Journal of General Education and Humanities
Vol. 4, No. 4, November 2025, pp. 1913 – 1928, https://doi.org/10.58421/gehu.v4i4.775
ISSN 2963-7147

Mapping Research Trends in Mathematical Communication: A Bibliometric Review Using VOSviewer

Zulaika Daningtyas[1], Nizlel H[illegible]a[2], Syamsir Sainuddin[3]
[1,2,3]Universitas Jambi, Jambi, Indonesia

Article Info

Article history:

Received 2025-09-26
Revised 2025-10-29
Accepted 2025-10-29

Keywords:

Bibliometric Analysis
Mathematical Communication
Research Trends
Scopus
Vosviewer

ABSTRACT

This study aims to examine the development and trends of research on mathematical communication indexed in the Scopus database through a bibliometric analysis using VOSviewer. Data were collected using the keyword "mathematical communication" for the period 2015–2025, resulting in 431 relevant documents and 53 terms grouped into three main clusters. The metadata were exported in RIS format and analysed to map author collaboration, keyword networks, citation patterns, and research development trends. The findings show that most publications are journal articles, with Indonesia contributing the largest share, particularly through the Infinity Journal. The publication trend reveals a fluctuating pattern with significant growth since 2023, indicating rising global interest in mathematical communication research. The analysis identifies emerging clusters on mathematical representation, RME-based instruction, and multimodal communication. Importantly, the findings highlight how mathematical communication research underpins 21st-century pedagogical innovation by linking communication, reasoning, and technology-enhanced learning. Furthermore, the study identifies research gaps in digital communication models and cross-national collaboration, highlighting the need for stronger international partnerships and theoretical integration to advance the field. By mapping this evolving domain, the study provides insights that can inform educators and policymakers in enhancing communication-centred mathematics curricula and promoting globally connected research initiatives.

.

Corresponding Author:

Zulaika Daningtyas
Master of Mathematics Education, Faculty of Teacher Training and Education, Universitas Jambi
Email: dtyaszulaika@gmail.com

1. INTRODUCTION

In the 21st century, mathematics education faces increasingly complex challenges that go beyond mastering concepts and computational skills. Learning now demands higher-order competencies, such as critical thinking, problem-solving, collaboration, and

https://doi.org/10.58421/gehu.v4i4.775

the ability to communicate mathematical ideas effectively in various forms, including oral, written, symbolic, and visual. In the 21st century, mathematics education faces increasingly complex challenges that go beyond mastering concepts and computational skills. Learning now demands higher-order competencies such as critical thinking, problem-solving, collaboration, and the ability to communicate mathematical ideas effectively in oral, written, symbolic, and visual forms [1], [2]. Mathematical communication has therefore become a key competency in mathematics learning, as it enables students to construct, represent, and share mathematical ideas clearly and logically. Effective communication not only reinforces conceptual understanding but also cultivates reasoning and reflective thinking skills [3], [4].

From a theoretical perspective, the relationship between communication and cognitive development has been emphasised in several learning frameworks. Sfard (2008) introduced the concept of *commognition*, which views communication and cognition as inseparable processes in learning mathematics. Similarly, Vygotsky's theory of social constructivism underscores that learning occurs through language-mediated interaction, where communication serves as a tool for constructing shared meaning and advancing understanding. These perspectives affirm that students' ability to articulate mathematical reasoning reflects the development of their cognitive processes within a social context. Empirical studies further confirm that communication plays a central role in strengthening conceptual understanding and encouraging students to express their reasoning in various forms of representation [5], [6], [7].

The National Council of Teachers of Mathematics (NCTM) [8] emphasizes communication as one of the essential standards for mathematics learning, as it enables students to express their ideas, justify their reasoning, and participate in mathematical discourse that fosters a more profound comprehension. However, despite these pedagogical and theoretical recognitions, challenges remain in measuring and enhancing students' mathematical communication, especially in digital and collaborative learning environments [9],[10],[11].

Although numerous studies have examined mathematical communication through instructional models, classroom practices, and assessment approaches, few have systematically investigated the broader research landscape. Despite the increasing research on mathematical communication, there remains a limited amount of bibliometric evidence summarising global publication trends, dominant themes, and collaboration patterns. A systematic and data-driven mapping is therefore needed to reveal how this research field has evolved and identify emerging directions for future inquiry.

Alongside advances in technology and the rapid growth of scientific publications, bibliometric analysis offers a powerful quantitative approach to illustrate knowledge mapping based on publications, keywords, author collaboration, and thematic development. VOSviewer, as one of the most widely used visualisation tools, enables researchers to identify research clusters, co-authorship networks, and keyword relationships within a large corpus of literature [11]. Integrating bibliometric analysis with a Systematic Literature Review (SLR) provides a comprehensive picture of the structure,

growth, and collaboration trends in mathematical communication research [12], [13], [14], [15], [16].

Accordingly, this study aims to analyse the development of mathematical communication research in mathematics education based on Scopus-indexed publications from 2015 to 2025, using bibliometric analysis with VOSviewer. Specifically, the study seeks to address the following research questions:

1. What are the main publication trends in mathematical communication research (2015–2025)?
2. Which countries, authors, and journals contribute most to this field?
3. What are the emerging themes and research gaps identified through keyword mapping?

The findings are expected to provide meaningful insights for educators, researchers, and policymakers in strengthening mathematical communication through the development of innovative instructional models, relevant assessment instruments, and international collaborative research initiatives.

