q4	*Educational Research and Reviews*	1	Q1	*Mathematical Thinking and Learning*	1
Q1	*Educational Studies in Mathematics*	5	Pros.	*Mathematics Education Research Group of Australasia*	3
Q3	*Egitim ve Bilim*	1	Q1	*Mathematics Education Research Journal*	5
Q3	*European Journal of Educational Research*	1	Q3	*Mathematics Teacher Education and Development*	1
Q1	*European Journal of Psychology of Education*	1	Q1	*NeuroImage*	1
Q2	*Frontiers in Psychology*	1	Q3	*Participatory Educational Research*	1
Q1	*Heliyon*	1	Q1	*Plos One*	1
Q4	*Historia Mathematica*	1	Pros.	*Procedia - Social and Behavioral Sciences*	1
Q3	*İlköğretim Online*	1	Buku	*Research in Mathematics Education in Australasia 2016–2019*	1
Q3	*Infinity Journal*	2	Q2	*Social Sciences*	1
Q2	*Int. J. Res. Undergrad. Math. Ed*	1	Q4	*Studies in Social Science Research*	1
Q3	*International Journal of Education in Mathematics, Science and Technology*	2	Q1	*The Journal of Mathematical Behavior*	2
Q1	*International Journal of Educational Development*	3	Q3	*The New Educational Review*	1
Q3	*International Journal of Elementary Education*	1	Q4	*Turkish Journal of Computer and Mathematics Education (TURCOMAT)*	1
Q3	*International Journal of Evaluation and Research in Education (IJERE)*	2	Q1	*ZDM*	8

The dominance of publications in Q1 and Q2 journals reflects that research on this topic is of internationally recognized quality. Q1 journals generally have global coverage with a rigorous review process, so that only articles with significant contributions are accepted (Geiger et al., 2015). The high number of publications in top-ranked journals indicates that mathematical literacy and numeracy are not merely local trends but have become a strategic focus of international research (OECD, 2019). Publications in proceedings, although relatively few in number, still play an important role in disseminating initial ideas, case study results, or instrument development that can later be republished in reputable journals (Afni & Hartono, 2020; Prabawati et al., 2019).

This finding aligns with bibliometric studies in mathematics education, which indicate that research relevant to international policies, such as PISA and TIMSS, is more likely to be published in Q1 and Q2 journals (Genc & Çolakoğlu, 2021; Graven & Jorgensen, 2024; Rosa & Orey, 2015). This is likely due to the global relevance of mathematical literacy and numeracy issues, which are directly linked to curriculum development and educational policies in various countries (Graven et al., 2022; Prabowo et al., 2023). Research focusing on international data-based evaluation, technology integration, and context-based learning innovation has a greater chance of being accepted in high-impact journals (Rosa & Orey, 2015; Yim, 2024). Thus, the results of this analysis indicate that future research should prioritize methodological quality and relevance to global issues in order to secure publication in high-ranking journals.

Researchers' Contributions to Research on Mathematical Literacy and Numeracy from 2014 to 2024

Bibliometric analysis shows that there are researchers who have consistently contributed to publications on mathematical literacy and numeracy from 2014 to 2024. Based on the data in Figure 3, several authors have more than one Scopus-indexed publication, including Vince Geiger (5 publications), Ratu Ilma Indra Putri (3 publications), Zulkardi (3 publications), Anne Bennison (3 publications), Helen Forgasz (3 publications), and Merrilyn Goos (3 publications). Other authors such as Lathiful Anwar, Hendro Permadi, Heri Purnomo, and others each have two publications with a high total link strength. This data indicates the presence of a dominant group of researchers in this field. Table 3 presented in this section details the authors' names, number of publications, and total link strength of research on mathematical and numeracy literacy.

