

Systematic Literature Review: Does Realistic Mathematics Education Approach Enhance Mathematical Literacy?

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ABSTRACT

Realistics Mathematics Education (RME) is an instructional approach that emphasizes the use of real-world problems and situations in mathematics teaching. This method is believed to significantly enhance students' mathematical literacy, which is crucial for their academic and everyday problem-solving skills. This systematic literature review aims to investigate the impact of RME on students' mathematical literacy by synthesizing existing research findings. A systematic review design was employed, focusing on studies that explore the relationship between RME and mathematical literacy. The Scopus database was utilized for bibliometric analysis, with the search term "mathematical literacy" restricted to article titles. Data extracted included author names, citation counts, titles, publication years, sources, publishers, and document types. The analysis revealed approximately total of 200 publications related to mathematical literacy were found with a total of 10,817 citations, resulting in an average of 54.1 citations per article, indicating a substantial body of research on this topic. Notable trends included the integration of computer-mediated learning and various pedagogical models. The findings suggest that RME is an effective pedagogical approach that promotes students' mathematical literacy through authentic and contextualized learning experiences. This review highlights the necessity of developing educational materials and teaching strategies that prioritize mathematical literacy, thereby enhancing students' proficiency in mathematics and preparing them for real-world applications.

Keywords : Realistics Mathematics Education, mathematical literacy

ABSTRAK

Pendidikan Matematika Realistik (RME) adalah pendekatan pengajaran yang menekankan penggunaan masalah dan situasi dunia nyata dalam pengajaran matematika. Metode ini diyakini dapat secara signifikan meningkatkan literasi matematika siswa, yang sangat penting untuk keterampilan pemecahan masalah akademis dan sehari-hari mereka. Tinjauan literatur sistematis ini bertujuan untuk menyelidiki dampak RME terhadap literasi matematika siswa dengan mensintesis temuan penelitian yang ada. Desain tinjauan sistematis digunakan, dengan fokus pada studi yang mengeksplorasi hubungan antara RME dan literasi matematika. Basis data Scopus digunakan untuk analisis bibliometrik, dengan istilah pencarian "literasi matematika" dibatasi pada judul artikel. Data yang diekstrak mencakup nama penulis, jumlah kutipan, judul, tahun publikasi, sumber, penerbit, dan jenis dokumen. Analisis mengungkapkan sebanyak 200 publikasi terkait literasi matematika ditemukan dengan total 10.817 sitasi, menghasilkan rerata 54,1 sitasi per artikel, menunjukkan adanya badan penelitian yang substansial tentang topik ini. Tren yang mencolok termasuk integrasi

pembelajaran berbantuan komputer dan berbagai model pedagogis. Temuan menunjukkan bahwa RME adalah pendekatan pedagogis yang efektif yang mempromosikan literasi matematika siswa melalui pengalaman belajar yang autentik dan kontekstual. Tinjauan ini menyoroti perlunya mengembangkan materi pendidikan dan strategi pengajaran yang memprioritaskan literasi matematika, sehingga meningkatkan kemampuan siswa dalam matematika dan mempersiapkan mereka untuk aplikasi di dunia nyata.

Kata kunci: Pendidikan Matematika Realistik, literasi matematika

INTRODUCTION

Mathematics education globally faces a significant challenge: ensuring inclusive and high-quality instruction for all learners. A critical component of this challenge lies in fostering mathematical literacy – the ability to apply mathematical concepts and skills to real-world situations. Realistic Mathematics Education (RME), an instructional approach emphasizing contextualized learning and real-world problem-solving, has emerged as a potential solution to this challenge. RME's pedagogical framework, grounded in the use of authentic contexts and student-centered activities, aims to develop deep conceptual understanding and enhance problem-solving skills (Freudenthal, 1973; Treffers, 1987). Existing research indicates a positive correlation between RME implementation and improved mathematical literacy and overall mathematics achievement (Reflina, 2022; Tümkaya & Ulum, 2020). These studies highlight RME's effectiveness in fostering deeper student understanding and increased motivation.

