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Literature Review (2020-2025): Numeracy Development and Mathematics Learning Models in Elementary Schools

Puji Lestari*[1], Eka Titi Andarani[1], Bambang Subali[2], Arif Widiyatmoko[2]
[1]*Departement of Elementary Education, Semarang State University, Semarang, 50229, Indonesia*
[2]*Faculty of Mathematics and Natural Sciences, Semarang State University, Semarang, 50229, Indonesia*

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* *Corresponding author:*

E-mail: Puji331@guru.sd.belajar.id

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A B S T R A C T

Numeracy skills are an important competency for elementary school students, but Indonesian students' numeracy achievement remains relatively low based on various assessment results. This study aims to map trends in numeracy research and mathematics learning models in elementary schools in the 2020–2025 period and identify research gaps, particularly related to the GEMBIRA Learning Model. This study used a Systematic Literature Review (SLR) approach based on the PRISMA protocol on 997 articles obtained through Google Scholar, resulting in 98 articles analyzed using content and bibliometric analysis with VOSviewer. The results show that numeracy research publications fluctuate with a significant spike in 2025, and are dominated by contextual approaches such as Realistic Mathematics Education, Ethno-RME, ethnomathematics, inquiry, and discovery learning. Bibliometric analysis indicates that numeracy and instructional models are the most dominant themes. However, no empirical studies have been found testing the implementation of the GEMBIRA Learning Model in elementary schools. These findings confirm that GEMBIRA is a potential framework but still wide open for further research.

1. Introduction

Numeracy skills are among the basic competencies that elementary school students must master because they are directly related to problem-solving in everyday life and decision-making (OECD, 2022). However, various assessment results, such as PISA and AKM, indicate that Indonesian students' numeracy achievement remains below the international average, and they face serious challenges in solving context-based problems (Kemendikbud, 2022). This situation is exacerbated by post-pandemic learning loss, which has further weakened students' conceptual understanding and numerical reasoning skills (Hata et al., 2024). This situation

indicates the need for a mathematics learning approach that fosters more meaningful numeracy from the elementary school level (Budiarto, M. T. et al., 2023). This condition is also reflected in recent empirical studies showing that many elementary school students continue to face difficulties in solving contextual numeracy problems and interpreting mathematical information meaningfully. (Hidayat et al., 2025)

In practice, mathematics learning in elementary schools is still dominated by a procedural approach, with a focus on memorizing formulas, making it difficult for students to connect mathematical concepts to real life (Setiawan et al., 2024). This mechanistic learning process results in low motivation to learn and reduced ability to solve contextual problems (Sutama et al., 2023). Numeracy, however, requires the ability to understand, represent, and interpret data in the form of tables, graphs, and everyday situations (Yuliani et al., 2021). Theoretically, numeracy development is closely related to students' ability to use visual representations, models, and various forms of mathematical reasoning. Various studies have shown that the use of visual models and concrete representations can help students build conceptual understanding and increase procedural flexibility in elementary school mathematics learning (Bailey, D. H., & Fyfe, 2019; Hersh & Dehaene, 1998).

Furthermore, mathematical reasoning and representation skills are essential components of numeracy because they enable students to interpret, communicate, and apply mathematical ideas in a variety of meaningful contexts (Downton, 2015; Yuliani et al., 2021). To address these challenges, the Independent Curriculum emphasizes a contextual and student-centered learning approach as a strategy for strengthening numeracy (Hafizha, 2022). Previous studies also indicate that teachers play a crucial role in guiding students through meaningful learning processes that support the development of numeracy skills (Astutik & Purwasih, 2023).

In line with this policy direction, research on numeracy has increased in recent years. Various studies indicate that elementary school students still struggle to understand data representation and context-based problems (Astutik & Purwasih, 2023). Other research has developed ethnomathematics-based numeracy tasks to link mathematical concepts to local culture, making learning more meaningful (Oktarisa et al., 2025). Furthermore, the Realistic Mathematics Education (RME) approach and its ethnomathematics-based variations have proven effective in helping students mathematize from real contexts to formal mathematical models (Pujiastuti et al., 2025; Rahmawati, N. & Purnomo, 2024).