2. METHOD

2.1 Research Design

This study employed a Systematic Literature Review (SLR) combined with bibliometric analysis using VOSviewer software to analyse the data. This method was selected because it is appropriate for identifying, evaluating, and interpreting existing research on mathematical communication, thereby providing a comprehensive overview of research development within a specific period (2015–2025).

2.2 Data Source and Retrieval

The subjects of this study were not individuals but scientific articles indexed in Scopus that focused on mathematical communication. The articles were obtained from the Scopus database using the keyword Title-Abs-Key ("mathematical communication") within the range of 2015–2025. All metadata were exported in RIS format. The process of obtaining the data involved two main steps: searching and screening. As stated by Yani and Soebagyo [17], the SLR process typically includes several essential stages. Articles that met the inclusion criteria were those published between 2015 and 2025, written in either English or Indonesian, and explicitly discussing the topic of mathematical communication. The initial search yielded 431 articles, which were subsequently filtered according to the following inclusion criteria. The selected articles were analysed using VOSviewer to map research trends, author collaborations, keywords, and citation networks.

2.3 Research Procedure

The research procedure followed the Systematic Literature Review (SLR) [18], which consists of three main phases: (1) planning the review, (2) conducting the review, and (3) reporting and dissemination. However, in practice, these phases were further developed into more detailed operational steps. Recent studies have proposed a more systematic and applicable framework known as Bibliometric-Systematic Literature

https://doi.org/10.58421/gehu.v4i4.775

Reviews (B-SLR), introduced by Marzi et al. [19], which involves ten main steps: (1) Needs, (2) Review Questions, (3) Scope, (4) Search, (5) Screening, (6) Coding, (7) Mapping, (8) Appraising, (9) Synthesizing, and (10) Communicating. All these steps were carried out using the Scopus database and analysed with VOSviewer to produce accurate bibliometric mapping and a comprehensive synthesis of relevant research.

2.4 Inclusion and Exclusion Process

According to Sauer and S. Seuring [20], the initial stages of an SLR include formulating the research question and defining the scope, as well as the inclusion/exclusion criteria. Consistent with this view, the present study applied four initial stages of SLR. The first phase involved introducing the SLR concept and formulating the main research questions. The third phase, scope, defined the boundaries and inclusion criteria to ensure the quality and relevance of the reviewed articles. Three criteria were used: (1) selecting research trends on mathematical communication from 2015 to 2025, (2) presenting data distribution related to mathematical communication, and (3) identifying the top five most-cited articles to highlight research quality. The fourth stage, search, involved retrieving data from Scopus using the keyword "mathematical communication" within the 10 years (2015–2025). This search produced 431 metadata records, which were exported in RIS format and analysed with VOSviewer.

2.5 Screening and Coding Process

The Screening stage was carried out in two phases. First, articles were filtered by title, keywords, citation count, publication year, and publisher, eliminating those not aligned with the study's focus. Duplicates and irrelevant records were removed manually. Second, the five most-cited articles were selected as the primary sources for in-depth analysis of mathematical communication. The Coding stage involved organising the selected Scopus metadata using VOSviewer to address the research questions within the SLR framework. The following stages, Mapping and Appraising, aimed to visualise relationships and assess article quality. The final stages, Synthesising and Communicating, summarised the main findings to answer the research questions and presented the results systematically for readers and future researchers.

2.6 Research Instruments and Software Parameters

The instruments used in this study included the Scopus database as the primary source of metadata, encompassing information such as article titles, authors, publication years, keywords, citation counts, and author affiliations. Metadata were exported in CSV or RIS format for further processing. VOSviewer (version 1.6.20) was utilised as the bibliometric analysis tool to map relationships among authors, keywords, citations, and publication trends. The bibliometric parameters analysed included co-authorship, co-occurrence, citation, and co-citation networks. The counting method used was full counting, with a minimum occurrence threshold of 5 to ensure significant node representation in the visualised networks. Additionally, a manual coding sheet was

developed to classify articles based on topic, research method, contribution, and relevance to the field of mathematical communication studies.

2.7 Data Collection Procedures

Data collection was conducted through several stages:

1. Retrieving articles from the Scopus database using the keyword "mathematical communication".
2. Defining the publication time frame (2015–2025).
3. Exporting metadata in RIS format.
4. Applying inclusion and exclusion criteria for screening.
5. Removing duplicate and irrelevant data manually.
6. Processing the filtered data through VOSviewer for bibliometric analysis to explore the development of mathematical communication research.

2.8 Data Analysis and Quality Assessment

Data analysis followed the SLR framework, which includes coding, mapping, appraising, and synthesising phases as suggested by Mengist et al. [21]. In this process, selected articles were coded based on essential aspects, including publication year, author names, research methods, study focus, keywords, and contributions to the development of mathematical communication. This systematic coding facilitated the organisation of data for subsequent analysis. After coding, data were mapped using VOSviewer to visually display relationships among authors, institutional collaborations, keyword distributions, publication trends, and citation networks related to mathematical communication.

The quality of each article was then assessed based on its relevance to the research theme, citation frequency, and contribution to the advancement of knowledge in mathematical communication. The results from mapping and evaluation were analysed narratively to identify dominant research patterns, emerging trends, and existing research gaps [22]. This analysis also sought to capture the theoretical, methodological, and practical evolution of mathematical communication studies from 2015 to 2025. Consequently, this research not only presents quantitative bibliometric visualisations but also provides deeper qualitative interpretations. The final stage involved presenting the analytical results in a structured narrative, including recent research trends, author and institutional collaboration networks, major contributions, and potential areas for future investigation. Through this comprehensive presentation, the study aims to provide an integrative understanding of the development of mathematical communication research, based on Scopus data, and to answer the research questions defined earlier.