Table 3. List of Authors with More Than One Publication on the Topic of Mathematical and Numeracy Literacy in Scopus (2014-2024)

No.	Author Name	Number of Publication	Total Link Strength
1	Vince Geiger	5	12
2	Ratu Ilma Indra Putri	3	9
3	Zulkardi	3	9
4	Anne Bennison	3	7
5	Helen Forgasz	3	7
6	Merrilyn Goos	3	7
7	Latifhul Anwar	2	10
8	Hendro Permadi	2	10

9	Heri Purnomo	2	10
10	Rully Charitas Indra Prahmana	2	6
11	Cholis Sa'dijah	2	6
12	Arthur Bakker	2	4
13	Paul Drijvers	2	4
14	Mellony Graven	2	3
15	Murat Genc	2	2
16	William Zahner	2	2

The presence of core researchers with high publication rates plays a role in guiding the development of topics in mathematical literacy and numeracy. Researchers such as Geiger and Zulkardi, who have long been recognized in the field of mathematics education, particularly in the development of contextual approaches and the integration of international assessment results into the national curriculum (Forgasz et al., 2024; Geiger et al., 2020; Risdiyanti et al., 2024). Their involvement extends beyond research publications to international collaboration activities, assessment instrument development, and teacher training (Geiger et al., 2023). This strengthens research networks and promotes improved research quality in the Asia-Pacific region and globally.

An analysis of the connections between authors (co-authorship network) shows that these core authors work in strong collaborations across countries and institutions. This pattern of collaboration is consistent with previous findings that extensive research networks contribute positively to scientific productivity and opportunities for publication in reputable journals (Bordons et al., 2015). The implication of these findings is the importance of encouraging research collaboration between Indonesian researchers and international researchers with expertise in mathematical literacy and numeracy. Thus, in addition to increasing the quantity of publications, this step can also improve the quality of research methodology and its global impact.

Types of Research on Mathematical Literacy and Numeracy from 2014 to 2024

An analysis of publications in Scopus from 2014 to 2024 shows that research on mathematical literacy and numeracy is dominated by quantitative methods, with a total of 35 publications (39%). Qualitative methods rank second with 27 publications (30%), followed by development research with 12 publications (14%). Mixed methods (mix method) account for 14 publications (16%). Bibliometric analysis-based research comprises only 1 publication (1%). These data indicate that research in this topic focuses more on hypothesis testing and numerical analysis than on exploring phenomena or mapping literature.

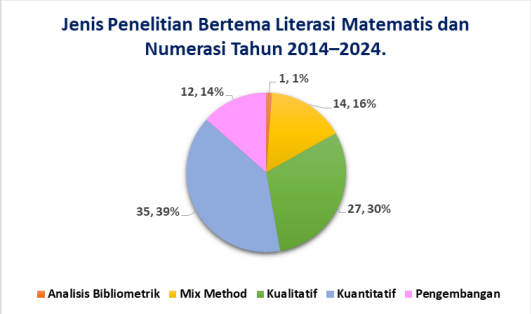

Figure 3. Types of Publications on Mathematical and Numeracy Literacy from 2014 to 2024

The dominance of quantitative research is in line with global trends that emphasize measuring learning outcomes through standardized instruments (OECD, 2019). Quantitative research provides objective, generalizable results that can be used as a basis for educational policy-making (Creswell & Creswell, 2017). Meanwhile, data from qualitative methods indicate researchers' interest in understanding the social context, learning strategies, and factors influencing literacy and numeracy (Beaudine, 2022). Developmental and mixed-method research suggests that these topics can be implemented in learning and assessment (Callingham et al., 2015; Forgasz et al., 2024).

In the Indonesian context, the diversity of research methods is closely related to the implementation of the Merdeka Curriculum and the National Assessment program, which prioritize literacy and numeracy as essential competencies (Hidayatulloh et al., 2025; Purnomo et al., 2022). Quantitative research can help the government in broadly assessing student achievements, while qualitative research can provide insights into the factors that hinder and support learning in the field (van der Wal et al., 2023). Development research contributes to the creation of contextual learning tools, while mixed methods allow for the integration of quantitative and qualitative data for comprehensive findings(Forgasz et al., 2024). Meanwhile, the low level of bibliometric research presents a great opportunity for Indonesian researchers to map topics related to mathematical and numeracy literacy.

