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A Bibliometric Analysis of Mathematics Education Research in Elementary Schools: Trends, Institutions, and Post-Pandemic Learning Integration (2020–2025)

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ABSTRACT

Research on elementary mathematics education in the post pandemic period reflects changes in publication patterns and research topics. This study aims to analyze publication trends, institutional contributions, and forms of learning integration in elementary mathematics education research published between 2020 and 2025. The method employed is a bibliometric analysis of 921 Scopus-indexed articles using RStudio. The analysis covers annual publication trends, institutional productivity, authors' geographical distribution, keyword-based thematic clusters, and citation patterns. The results show variations in annual publication output, with an increasing trend observed since 2023. Monash University and Universitas Negeri Yogyakarta are identified as the institutions with the highest publication output. Cluster analysis identifies three main thematic groups: student-oriented and numeracy-focused research, studies related to methodological approaches and teacher development, and research concerning pedagogy and curriculum. These findings describe the characteristics and thematic distribution of post pandemic research in elementary mathematics education.

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1. INTRODUCTION

Mathematics education in elementary school is a strategic field of study because it is related to the development of numeracy skills, problem solving, conceptual understanding, procedural fluency, and mathematical reasoning from the early stages of formal education. Mathematical competencies built during elementary school play an important role as a foundation for academic success in subsequent levels and involvement in careers that require quantitative skills [32] [3] . As identified in various literature, basic education plays a crucial role in preparing 21st-century competencies through the integration of mathematical literacy, critical thinking skills, and adaptability to technological changes [23].

Over the past few years, research related to mathematics education in elementary schools has grown rapidly, covering a variety of topics, including the effectiveness of various teaching approaches, common misconceptions among students in learning mathematical concepts, cognitive development in mathematical reasoning, teachers' content and pedagogical knowledge, curriculum design that supports conceptual understanding, and the use of technology in mathematics learning [43] [12] [23]. These findings confirm that the quality of teaching and teachers' professional competence have a strong influence on students' mathematics learning outcomes [8] [24].

Previous studies have provided an important foundation for understanding the development of mathematics education in elementary schools. For example, research by [5] found that mathematics learning in elementary schools becomes more effective when teachers use various representations (visual, concrete, symbolic) to help students understand basic concepts. [4]showed that the Realistic Mathematics Education (RME) approach helps elementary school students understand mathematics better because the material is related to real situations that they are familiar with. And [20] reported that the use of digital formative assessments in elementary school mathematics learning can improve student understanding and make it easier for teachers to monitor learning progress more accurately.

Although research on elementary mathematics education has increased, most studies still focus on case studies or the effectiveness of specific approaches, limiting a comprehensive understanding of the field's direction, structure, and dynamics [10] [49]. In particular, studies mapping citation patterns, collaboration networks, productive institutions, and the evolution of research themes remain limited [15] [38]. The growing number of studies has not been matched by systematic synthesis and mapping efforts, highlighting the need for approaches that integrate quantitative and visual information on the structure and dynamics of the field. This study aims to address this gap by providing a comprehensive bibliometric mapping of research from 2020 to 2025, combining analyses of publication trends, institutional collaboration, thematic clusters, and citation patterns, while identifying dominant and underexplored areas, thereby offering a more complete overview of the landscape of elementary mathematics education research.

The period from 2020 to 2025 is a unique time for education in general. The Covid 19 pandemic has triggered drastic changes in learning practices, including a shift to distance learning, adaptation to online learning, and various post pandemic recovery efforts [1] [37]. These changes have prompted a variety of new studies examining the impact of distance learning, educational access gaps, and the use of educational technology in mathematics learning in elementary schools [38] [15]. This dynamic has created significant research momentum and made the period 2020–2025 a relevant time to conduct a systematic mapping of the direction and trends of research development in this field [21] [48]. These aspects provide an integrated view in the context of post pandemic global educational changes [10] [49].

Based on this framework, the landscape of elementary mathematics education research from 2020 to 2025 was analyzed through five main aspects: publication trends, institutional productivity, geographic distribution of research, thematic structure and conceptual clusters based on keyword networks, and citation patterns. These aspects provide an integrated view of the temporal, spatial, and intellectual development of elementary mathematics education research in the context of post-pandemic global educational changes, with the research aimed at identifying trends, collaboration patterns, and both dominant and underexplored research areas, thereby providing a foundation for the development of future research and instructional practices in elementary mathematics education.