However, despite the growing body of research supporting RME's efficacy, a comprehensive synthesis of its impact on various facets of mathematical literacy remains limited. While individual studies have explored specific aspects of RME's influence, a systematic review is needed to consolidate findings, identify research gaps, and provide a clearer picture of its overall effectiveness in promoting mathematical literacy across diverse contexts and student populations. Furthermore, the integration of technology and diverse pedagogical approaches within the RME framework requires further investigation. The lack of a systematic analysis of these trends hinders a complete understanding of RME's potential and its optimal implementation strategies.

This research addresses the critical need for a systematic examination of RME's impact on mathematical literacy. The primary research problem focuses on identifying the extent to which RME enhances various components of mathematical literacy, including problem-solving, mathematical representation, and critical thinking. This systematic literature review aims to synthesize existing research on RME, analyze its contributions to mathematical literacy, and identify areas for future research and development in this crucial area of mathematics education.

Realistic Mathematics Education (RME) has been shown to significantly enhance mathematical literacy and overall mathematics achievement (Reflina, 2022; Tümkaya & Ulum, 2020). Through its design-based approach, RME improves students' understanding and motivation to learn mathematics (Fianingrum et al., 2023). Despite these benefits, one of the pressing global challenges in mathematics education

is inclusivity, where teachers often struggle to provide high-quality instruction that meets the diverse needs of all students (Gervasoni & Peter-Koop, 2020).

Current literature highlights a gap in understanding how RME can be effectively implemented to address these inclusivity challenges, particularly in varying educational contexts (Pham et al., 2025; Pratiwi & Pujiastuti, 2020; Pugalee, 1999; D. A. Putri & Widjajanti, 2019; Susanti et al., 2022; Trisnawati et al., 2018; Yuanita et al., 2018). This study aims to investigate the impact of RME on enhancing mathematical literacy while addressing the inclusivity issue in mathematics education. The objective of this article is to systematically review existing research on RME and its effectiveness in improving mathematical literacy, thereby contributing to the ongoing discourse on inclusive mathematics education.

METHOD

In order to summarise the body of knowledge regarding the impact of realistic mathematics education on students' mathematical literacy skills, this study used a systematic literature review methodology. Examining peer-reviewed journal papers, conference proceedings, and other relevant publications. The search was conducted using the following keywords: "realistic mathematics education," and mathematical literacy. Subsequently, the chosen research works underwent analysis and categorization grounded in the principal themes and conclusions pertaining to the impact of Realistic Mathematics Education on the mathematical literacy of students.

The three stages of this study are data collection, data analysis, and conclusion drawing. Published primary studies are the source of information found in indexed journal articles. The electronic databases that were used for the literature search were Scopus. The SLR process follows the PRISMA protocol, which starts with article identification using a database, followed by judul and abstract skrinig, kelayakan based on implicit criteria, and finally, article ententuan that will be analyzed. The PRISMA diagram is used to visually represent the article selection process.