3. RESULTS AND DISCUSSION

This section presents the results of a bibliometric analysis conducted on 431 documents related to mathematical communication, indexed in the Scopus database, from 2015 to 2025. The analysis aimed to identify the evolution of research trends, author collaboration networks, citation patterns, and keyword co-occurrences in this domain. The visualisation and mapping of bibliometric data were performed using VOSviewer software,

https://doi.org/10.58421/gehu.v4i4.775

which facilitated the detection of major clusters and interconnections among research topics.

3.1 Result

The data collection process was conducted using Scopus as the primary database, and the results were further analysed through the VOSviewer application. Scopus was chosen because it provides a comprehensive and reliable repository of scientific publications, while VOSviewer enables the visualisation of citation networks, article linkages, and other bibliometric analyses, facilitating a more in-depth identification of research trends. Using the keyword *"mathematical communication"*, a total of 431 documents were retrieved from Scopus and exported in RIS format for mapping and analysis with VOSviewer. The search covered ten years (2015–2025).

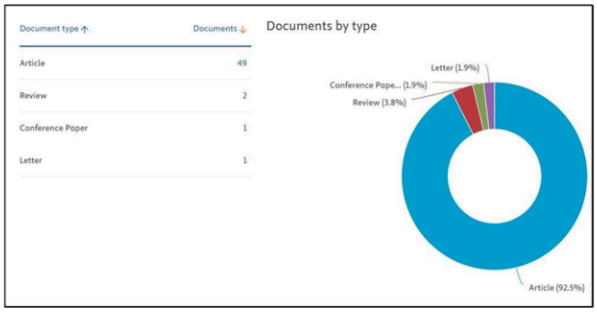

Figure 1. Presents the Distribution of the Retrieved Publications Based on Document Type
Source: Scopus data processed with VOSviewer

From the 431 metadata records identified, only 53 documents met the inclusion criteria after refinement. The distribution shows that journal articles dominate the publication type with 49 papers (92.5%), followed by two reviews (3.8%), one conference paper (1.9%), and one letter (1.9%). These findings highlight that scholarly journals are the main platform for disseminating knowledge related to mathematical communication. The limited number of reviews or meta-analyses indicates a gap in systematic studies within this field, which this bibliometric analysis aims to address.

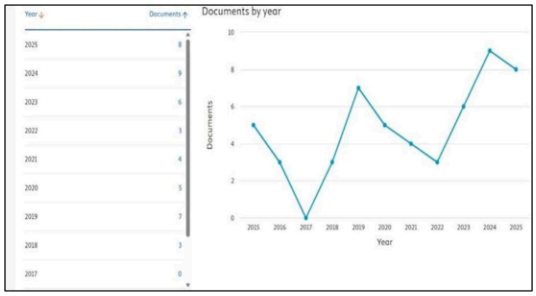

Figure 2. Distribution publication trend from 2015 to 2025.
Source: Scopus data processed with VOSviewer

The publication trend fluctuated over the decade, showing a general upward pattern. In 2015, five articles were published, followed by a sharp decline in 2017 when no publications appeared. The number rose again to three in 2018 and reached seven in 2019. After slight dips in 2020 and 2022, publications increased notably in 2023 (six articles), 2024 (nine articles), and 2025 (eight articles). The upward trajectory over the last three years indicates a renewed scholarly focus on mathematical communication, particularly as digital and collaborative learning models gain traction. The compound annual growth rate (CAGR) of publication output over the decade is estimated at 5.8%, suggesting steady development.

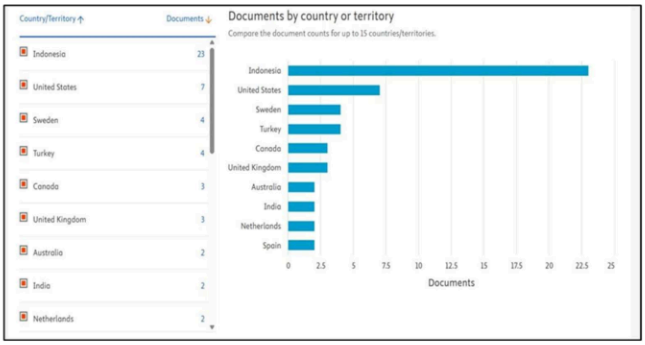

Figure 3. Displays the Distribution of Publications by Country of Origin.
Source: Scopus data processed with VOSviewer

Indonesia leads with 23 documents, followed by the United States (7), Sweden (4), Turkey (4), the United Kingdom (3), and Canada (3). Other countries, such as Australia, India, the Netherlands, and Spain, contributed two publications each. This dominance by Indonesian researchers demonstrates their active involvement in developing mathematical

https://doi.org/10.58421/gehu.v4i4.775

communication studies. However, the relatively limited international participation highlights the potential for broader global collaboration.