2. RESEARCH METHOD

This study employs a quantitative bibliometric approach to map the landscape of elementary mathematics education research from 2020 to 2025 [50]. The analysis covers publication trends, institutional productivity, citation patterns, and thematic evolution [22], using data from Scopus analyzed in RStudio across five stages: research design, data collection, analysis, visualization, and interpretation [7] [14] [31].

For network analysis, a minimum threshold of five publications per author was applied, Jaccard matrix normalization was used, and the Louvain clustering algorithm was employed to detect thematic communities. Bibliometric indicators included publication counts, citations, and keyword frequencies, with all methodological decisions justified to ensure transparency and reproducibility. While this methodology is robust, the study is limited to Scopus-indexed publications and does not include gray literature, meaning the analyzed trends primarily reflect formal, indexed data. Each step of the bibliometric analysis is described in detail in the following subsections.

2.1 Research Design

The purpose of this study is to analyze publication characteristics and identify research trends in elementary school mathematics education using a quantitative bibliometric approach [11] [14]. Given the large volume of publications in this field, bibliometric analysis is necessary to systematically map the research landscape and understand the overall patterns and dynamics of the studies [11] [14]. The search focused on publications related to elementary mathematics education for the period 2020–2025, conducted on November 25, 2025, at 14:54 WIB, with inclusion criteria limited to English-language articles, reviews, or conference papers within relevant subject areas. From an initial search yielding 2,120 documents, 1,098 remained after the first screening stage, and finally, 921 documents were retained for analysis.

2.2 Bibliometric Data Compilation

Bibliometric data were collected with a focus on publications related to elementary school mathematics learning [9] [22]. The initial search used the query (TITLE-ABS-KEY ("mathematics education" OR "math learning" OR numeracy) AND TITLE-ABS-KEY ("elementary school" OR "primary school" OR "primary education")), yielding 2,120 articles. The main PUBYEAR range was set to 2020–2025, with an additional PUBYEAR 2019–2026 to capture relevant early and late-year publications. The query was then refined with filters for language (English), document type (articles, reviews, and conference papers), and relevant subject areas (SOCI, MATH, PSYC, ARTS, and MULT), resulting in a final set of 921 articles for analysis. During screening, only publications explicitly addressing the elementary school context were included; studies focusing on secondary or higher education were excluded, particularly when titles or abstracts were unclear regarding the education level [40] [31]. All data were exported in both bib and RIS formats, duplicates were removed, and manual screening was conducted to ensure relevance, aiming to maintain transparency and facilitate replicability of the bibliometric analysis. A detailed overview is provided in the diagram below.

Compilation of bibliometrix data	: Capturing journal articles related to Mathematics learning in primary school.
Query Sterling	: (TITLE-ABS-KEY ("mathematics education" OR "math learning" OR numeracy) AND TITLE-ABS-KEY ("elementary school" OR "primary school" OR "primary education"))
Result	: A total of 2,120 articles related to mathematics general were retrieved

Compilation of bibliometrix data	: Additional filtering to search for ten years.
Query Sterling	: (TITLE-ABS-KEY ("mathematics education" OR "math learning" OR numeracy) AND TITLE-ABS-KEY ("elementary school" OR "primary school" OR "primary education")) AND PUBYEAR > 2019 AND PUBYEAR < 2026
Result	: A total of 1.098 articles related to mathematics general were retrieved

Compilation of bibliometrix data	: Additional filtering to search for strings that English-language, conference paper & review articles, journal sources and proceedings, and only four subjekt area humanities, arts, psychology, or multidisciplinary fields.
Query Sterling	: (TITLE-ABS-KEY ("mathematics education" OR "math learning" OR numeracy) AND TITLE-ABS-KEY ("elementary school" OR "primary school" OR "primary education")) AND PUBYEAR > 2019 AND PUBYEAR < 2026 AND (LIMIT-TO (SUBJAREA , "SOCI") OR LIMIT-TO (SUBJAREA , "MATH") OR LIMIT-TO (SUBJAREA , "PSYC") OR LIMIT-TO (SUBJAREA , "ARTS") OR LIMIT-TO (SUBJAREA , "MULT")).
Result	: A total of 921 articles reamined for analysis