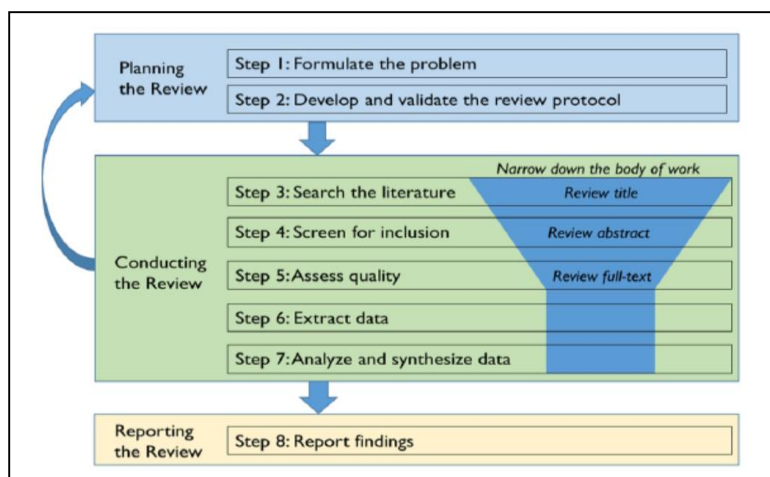


Figure 1. Process of systematic literature review

Twenty scientific articles that are pertinent to the topic are all from Indonesia. A meta-aggregation strategy is used for data analysis, synthesis, and interpretation. Its goal is to provide answers to research questions by providing a summary of different research findings (Aini et al., 2023; Dewantara et al., 2023; Fauzan et al., 2024; Fauzana et al., 2020; Isnaintri et al., 2024; Mariani & Kurniati, 2021; A. D. Putri,

Juandi, & Turmudi, 2024; A. D. Putri, Juandi, Turmudi, et al., 2024). The study's findings are provided in-depth in order to address the research question.

Because the Scopus database had several electronically well-qualified articles from a variety of scientific domains, it was used to find the documents pertaining to mathematical literacy research (Zhu & Liu, 2020). To find potential documents relevant to studies on keyword "mathematical literacy" was created. On October 04, 2024, at precisely 10.27 AM Western Indonesian Time, a search of the Scopus database was conducted. 200 documents from 2000 to 2024 that were sourced from books, journals, conference proceedings, and book series were found in the first search results. The materials, which included an article, book chapter, conference paper, review, editorial, conference review, book, note, and brief survey, were in the final stages of publication and were in press. Many languages, including English, German, Japanese, Chinese, Korean, Portuguese, Spanish, French, Russian, Italian, and Turkish, were used in the writing of the documents.

A few basic requirements are stated in order to obtain documents related to mathematical studies. First and foremost, the document's title should include the word "mathematical literacy". However, the document is only written in English, and its publication date is already final. Third, the document is only sourced. Third, the only sources of the documents are journals and conference proceedings; the types of documents are articles, reviews, and conference proceedings. Furthermore, the document is dated from 2000 until 2024. Documents that do not meet the requirements are the result of the selection process. According to some literature, there are four steps to methodically review documents: (1) identification, (2) screening, (3) eligibility, and (4) inclusion (Chen et al., 2021; de Dieuleveult et al., 2017; Page et al., 2021).

RESULT AND DISCUSSION

Numerous research studies have shown that Realistic Mathematics Education (RME) has a major impact on students' literacy mathematics skills. RME has a strong emphasis on real-world scenarios, which improves students' capacity to use mathematical ideas in practical ways. RME's Ability to Increase mathematical literacy ME dramatically increased pupils' literacy mathematics skills, as demonstrated by a quasi-experimental study that produced an N-Gain Score of 61%, indicating a "moderately effective" improvement (Connor et al., 2018; OECD, 2014; Sari & Yuniati, 2018).

Students are able to make connections between mathematical concepts through the integration of real-life applications in RME, which is essential for problem-solving abilities (Tumangger et al., 2024). Effect on Ability to Solve Problem studies reveal that RME increases students' capacity for problem-solving as well as their literacy, with notable gains seen in their analytical abilities (Fitriana & Waswa, 2024). According to a systematic review, students frequently face difficulties with numeracy skills as a result of a deficiency of real-world applications. RME effectively overcomes this issue.

Table 1. Metrics for publications and citations

Description	Results
Publication years	2000-2022
Citation years	20 (2000-2024)
Total Publication (Papers)	200
Total Citation	10817
Author	1.00
Cites/year	450,71
Cites/paper	10817.00
Authors/paper	200.00
h-Index	53
g-Index	94

According to Table 1, there were 200 publications on literacy mathematics abilities between 2000 and 2024. These publications were cited 45.71 times in total, with an average of 20 citations annually. There are about 200 publications related to mathematical literature, with a total of 10.817 views, yielding an average of 54.1 views per article. Furthermore, each of the gathered documents was cited at least three times or more, with an average citation per paper of 10817. The total number of authors involved in the publication of the documents is 248; each paper has 200 contributors. Additionally, there are 53 documents having at least 94 citations, as indicated by the document's h-index of 53. There are 94 papers with the greatest citation of at least 256, according to the g-index of 53.