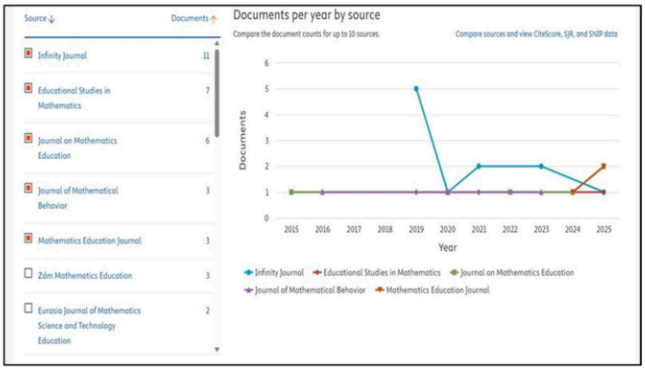

Figure 4. Distribution of Mathematical Communication Publications per Year (2015–2025)
Source: Scopus data processed with VOSviewer

The Infinity Journal contributes the highest proportion of publications (36.7%), followed by Educational Studies in Mathematics (23.3%) and Journal on Mathematics Education (20%). Other contributors include The Journal of Mathematical Behaviour and the Mathematics Education Journal (each at 10%). This distribution illustrates a balanced representation between national and international outlets, reflecting growing global engagement in this domain.

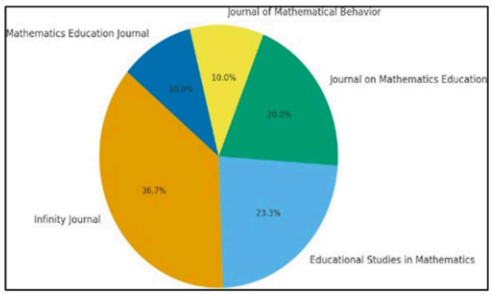

Figure 5. Percentage of the Top 5 Publishers Producing the Most Articles on Mathematical Communication from 2015 to 2025

Figure 5 shows the distribution of publications by journal and publisher. The *Infinity Journal* is the leading source, accounting for 36.7% of total publications, followed by *Educational Studies in Mathematics* (23.3%) and *Journal on Mathematics Education* (20%). Other contributors include *The Journal of Mathematical Behaviour and the*

Mathematics Education Journal, each with a 10% contribution. The combination of national and international journals demonstrates the balanced development of mathematical communication research across different academic forums.

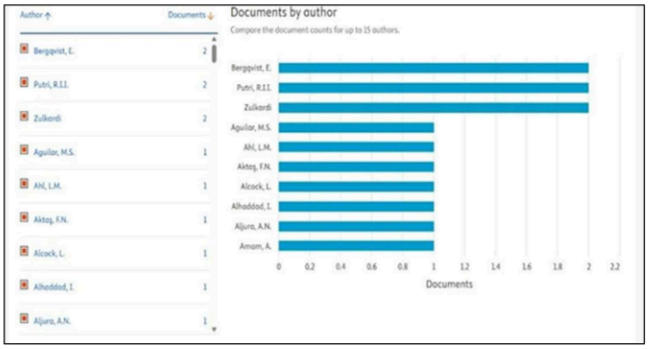

Figure 6. Distribution of Publications by Author (2015–2025)
Source: Scopus data processed with VOSviewer

In terms of authorship (Figure 6), publication output remains relatively dispersed, with no single author dominating the field. The most active contributors are Bergqvist, E., Putri, R.I.I., and Zulkardi, each with two publications, indicating consistent engagement in this research domain. The remaining contributors, including Aguilar, M.S., Ahl, L.M., Aktaş, F.N., and others, each produced one publication. This pattern indicates that research on mathematical communication attracts numerous scholars from various institutions, thereby creating opportunities for interdisciplinary and cross-institutional collaboration.

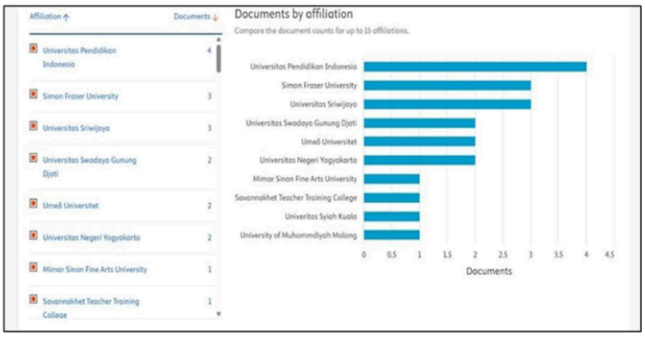

Figure 7. Institutional Distribution of Publications (2015–2025)
Source: Scopus data processed with VOSviewer

https://doi.org/10.58421/gehu.v4i4.775

Institutional distribution (Figure 7) reveals that Universitas Pendidikan Indonesia (UPI) ranks first, with four publications, followed by Simon Fraser University and Universitas Sriwijaya, each with three publications. Other institutions, such as Universitas Negeri Yogyakarta and Umeå University, contributed two publications. These data show that Indonesian universities play a significant role in this area, alongside some active international institutions.

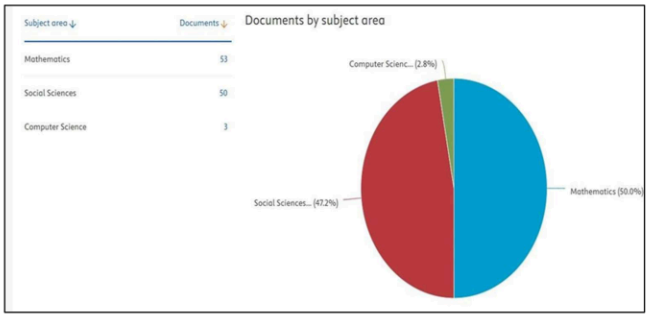

Figure 8. Distribution of Documents Based on the Field of Study in the Topic of Mathematical Communication

Table 1 presents the top five most cited articles in this domain. The most cited paper is by Santos and Semana [23], published in *Educational Studies in Mathematics*, which emphasizes the importance of written mathematical communication, supported by effective assessment strategies. Other highly cited works, such as those by Kaya and Aydin [24] and Ingram et al. [25], focus on teachers' perceptions and student explanations. Furthermore, Setiyani et al. [26] discuss digital teaching modules based on mathematical communication, while Aguilar and Castaneda (2021) [27] connect mathematical competence to the interpretation of COVID-19 data, expanding the application of mathematical communication beyond formal education.