2.3 Analysis and Visualization

This stage pertains to the software used for data analysis. While Scopus provides basic analyses and visualizations such as annual article publication counts in indexed journals, sources of indexed journals, influential authors, and productive institutions additional tools are required for more comprehensive bibliometric analysis. This study utilizes RStudio to analyze and visualize bibliographic data from BibTeX and RIS files. RStudio is employed for data visualization, providing graphical representations of relationships among keywords, authors, and institutions involved in this research [29]. The integration of RStudio is crucial for presenting complex data visualizations, enabling an in-depth examination of research dynamics in mathematics education, including the identification of key actors and dominant thematic focuses [28] [45]. All visualizations were generated by the authors using Scopus data through RStudio and are therefore cited as “Source: Author’s analysis using Scopus data (RStudio)” to ensure transparency and reproducibility.

3. RESULT AND ANALYSIS

3.1 Up-and-Down Trends in Scientific Publications (2020–2025)

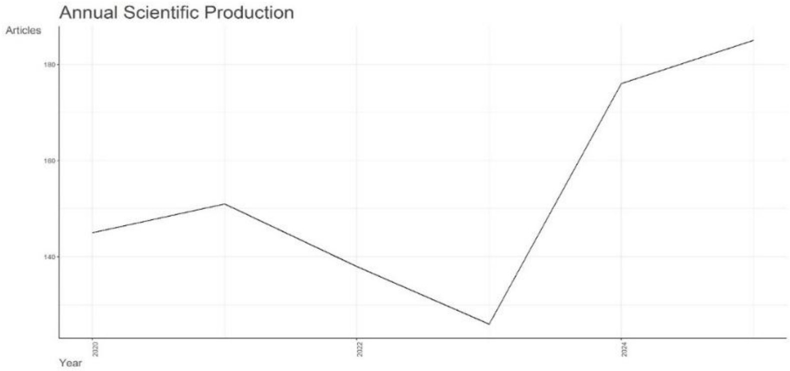

Figure 1. Up-and-down trends in scientific publications (2020–2025)

The data show fluctuations in the number of elementary school mathematics education research publications during the 2020–2025 period. Publication counts increased from 2020 to 2021, declined between 2021 and 2023, and then rose significantly through 2025 [34] [26] [19]. This visualization presents annual descriptive data on the number of published articles without directly linking the changes in publication counts to specific causes.

3.2 Campus Power Map: The Dominance of Indonesia and Australia

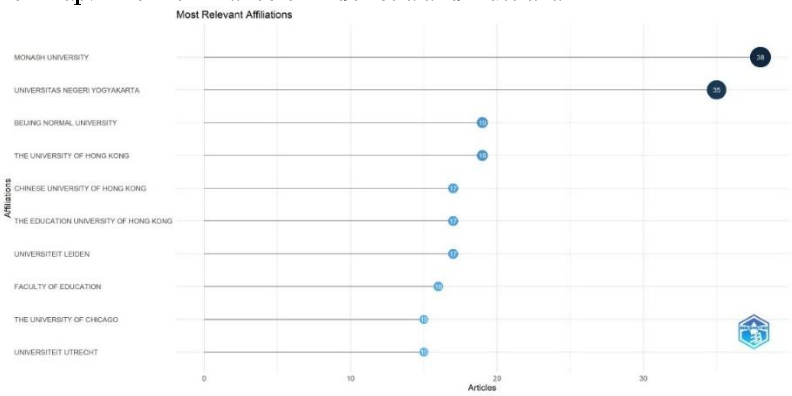

Figure 2. Campus power map: the dominance of Indonesia and Australia

Mapping institutional contributions in the Asia-Pacific region shows that Monash University (Australia) and Universitas Negeri Yogyakarta (Indonesia) have the highest publication counts [27] [17] [35]. This map illustrates the distribution of publication output across institutions, highlighting that certain institutions are more productive in research, without attributing the differences to policy factors or institutional quality.