This examination of scholarly outputs and their corresponding citations is employed to delineate the evolution of the quantity of publications and citations pertaining to mathematical representation during the period of 2013 to 2022. Patterns in scholarly publications and citation references are illustrated in Figure 3 and 4.

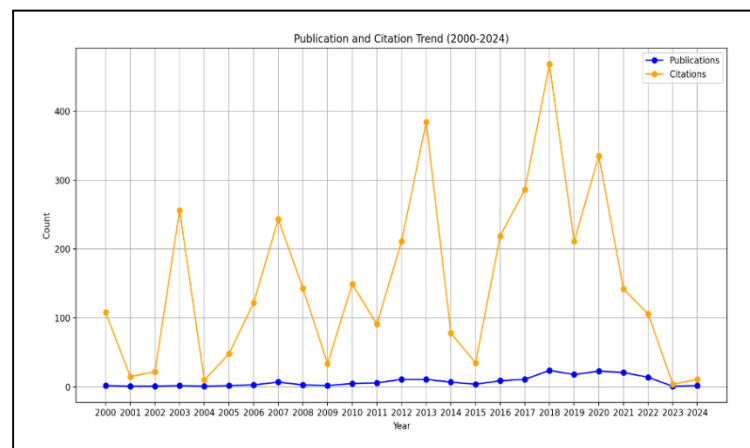


Figure 3. Analysis of the publication and citation patterns of scholarly documents spanning the years 2000 to 2024

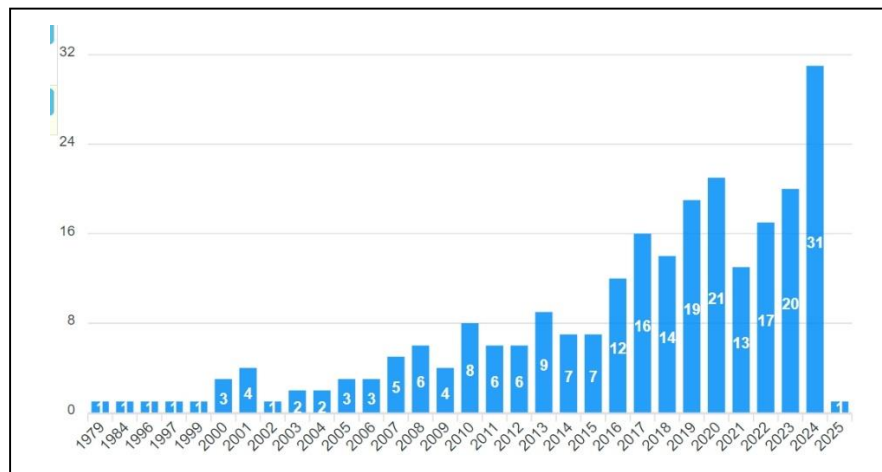


Figure 4. Analysis of the publication and citation patterns of scholarly documents spanning the years 1979 to 2024

The heatmap analysis shows a strong positive correlation between the variable "Cites" and variables such as "CitesPerAuthor" and "ECC," with correlation coefficients of ****1.00****, suggesting a direct relationship between these metrics. This implies that as the number of citations increases, both the citations per author and the ECC (presumably a citation-related metric) increase in parallel. Additionally, "CitesPerYear" also has a strong correlation with "Cites" at ****0.70****, reflecting that the number of citations per year is another strong indicator of overall citation count. On the contrary, "Year" shows a negative correlation with "Cites" (-0.38), indicating that more recent publications may have fewer citations compared to older ones (see Figure 5).

The variable "Year" exhibits a significant negative correlation with "Age" (-1.00), which is expected, as more recent publications are younger by nature. Interestingly, "Year" has a positive but moderate correlation with variables such as "GSRank" (0.39) and "Volume" (0.29), suggesting that more recent publications are ranked higher on Google Scholar (GSRank) and published in higher volumes. This might reflect recent trends in journal publishing where higher volumes are associated with better rankings. However, its correlation with "Cites" is negative (-0.38), which might indicate that newer papers have had less time to accumulate citations.