Contextual learning media and culture-based modules have also been reported to increase students' interest in and understanding of numeracy (Pujiastuti et al., 2025). Effective numeracy learning also requires pedagogical strategies that support inquiry activities and step-by-step guidance. Inquiry-based and modeling-based learning approaches have been widely recommended for their ability to improve students' problem-solving skills and numeracy development (Fauzan, A., Plomp, T., & Gravemeijer, 2013; Maass, 2018). Furthermore, teacher scaffolding plays a crucial role in helping students gradually construct mathematical meaning

and apply it to contextual situations (Nurre, C., & Lin, 2021; Yusof, Y., & Tall, 2021).

This research has led to the emergence of the integrative Ethno-Realistic Mathematics Education (Ethno-RME) approach, which combines RME principles with local cultural contexts to strengthen students' mathematical reasoning and numeracy (Rahmawati, N. & Purnomo, 2024). In 2025, Widdiharto et al. developed the GEMBIRA Mathematics Learning Model as an instructional framework explicitly designed to support the National Numeracy Movement (Widdiharto et al., 2025). This model an acronym derived from five instructional stages: Gali dan Eksplorasi konteks yang dekat dengan siswa (Explore contexts close to students), Muat konten numerasi hasil eksplorasi (Embed numeracy content from exploration), Buat aktivitas yang bermakna (Design meaningful learning activities), Ikuti alur pikir siswa dalam evaluasi (Follow students' thinking in evaluation), and Rayakan dan Akhiri pembelajaran dengan menyenangkan (Celebrate and conclude the learning joyfully), which align with the principles of Ethno-RME. However, studies on GEMBIRA have so far been limited to the conceptual level through integrative reviews and have not been widely tested empirically, especially at the elementary school level (Widdiharto et al., 2025).

Although various studies have examined the effectiveness of learning models such as RME, inquiry, discovery learning, and ethnomathematics in improving numeracy, most are partial and focus on established models. Research that comprehensively maps the development, interrelationships, and direction of numeracy research and mathematics learning models in elementary schools, using a systematic and bibliometric approach, remains relatively limited. Furthermore, the position and potential of the GEMBIRA Learning Model as a new framework specifically designed to strengthen numeracy has not been widely studied within the broader research landscape. This situation indicates a significant research gap regarding how GEMBIRA is positioned, developed, and potentially tested in the context of numeracy learning in elementary schools. Therefore, this study aims to map and analyze trends in numeracy research and mathematics learning models in elementary schools for the period 2020–2025 through a Systematic Literature Review approach based on the PRISMA protocol and bibliometric analysis, and to identify research gaps related to the GEMBIRA Learning Model explicitly.

2. Methodology

This study uses a Systematic Literature Review (SLR) approach, following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. In the context of SLR, the unit of analysis of this study is not students or teachers, but rather scientific articles that discuss numeracy development and mathematics learning models in elementary schools. The purpose of using SLR is to obtain a comprehensive overview of research trends, learning approaches, and research gaps, including those related to Realistic Mathematics Education (RME), Ethno-RME, and the GEMBIRA Learning Model. The research process follows the

four main stages of PRISMA, namely Identification, Screening, Eligibility, and Inclusion, all of which are visualized in the PRISMA Flowchart.

Identification

The identification stage was conducted to collect all relevant scientific publications. A literature search was conducted in Publish or Perish using the Google Scholar database. The keywords used were a combination of the terms "numeracy," "mathematics learning," "instructional model," and "elementary school," as well as their Indonesian equivalents, such as "numerasi," "pembelajaran Matematika," and "model belajar." The search was limited to Indonesian and English-language articles published between 2020 and 2025. This initial search yielded 997 articles, which were exported in .csv format for data management and further analysis.

Screening

At the screening stage, all identified articles were systematically reviewed to assess their relevance to the study's focus. The evaluation examined article titles, keywords, and abstracts to ensure alignment with numeracy development and mathematics learning models in elementary schools. Articles that did not address numeracy, were unrelated to mathematics learning, focused on educational levels beyond elementary school, or fell outside the scope of instructional models were excluded. In addition, publications that were conceptual and lacked clear relevance to learning practices or numeracy outcomes were also eliminated. This screening process was conducted consistently based on predefined criteria to maintain transparency and minimize selection bias. As a result, 314 articles were excluded, leaving 683 for further analysis in the eligibility stage.