Research Trends in Mathematical and Numeracy Literacy Research from 2014 to 2024

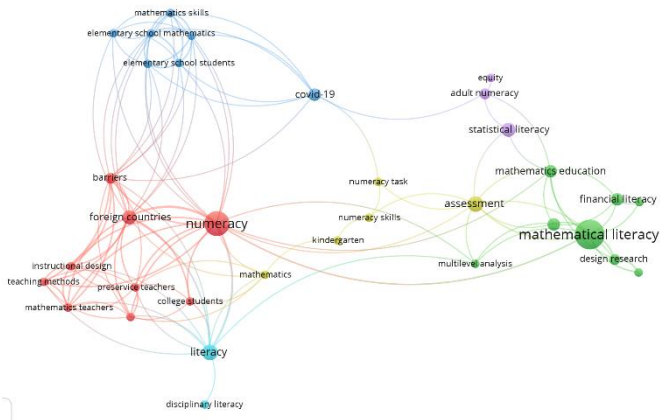

Figure 4. Research Topic Network for Mathematical and Numeracy Literacy from 2014 to 2024

The visualization of the keyword network map from VOSviewer shows several main clusters that illustrate research trends in mathematical literacy and numeracy from 2014 to 2024. The red cluster is

dominated by keywords such as numeracy, barriers, foreign countries, instructional design, teaching methods, preservice teachers, and mathematics teachers. The green cluster centers on mathematical literacy, which is closely related to financial literacy, design research, mathematics education, and multilevel analysis. The blue cluster highlights themes such as literacy, elementary school mathematics, elementary school students, and mathematics skills. The yellow cluster focuses on keywords such as assessment, numeracy skills, numeracy tasks, and kindergarten. The purple cluster is relatively small, with a focus on equity, adult numeracy, and statistical literacy.

The results of this mapping show that research on mathematical literacy and numeracy is developing in several key directions. First, there is a focus on numeracy learning and teaching at various levels of education, including pre-service teachers and mathematics teachers, as reflected in the red cluster. Second, the green cluster indicates a strong interest in integrating mathematical literacy with other aspects of literacy, such as financial literacy, as well as the use of research design to develop effective learning interventions. Third, the connection between literacy, mathematical skills, and basic education is evident in the blue cluster, indicating a focus on learning at the elementary school level. This global trend aligns with international agendas such as the OECD Learning Compass and PISA, which emphasize mathematical literacy and numeracy as 21st-century competencies (OECD, 2019).

In the Indonesian context, the trends depicted in this map are relevant to the implementation of the National Assessment, which measures numeracy literacy among students at various levels of education (Farokhah et al., 2024; Hidayatulloh et al., 2025). The yellow cluster containing the keyword “assessment” indicates research opportunities in developing numeracy assessment instruments tailored to local contexts (Rosa & Orey, 2015). Additionally, the presence of keywords such as “financial literacy” and “design research” indicates room for innovative learning that integrates mathematical literacy with practical daily life needs (Bennison, 2022; Ozkale & Ozdemir Erdogan, 2020). The low correlation between the keyword “adult numeracy” and research in Indonesia shows that numeracy literacy for adults is still understudied (Heyd-Metzuyanim et al., 2021). This opens up new research opportunities, particularly in supporting equivalency education programs and improving the numeracy competencies of the workforce.

CONCLUSION

This study examines trends in mathematical literacy and numeracy based on a bibliometric analysis of publications in the Scopus database during the period 2014–2024. The results of the analysis show an increase in the number of publications from year to year, with a predominance of quantitative and qualitative research, as well as significant contributions from a number of prominent authors such as Vince Geiger, Ratu Ilma Indra Putri, and Zulkardi. Keyword mapping reveals five main clusters reflecting global research directions, including numeracy instruction, integrated mathematical literacy, mathematics education in elementary schools, numeracy assessment development, and adult numeracy literacy, which remains under-researched. These findings are relevant to Indonesia's education policies,

particularly the implementation of the National Assessment and the strengthening of 21st-century competencies. Further research is recommended to expand the focus on adult numeracy literacy, the integration of financial literacy into learning, and the development of assessment instruments that are contextualized to local culture and needs.

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