Several publication-specific characteristics such as "Volume" and "Issue" show strong positive correlations with each other (0.54) and with page-related variables like "StartPage" and "EndPage" (both 0.54), implying that the structure of publications is inherently related. For instance, a higher volume is likely associated with more extensive issues and articles spanning multiple pages. These correlations suggest that the structural attributes of a publication, such as volume and issue, are important factors in determining the overall scope of the published work. However, "GSRank" exhibits relatively weak correlations with these variables, suggesting that the structure and ranking of publications may not be as strongly connected.

These insights help to contextualize the relationships between key citation metrics, publication years, and structural elements, providing a comprehensive overview of how these factors interact in scholarly publication contexts (see Figure 6).

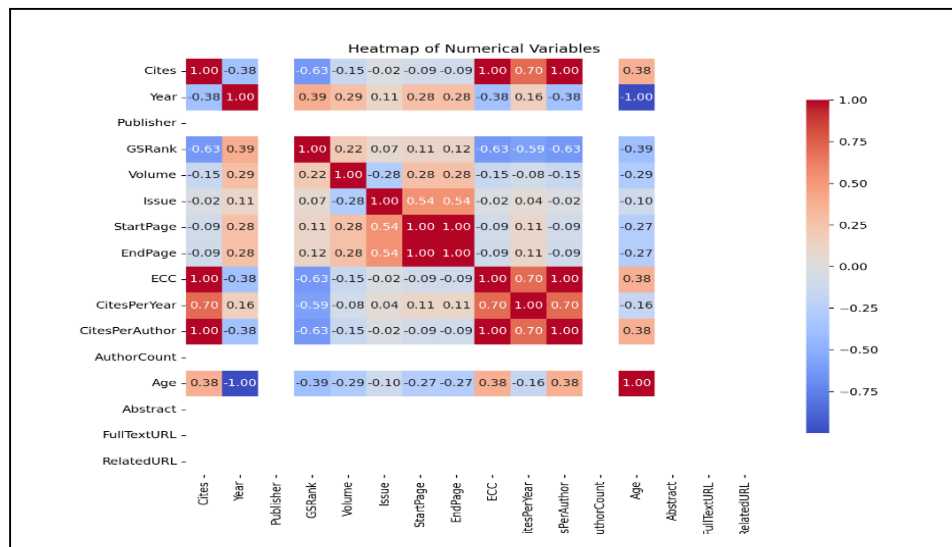


Figure 5. Headmap analysis



Figure 6. Wordcloud 6

Findings from studies on realistic mathematics education approach that promotes numeracy can be seen in Table 2.

Table 2. Findings from studies on realistic mathematics education approach that promotes numeracy

Cites	Authors	Title	GS Rank	CitesPer Year	CitesPer Author
7	Ü. Çakıroğlu	Virtual Reality in Realistic Mathematics Education to Develop Mathematical Literacy Skills	126	7	7
18	R Fauzana, JA Dahlan, A Jupri	The influence of realistic mathematics education (RME) approach in enhancing students' mathematical literacy skills	2	4.5	6