3.3 The Geography of Global Research Productivity and Determinants of Inequality

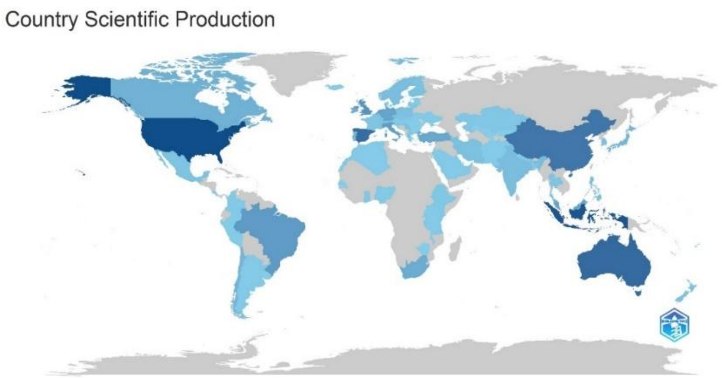

Figure 3. The geography of global research productivity and determinants of inequality

The distribution of publications by country indicates uneven global research productivity [33] [42] [44] [30]. Countries such as the United States, the United Kingdom, Germany, China, Japan, Indonesia, and Australia have high publication counts, while other countries show lower output. The visualization uses a color gradient to differentiate productivity levels, allowing readers to observe the global distribution without making causal claims

3.4 Topic Transformation Based on Cluster Color

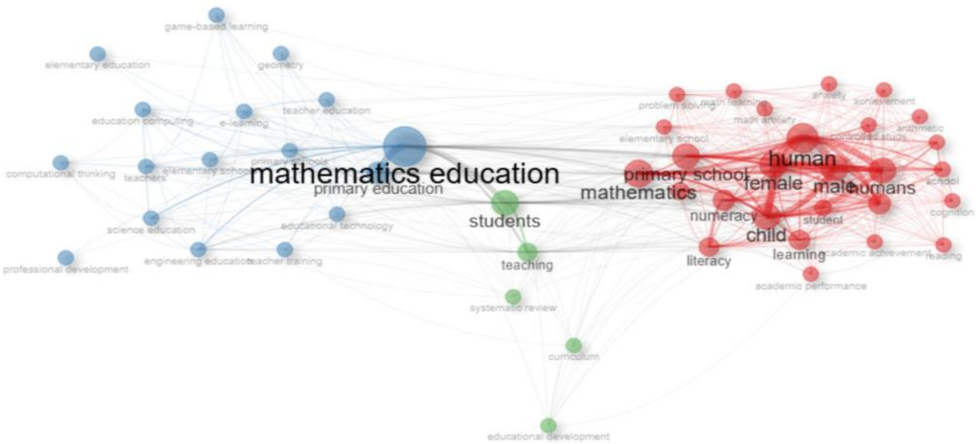

Figure 4. Topic transformation based on cluster color

Keyword cluster analysis identified three main themes. The red cluster relates to students and numeracy, highlighting keywords such as student, child, learning, and numeracy [47] [2]. The blue cluster is associated with methodological innovation and teacher development, with keywords including game-based learning, e-learning, and teacher education [25]. The green cluster emphasizes pedagogical and curriculum foundations, with keywords such as teaching, curriculum, and educational development [16]. This visualization presents a descriptive overview of research topic distribution and illustrates variations in research focus within the field of mathematics education