Table 1. Top 5 Articles with the Highest Citations

No	Author	Title	Document Type	Year	Source Title	Cite by
1	L., Santos, Leonor; S., Semana, Silvia	Developing mathematics written communication through expository writing supported by assessment strategies	Review	2015	Educational Studies in Mathematics	30
2	Kaya, Defne; H., Aydin, Hasan	Elementary mathematics teachers' perceptions and lived experiences on mathematical communication	Article	2016	Eurasia Journal of Mathematics, Science and Technology Education	27
3	J., Ingram, Jenni; N., Andrews, Nick; A., Pitt, Andrea	When students offer explanations without the teacher explicitly asking them to	Article	2019	Educational Studies in Mathematics	27
4	S., Setiyani, S.; D.P., Putri, Dian Permana; F., Ferdianto, Ferry; S.H., Fauji, Sandi Hermana	Designing a digital teaching module based on mathematical communication in relation and function	Article	2020	Journal on Mathematics Education	26
5	M.S., Aguilar, Mario Sánchez; A., Castaneda, Apolo	What mathematical competencies does a citizen needs to interpret Mexico's official information about the COVID-19 pandemic?	Article	2021	Educational Studies in Mathematics	23

Bibliometric term mapping using VOSviewer (Figure 10–12) identifies recurring keywords such as *students' mathematical communication skills*, *realistic mathematics education (RME)*, and *junior high school students*. These terms indicate that most studies focus on students' communication skills, RME-based teaching approaches, and their connection to representation and higher-order thinking skills. The keyword co-occurrence analysis grouped the terms into several clusters, as summarised in Table 2, reflecting diverse subfields such as language use, writing, cognitive reasoning, and task-based learning.

The overlay visualisation (Figure 11) further reveals three chronological phases of development:

1) 2015–2021 – theoretical studies focusing on mathematical language and symbols;
2) 2021–2022 – transition toward student competencies and classroom-based implementation
3) (3) 2022–2023 – focus on communication indicators (questioning, reasoning, awareness) and integration with RME.

https://doi.org/10.58421/gehu.v4i4.775

The density visualisation (Figure 12) shows the intensity of research clusters based on keyword relationships. Brighter colours represent stronger linkages, dominated by the terms "communication skill," "realistic mathematics education," and "language."

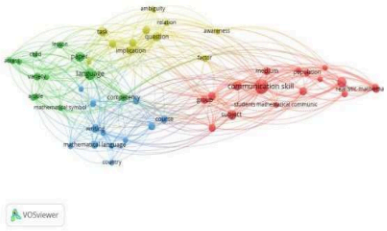

Figure 10. Network Visualization

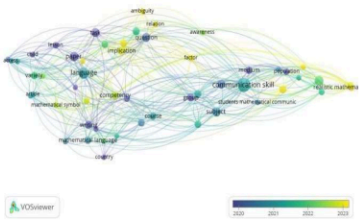

Figure 11. Overlay Visualization

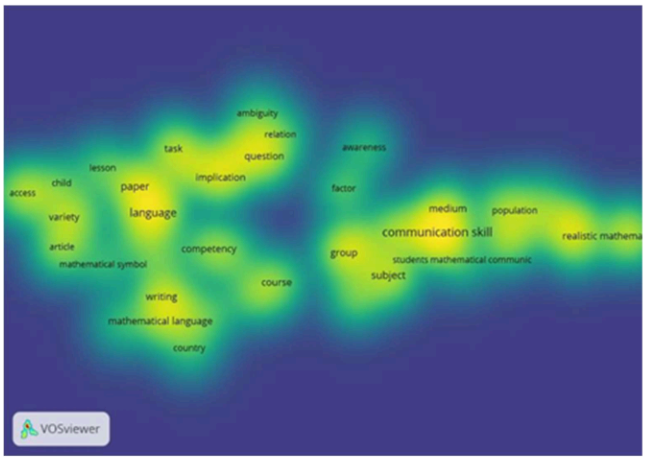

Figure 12. Density Visualization

3.2. Discussion

The bibliometric findings reveal a dynamic and continuous growth in research on mathematical communication over the past decade. Although publication activity fluctuated, a strong resurgence has occurred since 2023, reflecting a renewed scholarly focus aligned with the global emphasis on 21st-century skills [1]. This trend coincides with the increasing integration of digital tools, collaborative platforms, and artificial intelligence (AI) in mathematics education, showing that mathematical communication extends beyond verbal and written modes to encompass multimodal and visual representations.