Cites	Authors	Title	GS Rank	CitesPer Year	CitesPer Author
2	AD Putri, D Juandi, T Turmudi	Realistic mathematics education and mathematical literacy: a meta-analysis conducted on studies in Indonesia	3	2	1
0	E Isnaintri, S Syamsuri, H Nindiasari ...	The Effect of Realistic Mathematics Education (RME) Approach on Students' Mathematical Ability: A Meta-analysis Study	4	0	0
1	S Mariani, CN Kurniati	Mathematics literacy abilities and responsibility with realistic mathematics education learning based ethnomathematics	5	0,33	1
14	U. Umbara	Implementation of realistic mathematics education based on adobe flash professional cs6 to improve mathematical literacy	4	2.33	14
2	R.A. Apsari	Fostering mathematical literacy amongst primary school students using realistic mathematics education approach	15	1	2
1	AD Putri, D Juandi, T Turmudi, D Fardian...	Does The Realistic Mathematics Education Approach Enhance Students' Mathematical Literacy? A Systematic Literature Review	8	1	0
4	CN Kurniati, S Mariani	Qualitative analysis on mathematical literacy ability and student responsibility with realistic mathematics education learning models of ethnomathematics nuance	9	1	2
21	S Maslihah, SB Waluya, N Karomah...	Increasing mathematical literacy ability and learning independence through problem-based learning model with realistic mathematic education approach	10	7	5
1	F Al Ahadi, M Asikin, W Wardono	Mathematical Literacy Reviewed from Student's Metacognition On the PJBL Learning with RME Approach Assisted Edmodo	11	0.33	0
6	L Nurmasari, J Nurkamto, M Ramli	Realistic Mathematics Engineering for Improving Elementary School Students' Mathematical Literacy.	12	6	2
2	M Wesna	Mathematical literacy ability in terms of the independent learning students on reciprocal teaching learning models with approaching RME assisted by google ...	13	0.67	2

Cites	Authors	Title	GS Rank	CitesPer Year	CitesPer Author
3	K.L. Purwanti	Mathematical literacy ability with RME (realistic mathematics education) approach in fifth grade students	14	0.5	3
15	Ü Çakıroğlu, M Güler, M Dündar...	Virtual reality in realistic mathematics education to develop mathematical literacy skills	15	15	4
5	A.D. Putri	Development of realistic mathematics education-based teaching materials to increase students' mathematical literacy ability	12	5	5
2	N. Sari	Development of E-Worksheet Based on Realistic Mathematics Education to Support Mathematical Literacy Skills of Junior High School Students	16	1	2
43	A Fauzan, IM Arnawa	Designing mathematics learning models based on realistic mathematics education and literacy	18	10.75	22
0	A.N. Cahyo	Mathematical literacy ability of class v elementary school students through RME model in solving HOTS questions	18	0	0
35	Wardono	Mathematics Literacy on Problem Based Learning with Indonesian Realistic Mathematics Education Approach Assisted E-Learning Edmodo	2	3.89	35

From the analysis of 20 articles, we identified several key findings related to the impact of RME on students' literacy skills:

Improved Concept Understanding: Most studies show that the RME approach helps students understand mathematical concepts better. For example, research by (Gravemeijer et al., 2004; Zulkardi et al., 2020) states that students who learn through realistic contexts show a deeper understanding of the concepts of measurement and estimation.

Student Engagement: RME encourages students' active involvement in learning. Some studies, such as the one by (Van Den Heuvel-Panhuizen, 2003; Zulkardi et al., 2020), show that students are more motivated and engaged when they learn through problems relevant to everyday life.

Positive Impact on mathematical literacy Skills: Several studies found that students taught with the RME approach showed significant improvements in their mathematical literacy skills compared to traditional methods. For example, a study by (Pugalee, 1999; A. D. Putri, Juandi, & Turmudi, 2024; A. D. Putri, Yerizon, Arnellis, et al., 2024; Umbara & Nuraeni, 2019) showed an improvement in students' ability to apply mathematical literacy skills in real-life situations following RME-based learning.

Reduction of Maths Anxiety: There is evidence that RME can help reduce maths anxiety among students. This approach provides a more enjoyable and relevant

learning experience, which can increase students' confidence in dealing with mathematics (Van Den Heuvel-Panhuizen et al., 2014) .