3.5 The Dominance of Contemporary Literature in Mathematics Education Research

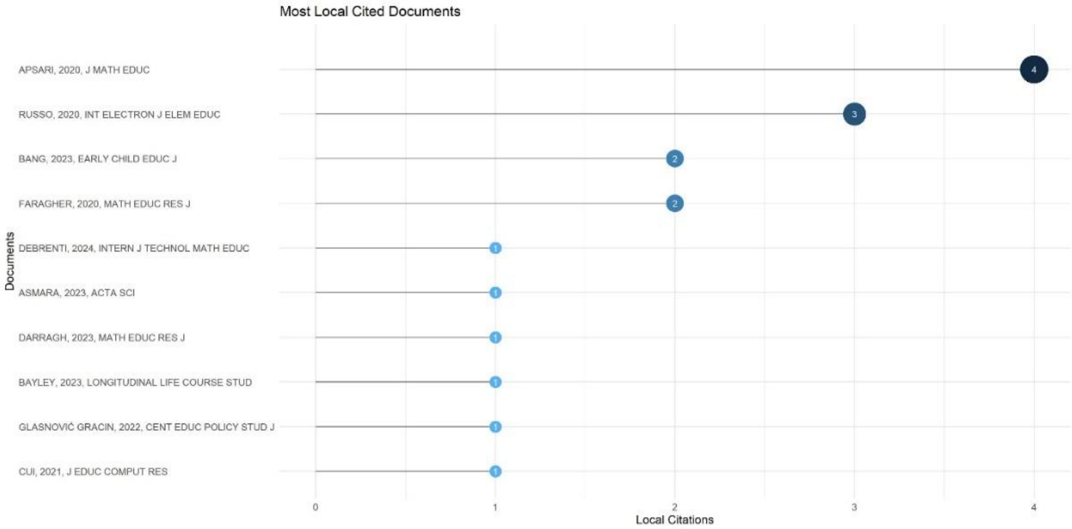

Figure 5. The dominance of contemporary literature in mathematics education research

Citation analysis indicates that the majority of references come from publications between 2020 and 2023, while classical literature, such as Pedagogical Content Knowledge by [6], continues to serve as a theoretical foundation [41] [39] [46] [41]. This figure illustrates the distribution of citations and the tendencies in literature usage among researchers, without assuming a direct impact on research quality or educational practice. Furthermore, these citation patterns may provide initial insights into the potential causes behind the observed research trends and regional disparities, such as differences in access to international publications, institutional focus on specific topics, or local education policy priorities. This analysis helps to understand how regional and temporal contexts influence the development of literature and the direction of elementary mathematics education research.

3.6 Publication Trends and Post-Pandemic Dynamics

The fluctuations in elementary school mathematics education research publications during 2020–2025 reveal interesting dynamics [34] [26] [19]. The increase in publications in 2020–2021 likely reflects the academic response to the pandemic emergency, while the decline in 2021–2023 marks a transitional period. The subsequent rise from 2023 indicates a recovery in research productivity and presents opportunities to explore factors driving the continuity of post pandemic research

3.7 Institutional and Geographic Inequality

Institutional productivity distribution highlights Monash University and Universitas Negeri Yogyakarta as the most significant contributors in the Asia-Pacific region [27] [17] [35]. The dominance of certain institutions reflects concentrated research capacity but does not automatically indicate research quality or local policy impact. Globally, countries such as the United States, the United Kingdom, Germany, China, Japan, Indonesia, and Australia lead in output, while many others have low publication numbers [33] [42] [44] [30] [18]. Structural factors such as access to research facilities, funding, and international collaboration networks likely influence this distribution, underscoring the limitations of bibliometrics in assessing research quality directly.

3.8 Thematic Evolution and Student/Teacher/Curriculum Focus

Keyword cluster analysis identified three primary foci: student-oriented numeracy, methodological innovations and teacher development, and pedagogical and curriculum foundations [47] [2] [25] [16]. These findings indicate the research community's response to the multidimensional complexity of mathematics education, ranging from student characteristics to teaching strategies and curriculum design. The thematic analysis complements quantitative publication and institutional distributions, providing deeper context to observed research patterns.

3.9 Citation Behavior and Theoretical Foundations

Citation patterns show the dominance of contemporary literature, with recent references widely used, while classic works remain foundational [40] [39] [46] [6]. This trend reflects researchers' efforts to connect findings to post-pandemic issues while maintaining theoretical continuity, integrating classic and contemporary literature to enrich the understanding of thematic and institutional patterns.

3.10 Strengthening the Applied Mathematics Perspective

This quantitative bibliometric approach also opens avenues for further exploration from an applied mathematics perspective. Network metrics, the Louvain clustering algorithm, and optimization concepts can be employed to detect research communities, measure the centrality of dominant nodes, and test the robustness of bibliometric networks. Applying these methods in future studies can deepen understanding of intellectual structures, knowledge diffusion patterns, and the relationships among institutions or research topics.

4. CONCLUSION

This bibliometric study maps the landscape of elementary school mathematics education research from 2020 to 2025, covering publication trends, institutional and geographic distribution, thematic evolution, and citation patterns. Results reveal publication fluctuations linked to the pandemic, concentration of contributions from certain institutions, and research focus on student numeracy, teacher methodological innovations, and curriculum development. The findings carry practical implications and inform future research directions, including the development of adaptive learning modules, evidence-based teacher training, and educational policy. Future studies may explore the integration of digital technologies, the longitudinal effectiveness of numeracy strategies, or cross-country comparative analyses.

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