From a theoretical perspective, these findings are strongly linked to two foundational frameworks: the communication standard of the National Council of Teachers of Mathematics (NCTM) and Vygotsky's social constructivism. The NCTM [8] emphasises communication as a crucial pillar of mathematics learning, enabling students to express, justify, and refine their mathematical ideas through structured discourse. Vygotsky's theory emphasises that learning occurs through socially mediated interaction, where language and communication serve as tools for constructing shared meaning and promoting cognitive development. This bibliometric mapping supports these theoretical propositions, as the co-occurrence of keywords such as *communication*, *representation*, and *reasoning* demonstrates that mathematical communication facilitates conceptual understanding and cognitive development [5], [6].

Compared with the bibliometric study [15], which mainly focused on publication counts and keyword frequency, the present research extends the analysis by exploring author networks, institutional affiliations, and thematic clusters. The results demonstrate a clear evolution from theoretical exploration to contextually oriented and technology-driven practices in mathematics education. In particular, the emergence of clusters related to *Realistic Mathematics Education (RME)* and *digital communication* reflects a pedagogical shift toward contextual and student-centred learning [25], which has demonstrated the effectiveness of digital modules in strengthening students' mathematical communication skills.

Geographically, Indonesia emerged as the most dominant contributor, underscoring its leadership in advancing mathematical communication research. This aligns with [12], who reported that innovative pedagogical models, such as Problem-Based Learning, significantly improve students' mathematical communication and confidence in the classroom. Pedagogically, the findings suggest that mathematics instruction should incorporate meaningful discourse, digital literacy, and multimodal expression as integral components of the teaching and learning process. Teachers can apply these insights by promoting student discussions, peer explanations, and the use of digital visualisation tools to articulate mathematical reasoning more effectively. These implications highlight how bibliometric findings can directly inform curriculum design and instructional strategies aimed at enhancing mathematical communication competence. Nevertheless, the strong dominance of Indonesian publications also reflects a potential dataset bias, as Scopus-indexed and English-language journals may underrepresent research conducted in local or regional contexts. Expanding future reviews to include non-indexed or regional databases could yield a more inclusive global perspective.

This study was limited to Scopus-indexed literature, potentially excluding relevant regional studies published in non-indexed journals. Therefore, while the findings capture global publication trends, they may not represent the full diversity of mathematical communication research. Despite this limitation, the analysis confirms that mathematical communication is increasingly recognised as a key competency in mathematics education, supported by both local and international research efforts. The integration of theoretical, technological, and contextual perspectives illustrates that communication bridges reasoning, representation, and higher-order thinking [5].

Future bibliometric research should integrate *co-citation* and *thematic evolution analyses* to uncover deeper conceptual linkages. Moreover, adopting *AI-assisted learning* and *multimodal discourse analysis* could enhance understanding of how students express mathematical ideas in digital and cross-cultural environments. By mapping this evolving field through clear structural organisation and pedagogically informed interpretation, this study contributes valuable insights for educators, researchers, and policymakers seeking to strengthen communication-focused mathematics curricula and classroom practices worldwide.

4. CONCLUSION

This study successfully reviewed the development and research direction of mathematical communication in mathematics education based on Scopus-indexed publications from 2015 to 2025. The findings indicate an upward trend in publication activity and a strong relationship between mathematical communication, higher-order thinking skills, and mathematical representation. Moreover, contextual learning approaches such as Realistic Mathematics Education (RME) have played a significant role in supporting communication-focused mathematics instruction.

Beyond these findings, this study opens up new avenues for further exploration, particularly in examining the deeper interrelations between mathematical communication and other 21st-century competencies, such as collaboration, creativity, and digital literacy. Future studies should employ a mixed-methods approach that combines bibliometric and content analysis to explore how the conceptual dynamics of mathematical communication evolve across different contexts and in response to technological transformations. Such approaches could reveal thematic evolution, co-citation patterns, and emerging research frontiers that are currently underexplored in the literature. The analysis in this study was limited to Scopus-indexed publications, which may have excluded relevant research from non-indexed or locally published journals. Addressing this limitation in future studies will improve representativeness and strengthen the global understanding of mathematical communication research.

Overall, this bibliometric review not only maps the current landscape of mathematical communication research but also provides a strategic direction for future studies that integrate pedagogical innovation, technological advancement, and interdisciplinary collaboration. By mapping this evolving field, the study offers valuable insights for educators and policymakers seeking to enhance communication-focused mathematics curricula and to foster adaptive learning designs aligned with the demands of 21st-century education.

ACKNOWLEDGEMENTS

The authors would like to express their deepest gratitude to Dr. Dra. Nizlel Huda, M.Kes., and Dr. Syamsir Sainuddin, S.Pd., M.Pd., for their invaluable guidance, insightful feedback, and continuous encouragement throughout the preparation of this article. Special thanks are also extended to the Master's Program in Mathematics Education, Universitas Jambi, for the academic and institutional support provided during this research. This study

was developed through bibliometric analysis using the VOSviewer software and is expected to contribute to the advancement of research in the field of mathematics education.

REFERENCES

[1] W. N. Yanuarto, E. Setyaningsih, and M. I. Zakaria, "The 21st Century Skills Model of Mathematics Students Today's Instruction Age," *JPI J. Pendidik. Indones.*, vol. 14, no. 2, pp. 467–476, June 2025, doi: 10.23887/jpi-undiksha.v14i2.85109.

[2] N. P. Cipriano, "Exploring Mathematics Education In The 21st Century".

[3] T.-T. Nguyen, N. D. Nguyen, T. P. T. Trinh, D. H. Tong, B. P. Uyen, and N. N. Han, "Vietnamese sixth graders' mathematical communication competency developed by teaching fraction topics using the 5E model," *Heliyon*, vol. 10, no. 20, p. e39440, Oct. 2024, doi: 10.1016/j.heliyon.2024.e39440.