Eligibility

The eligibility stage involved reading the full texts of the 683 articles that passed the screening stage to ensure their substantive relevance to the objectives of this study. The evaluation was carried out based on predefined inclusion criteria, including: (1) studies discussing numeracy or mathematics learning models, (2) research focusing on the elementary school context, (3) articles presenting empirical findings or systematic studies that could be meaningfully analyzed, and (4) publications released within the 2020–2025 period. Articles that did not meet one or more of these criteria were excluded from further consideration. This full-text assessment ensured that only studies with sufficient methodological and contextual relevance were retained for analysis. As a result, 585 articles were excluded, leaving 98 eligible articles, which were used as the final data corpus (N = 98) in this study.

Inclusion & Analysis

The inclusion stage identified 98 articles as the primary sources for analysis. The analysis was conducted in two forms. First, content analysis was used to extract the research objectives, numeracy focus, types of mathematics learning models,

research methods, and key findings related to improving elementary school students' numeracy skills. Second, a bibliometric analysis was conducted using VOSviewer software. Article data formatted in RIS format were analyzed using network visualization to map keyword clusters, overlay visualization to view the development of research topics from year to year, and density visualization to identify the most dominant keywords in numeracy research during the 2020–2025 period. The entire literature selection process, from identification to inclusion, is depicted in the PRISMA Diagram in Figure 1 to ensure transparency and accuracy of the research process.

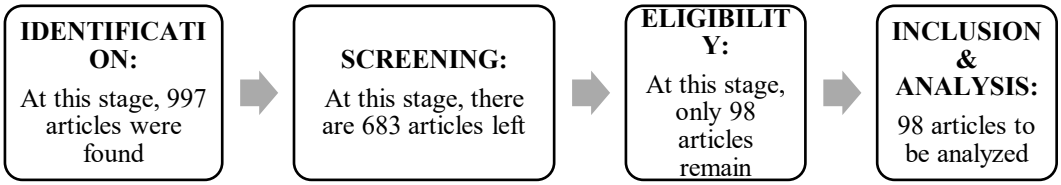

Figure 1. Stages of the PRISMA Model

3. Results and Discussion

Results

An analysis of 98 articles that met the inclusion criteria illustrates the distribution of research publications on numeracy and mathematics learning models in elementary schools during the 2020–2025 period. The annual distribution of these publications is presented in Figure 2 to provide a clear overview of research output over time. The findings indicate that 13 relevant articles were published in 2020, followed by a slight decrease to 10 publications in 2021. In 2022, the number of studies increased to 14 articles and remained stable in 2023. The publication output then declined again to 10 articles in 2024. A notable increase was observed in 2025, with 27 articles identified, the highest number during the analyzed period. The annual distribution of research publications on numeracy and mathematics learning models in elementary schools during the 2020–2025 period is presented in Figure 2.

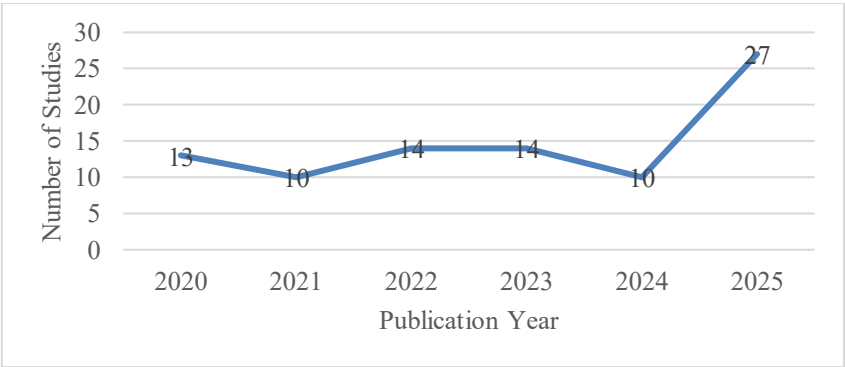

Figure 2. Distribution of Research Publications on Numeracy and Mathematics Learning Models (2020–2025)

Mapping the relationships between keywords through bibliometric analysis produced a network visualization Figure 3 that illustrates the structure and interconnections of research themes in numeracy studies at the elementary school level. The visualization represents keywords as nodes, with links indicating co-occurrence frequency across the analyzed articles. The network map shows that the keywords *numeracy*, *instructional model*, *primary school*, *teacher*, and *elementary student* have the highest connectivity within the network. These highly connected keywords occupy central positions, indicating their frequent appearance and strong associations with other research terms. In contrast, keywords located at the periphery of the network exhibit lower connectivity, reflecting more specific or less frequently studied topics. Overall, the network visualization provides an overview of the dominant and interconnected themes characterizing numeracy research during the 2020–2025 period.

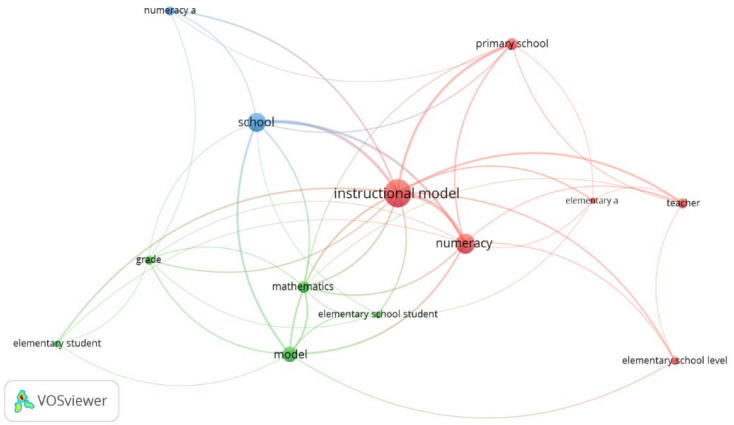

Figure 3. Visualization of the Keyword Network for Numeracy Research and Mathematics Learning Models in Elementary Schools (2020-2025).

The development of the research topic focus over time is illustrated in the overlay visualization in Figure 4, which highlights changes in keyword prominence across the 2020–2025 period. This visualization uses color gradients to represent the temporal distribution of keywords, enabling the observation of trends in research focus. The results indicate that during the initial period of the analysis, research was predominantly characterized by general keywords such as *'school'* and *'mathematics'*. These terms reflect broader studies on mathematics education without a specific emphasis on numeracy. In contrast, during the 2023–2025 period, more specific keywords such as *numeracy*, *instructional model*, and *primary school* became increasingly visible. This shift in keyword prominence indicates a clearer thematic focus in more recent publications within the analyzed literature.

The density of keyword occurrences is presented in Figure 5, which illustrates the frequency and concentration of keywords within numeracy research on mathematics learning in elementary schools. In this visualization, areas with higher density are represented by warmer colors, indicating keywords that appear more frequently across the analyzed articles. The results show that the keywords

numeracy and *instructional model* exhibit the highest occurrence rates and are concentrated in the most densely populated areas of the map.

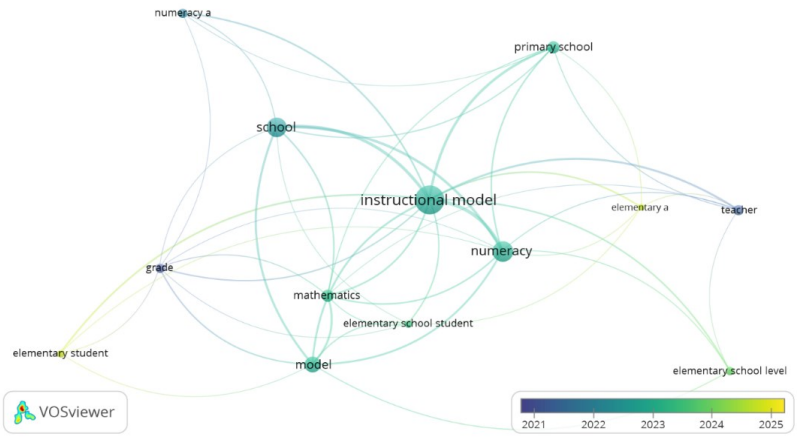

Figure 4. Overlay Visualization of the Development of Numeracy Research Topics and Instructional Models (2020–2025)

Other frequently occurring keywords include *school*, *teacher*, and *mathematics*, although their density levels are comparatively lower. The prominence of these keywords reflects their recurring use in the selected literature. Overall, the density visualization highlights the dominant themes that characterize numeracy research during the 2020–2025 study period.