[4] T.-T. Nguyen, N. D. Nguyen, T. P. T. Trinh, D. H. Tong, B. P. Uyen, and N. N. Han, "Vietnamese sixth graders' mathematical communication competency developed by teaching fraction topics using the 5E model," *Heliyon*, vol. 10, no. 20, p. e39440, Oct. 2024, doi: 10.1016/j.heliyon.2024.e39440.

[5] A. Teledahl, C. Kilhamn, L. M. Ahl, and O. Helenius, "Defining and measuring quality in students' mathematical writing: a systematic literature review," *Math. Educ. Res. J.*, vol. 37, no. 3, pp. 557–576, Sept. 2025, doi: 10.1007/s13394-024-00501-4.

[6] T. Scheiner and M. Bosch, "Dialogues Between Theoretical Approaches in Mathematics Education Research: A Systematic Review," *ZDM – Math. Educ.*, vol. 57, no. 4, pp. 711–725, Aug. 2025, doi: 10.1007/s11858-025-01687-y.

[7] Z. N. Na'im and M. Mukhlis, "Exploration of students' mathematical communication abilities," *J. Ris. Pendidik. Mat.*, 2024.

[8] N. Planas and D. Pimm, "Mathematics education research on language and on communication including some distinctions: Where are we now?," *ZDM Math. Educ.*, vol. 56, no. 1, pp. 127–139, Feb. 2023, doi: 10.1007/s11858-023-01497-0.

[9] P. P. Uddin, A. Aulia, M. Rizal, R. Nasir, B. Muhammad, and S. U. Hasanah, "Mathematical communication of students with low performance in mathematics," *Int. J. Learn. Teach.*, vol. 15, no. 3, pp. 133–146, July 2023, doi: 10.18844/ijlt.v15i3.9129.

[10] N. I. P. Putri and R. Sundayana, "Perbandingan Kemampuan Komunikasi Matematis Siswa antara Problem Based Learning dan Inquiry Learning," *J. Pendidik. Mat.*, vol. 1, no. 1, 2021.

[11] A. Ozturk, "Teacher Moves for Building a Mathematical Modeling Classroom Community," *Educ. Sci.*, vol. 15, no. 3, p. 376, Mar. 2025, doi: 10.3390/educsci15030376.

[12] B. Basarudin, "Penerapan Model Problem Based Learning (PBL) Untuk Meningkatkan Kemampuan Komunikasi Matematis Dan Rasa Percaya Diri Siswa Kelas X Sma Negeri 2 Muara Beliti," *J. Math. Sci. Educ.*, vol. 7, no. 1, pp. 1–9, Dec. 2024, doi: 10.31540/jmse.v7i1.3324.

[13] S. Yildiz and S. Goktepe, "Trends and insights of AI in mathematics education: A bibliometric analysis," *Int. Electron. J. Math. Educ.*, 2025, doi: https://doi.org/10.29333/iejme/16401.

[14] Y. Adhitya, N. S. Putri, and B. C. R. Bustaren, "Trends and research mapping of mathematical mindset publications: A bibliometric analysis using Vosviewer," *J. Focus Action Res. Math. Factor M*, vol. 8, no. 1, pp. 52–67, June 2025, doi: 10.30762/f_m.v8i1.4931.

[15] N. F. Yani and J. Soebagyo, "Bibliometric Analysis of Mathematical Communication Skills Using Scopus Database," *J. Pendidik. Mat. Dan IPA*, vol. 14, no. 1, p. 57, Jan. 2023, doi: 10.26418/jpmipa.v14i1.53902.

[16] M. Gauffriau, "Counting methods introduced into the bibliometric research literature 1970–2018: A review," *Quant. Sci. Stud.*, vol. 2, no. 3, pp. 932–975, Nov. 2021, doi: 10.1162/qss_a_00141.

[17] C. Cooper, A. Booth, J. Varley-Campbell, N. Britten, and R. Garside, "Defining the process to literature searching in systematic reviews: a literature review of guidance and supporting studies," *BMC Med. Res. Methodol.*, vol. 18, no. 1, p. 85, Dec. 2018, doi: 10.1186/s12874-018-0545-3.

[18] J. Joklitschke, B. Rott, and M. Schindler, "Notions of Creativity in Mathematics Education Research: a Systematic Literature Review," *Int. J. Sci. Math. Educ.*, vol. 20, no. 6, pp. 1161–1181, Aug. 2022, doi: 10.1007/s10763-021-10192-z.

[19] G. Marzi, M. Balzano, A. Caputo, and M. M. Pellegrini, "Guidelines for Bibliometric-Systematic Literature Reviews: 10 steps to combine analysis, synthesis and theory development," *Int. J. Manag. Rev.*, vol. 27, no. 1, pp. 81–103, Jan. 2025, doi: 10.1111/ijmr.12381.

[20] P. C. Sauer and S. Seuring, "How to conduct systematic literature reviews in management research: a guide in 6 steps and 14 decisions," *Rev. Manag. Sci.*, vol. 17, no. 5, pp. 1899–1933, July 2023, doi: 10.1007/s11846-023-00668-3.

[21] W. Mengist, T. Soromessa, and G. Legese, "Method for conducting systematic literature review and meta-analysis for environmental science research," *MethodsX*, vol. 7, p. 100777, 2020, doi: 10.1016/j.mex.2019.100777.