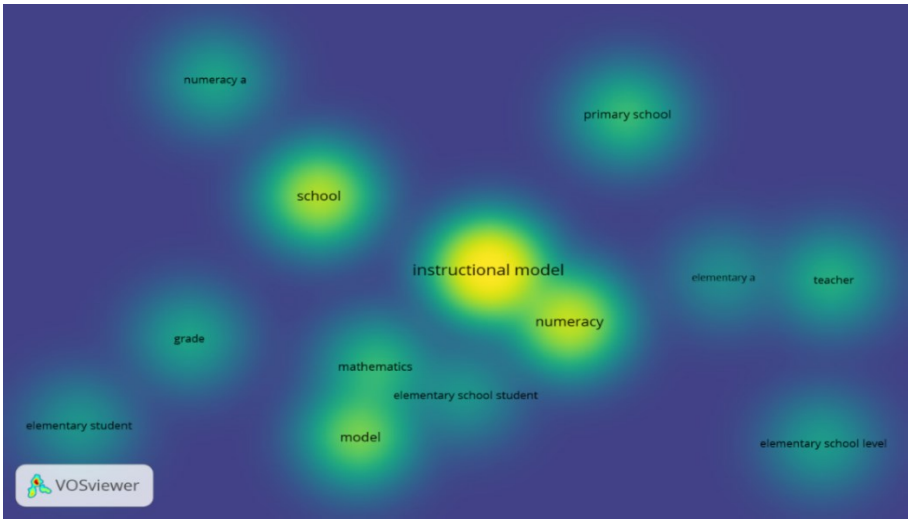

Figure 5. Visualization of Numeracy Research Keyword Density and Mathematics Learning Models in Elementary Schools (2020–2025)

Discussion

A synthesis of 98 articles shows that numeracy research in elementary schools experienced fluctuating developments during the 2020–2025 period, with a

significant surge in publications in 2025. This surge reflects increased academic attention to numeracy strengthening post-pandemic, particularly in response to learning inequalities and declining student foundational skills, which require more systematic pedagogical interventions (Hata et al., 2024; OECD, 2022). This trend also aligns with the direction of national curriculum policy, which emphasizes contextual and student-centered learning approaches as the primary strategy for strengthening mathematical representation and reasoning skills from elementary school (Setiawan et al., 2024). Similar findings have been reported in previous studies, demonstrating that the application of innovative instructional models can positively influence students' numeracy skills and learning motivation. (Julaikum et al., 2025; Rizqi et al., 2025)

The results of a bibliometric analysis using overlay visualization indicate a shift in research focus from general studies of mathematics learning to the development of instructional models explicitly targeting numeracy improvement (Ngaisah & Kusuma, 2025). In the early period, research focused more on general aspects of schooling and mathematics learning. Since 2023, topics such as instructional models, numeracy, and teachers have increasingly dominated publications, marking a paradigm shift in primary education research (Nwoko et al., 2023). This shift demonstrates the growing need for more active, structured, and contextually grounded learning strategies to deepen students' numeracy understanding (Ngaisah & Kusuma, 2025; Nwoko et al., 2023).

Several recent studies also emphasize the role of digital technology in strengthening numeracy through interactive representations, immediate feedback, and more individualized learning (Kim, H., & Park, 2020). In the Indonesian context, the implementation of Realistic Mathematics Education and a culturally responsive approach has been shown to support curriculum objectives and increase student engagement in completing numeracy tasks (Dewi, N., & Hidayat, 2023; Fauzan, A., Plomp, T., & Gravemeijer, 2013).

Findings from density visualizations reinforce this trend, with the keywords instructional model and numeracy being the focus of research (Dewi et al., 2025). The dominance of approaches such as Realistic Mathematics Education (RME) and Ethno-RME suggests that realistic and cultural contexts play a crucial role in helping students connect real-world situations to formal mathematical models (Pujiastuti et al., 2025; Sheila Herliza, 2024). Furthermore, the application of problem-based learning, inquiry, and discovery learning has also been widely reported to improve mathematical representation and problem-solving skills through students' active engagement in the learning process (Nwoko et al., 2023). Although most articles report positive effects on cognitive and affective aspects, the variety of designs and instruments used suggests that these results should be interpreted cautiously and in context (Setiawan et al., 2024). This finding is consistent with previous research highlighting that structured and interactive learning approaches are effective in strengthening students' numeracy literacy across different educational contexts (Ismail et al., 2025) .

In addition to the learning model, the role of teachers has emerged as a key factor in determining the quality of numeracy learning (Nurre, C., & Lin, 2021; Yusof, Y., & Tall, 2021). Various studies confirm that the success of numeracy reinforcement depends heavily on teachers' ability to design scaffolding, select contextual media, and facilitate students' gradual mathematization (Pujiastuti et al., 2025). However, challenges such as limited teacher competency in integrating culture-based approaches, low utilization of learning technology, and minimal ongoing numeracy training are still frequently reported (Ngaisah & Kusuma, 2025; Setiawan et al., 2024). This situation suggests that improving teacher professional competency is a crucial prerequisite for the successful implementation of innovative numeracy learning models.

Although various learning models have been developed, this study identified a significant research gap: the lack of empirical studies directly testing the implementation of the GEMBIRA Learning Model in numeracy learning in elementary schools (Widdiharto et al., 2025). In fact, conceptually, GEMBIRA integrates cultural context, student exploration, meaningful activities, and strengthening mathematical reasoning, aligning with the principles of Ethno-RME and the demands of 21st-century numeracy (Pujiastuti et al., 2025; Rahmawati & Purnomo, 2024). The absence of classroom-based studies indicates that GEMBIRA is still in its early stages in the research landscape and opens up ample opportunities for future experimental research and development.

Overall, these findings confirm that numeracy develops more optimally when learning is designed in a contextual, culturally based, interactive manner, and oriented toward students' mathematical thinking processes (Dewi et al., 2025). The integration of appropriate learning models, teacher pedagogical competence, and local contextual relevance has been proven to be a dominant factor in successful numeracy learning (Pujiastuti et al., 2025). Therefore, further research is needed to develop authentic numeracy assessments, strengthen teacher training, and empirically test new learning models such as GEMBIRA, so that numeracy reinforcement in elementary schools can be more effective, sustainable, and tailored to student needs (Widdiharto et al., 2025).

This study has several limitations. First, this study only used Google Scholar as the primary database, so there may be relevant publications from other databases that were not yet accessible. Second, the analysis used was descriptive and bibliometric, so the methodological quality of each study was not thoroughly evaluated. Therefore, the results of this study need to be interpreted within the context of these limitations and can be supplemented by more specific and in-depth follow-up studies.

4. Conclusion

The results of this systematic literature review indicate that research on numeracy skill development in elementary schools continues to grow during the 2020-2025 period, both in terms of study focus and the variety of learning approaches used.

Research findings indicate that numeracy is a complex competency and requires meaningful, contextually oriented learning designs that support students' thinking processes. Various learning models, such as Realistic Mathematics Education, ethnomathematics, inquiry, and discovery approaches, have been shown to improve students' conceptual understanding, reasoning, and problem-solving skills. Integrating cultural context has also been found to strengthen engagement and relevance of learning for elementary school students.

However, this review identifies a significant research gap: the lack of empirical studies directly testing the application of the GEMBIRA Learning Model in classroom numeracy learning practices. This suggests that while GEMBIRA has a strong conceptual foundation and aligns with contextual and Ethno-RME approaches, its effectiveness still needs to be demonstrated through classroom-based research. Therefore, further research is needed to empirically test the GEMBIRA model, strengthen teacher competencies, and develop authentic numeracy assessments to ensure more effective and sustainable numeracy development in elementary schools. Overall, this review successfully addresses its research objectives by mapping research trends, identifying dominant learning approaches, and highlighting opportunities for innovation in numeracy learning development in elementary schools.

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