[22] R. Risantika, E. E. Muchlis, A. Sovia, E. Susanto, and R. Agustinsa, "Bibliometric Analysis: Trends In Studies On Realistic Mathematics Education Learning To Enhance Mathematical Reasoning Abilities," *Mathline J. Mat. Dan Pendidik. Mat.*, vol. 10, no. 2, pp. 489–504, June 2025, doi: 10.31943/mathline.v10i2.828.

[23] L. Santos and S. Semana, "Developing mathematics written communication through expository writing supported by assessment strategies," *Educ. Stud. Math.*, vol. 88, no. 1, pp. 65–87, Jan. 2015, doi: 10.1007/s10649-014-9557-z.

[24] D. Kaya and H. Aydın, "Elementary Mathematics Teachers' Perceptions and Lived Experiences on Mathematical Communication," *EURASIA J. Math. Sci. Technol. Educ.*, vol. 12, no. 6, June 2016, doi: 10.12973/eurasia.2014.1203a.

[25] J. Ingram, N. Andrews, and A. Pitt, "When students offer explanations without the teacher explicitly asking them to," *Educ. Stud. Math.*, vol. 101, no. 1, pp. 51–66, May 2019, doi: 10.1007/s10649-018-9873-9.

[26] S. Setiyani, "Blended Learning: The Effectiveness Of Schoology Based E-Learning On Mathematic Communication Ability," *Jurnal Kependidikan: Penelitian Inovasi Pembelajaran*, vol. 3, no. 2, pp. 143–155, Nov. 2019, doi: 10.21831/jk.v3i2.23820.

[27] M. S. Aguilar and A. Castaneda, "What mathematical competencies does a citizen need to interpret Mexico's official information about the COVID-19 pandemic?," *Educ. Stud. Math.*, vol. 108, no. 1–2, pp. 227–248, Oct. 2021, doi: 10.1007/s10649-021-10082-9.

Zulaika_Final_Turnitin

ORIGINALITY REPORT

11%	8%	8%	4%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to Capella University Student Paper	2%
2	journal-gehu.com Internet Source	1%
3	repository.unja.ac.id Internet Source	1%
4	eprint.innovativepublication.org Internet Source	1%
5	link.springer.com Internet Source	<1%
6	repository.uhamka.ac.id Internet Source	<1%
7	academic-publishing.org Internet Source	<1%
8	ipfs.io Internet Source	<1%
9	www.bauhaus-dessau.de Internet Source	<1%
10	"International Horizons in Mathematics Modelling Education", Springer Science and Business Media LLC, 2025 Publication	<1%
11	Submitted to Universitas Jambi Student Paper	<1%
	www.kheljournal.com	

12	Internet Source	<1 %
13	dergipark.org.tr Internet Source	<1 %
14	edulearn.intelektual.org Internet Source	<1 %
15	www.esd-conference.com Internet Source	<1 %
16	www.sciencegate.app Internet Source	<1 %
17	iris.imtlucca.it Internet Source	<1 %
18	Marco Balzano, Giacomo Marzi, Teresa Turzo. "SMEs and institutional theory: major inroads and opportunities ahead", Management Decision, 2024 Publication	<1 %
19	Nadya Bosra, Muhammad Ammar Naufal, Ja'faruddin, Jacinta Johnny. "The Role of Problem Posing in Developing Students' Mathematical Communication: A Systematic Literature Review", Venn: Journal of Sustainable Innovation on Education, Mathematics and Natural Sciences, 2025 Publication	<1 %
20	Wardono Wardono, Rochmad Rochmad, Khasanah Uswatun, Scolastika Mariani. "Comparison between Generative Learning and Discovery Learning in Improving Written Mathematical Communication Ability", International Journal of Instruction, 2020 Publication	<1 %

21	Hamed Taherdoost, Tuan-Vinh Le, Khadija Slimani. "Cryptographic Techniques in Artificial Intelligence Security: A Bibliometric Review", Cryptography, 2025 Publication	<1 %
22	YUS MOCHAMAD CHOLILY, ANIS FARIDA JAMIL, MAYANG DINTARINI, RIRIN DWI AGUSTIN. "WORKING COLLABORATIVELY IN PROVING GEOMETRY PROBLEMS TO ENHANCE UNDERGRADUATE STUDENTS' COMMUNICATION OF MATHEMATICAL THINKING", Riemann: Research of Mathematics and Mathematics Education, 2024 Publication	<1 %
23	ai4d.acts-net.org Internet Source	<1 %
24	digital.library.adelaide.edu.au Internet Source	<1 %
25	ebin.pub Internet Source	<1 %
26	es.scribd.com Internet Source	<1 %
27	files.eric.ed.gov Internet Source	<1 %
28	www.mdpi.com Internet Source	<1 %
29	www.srustimanagementreview.ac.in Internet Source	<1 %
30	Murat Genç, Mustafa Akıncı, İlhan Karataş, Özgür Murat Çolakoğlu, Nurbanu Yılmaz Tığlı. "From Thinking to Creativity: The Interplay of	<1 %

Mathematical Thinking Perceptions, Mathematical Communication Dispositions, and Creative Thinking Dispositions", Behavioral Sciences, 2025
Publication

31 Joan Belen Sionicio. "Examining the Impact of Writing Strategies in Enhancing Pre-Service Teachers' Mathematical Problem-Solving Skills", Jurnal Pendidikan Progresif, 2025 <1%
Publication

Exclude quotes	Off	Exclude matches	Off
Exclude bibliography	On		