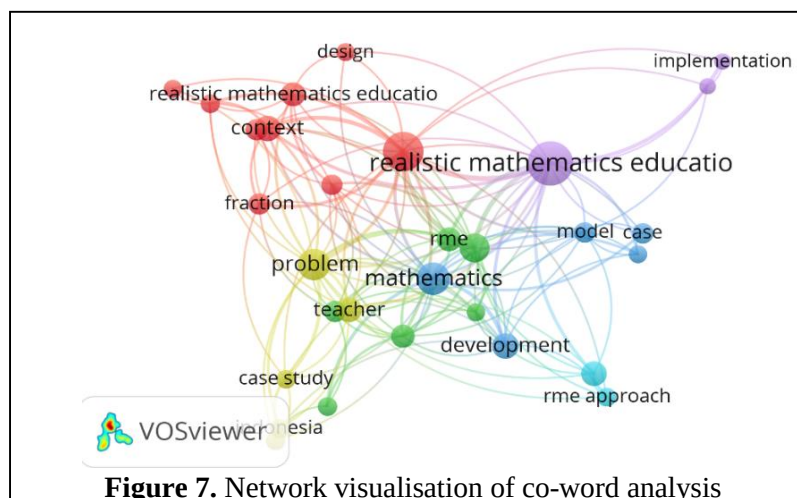


Figure 7 presents a network visualisation of co-word analysis, illustrating the relationships between key terms related to realistic mathematics education (RME). The co-word analysis groups terms into clusters based on their co-occurrence in literature, highlighting how frequently these terms are used together in research studies.

The visualisation shows several key clusters, each represented by a different colour, and connects terms that appear together frequently, forming a network. The size of the nodes represents the frequency of the term's occurrence, and the proximity between nodes indicates the strength of the relationship between terms. Larger nodes indicate terms that are more central to the network, while smaller nodes suggest terms that are less dominant but still important in the overall structure.

The network visualization image in the co-word analysis displays clusters of key terms that reflect the main thematic areas in Realistic Mathematics Education (RME) research. Central terms such as “realistic mathematics education,” “mathematics,” “context,” and “problem” form the core of the network, emphasizing the main components in RME research.

The red cluster consists of the terms “realistic mathematics education,” “context,” and “design,” highlighting the foundational framework of RME and its application in instructional design. This underscores the importance of placing mathematics within real-life contexts to make learning more meaningful. The yellow cluster is dominated by the terms “problem” and “teacher,” indicating a focus on problem-solving and the role of teachers in facilitating student understanding through RME strategies. Meanwhile, the green cluster features the terms “RME,” “mathematics,” and “case study,” indicating an emphasis on specific case studies related to the application of RME in mathematics learning. In the blue cluster, terms such as “model case,” “development,” and “RME approach” are the focus, indicating an emphasis on developing models and case studies that practically apply the RME approach. The purple cluster highlights the terms ‘implementation’ and “fraction,” referring to research on the implementation of RME and specific mathematical topics such as fractions.

This network visualization analysis underscores the importance of context, problem-solving, and teaching strategies in RME. The relationships between terms

show how RME connects theoretical mathematical concepts with real-world applications, making mathematics more relevant and easier for students to understand. Additionally, the grouping of terms also indicates potential areas for further research, such as developing teaching models for complex topics (e.g., fractions) or improving the practical implementation of RME in various classroom settings.

Regarding the metadata analysis focused on the “Cites” field in the Sankey diagram, the number of citations (“Cites”) serves as the primary metric determining the visibility and significance of a publication. The large flow from “Cites” to “GSRank” indicates a strong relationship between the number of citations and Google Scholar rankings, meaning that publications with high citations tend to have better rankings. ‘Cites’ also influences “CitesPerAuthor,” where the more citations there are, the higher the average citations per author.

The relationship between “Year” (publication year) and other metadata variables shows that older publications tend to have more citations, as they have been in circulation and referenced for longer. However, there is also a moderate flow between ‘Year’ and “CitesPerYear,” indicating that new articles can still receive significant annual citations, thus remaining relevant in the development of science.

Finally, the correlation between the number of authors (“Author Count”) and citation metrics shows that publications with more authors tend to have higher citation counts. Collaboration in research expands academic networks and increases the chances of publications being recognized and cited. The relationship between “Author Count” and “CitesPerYear” also shows that the more authors there are, the higher the citation rate per year, emphasizing the importance of collaboration in enhancing the academic impact of a work.

The results of this literature review indicate that the RME approach has strong potential to improve students' mathematical literacy skills. By placing students in a realistic and relevant context, RME not only helps students understand mathematical concepts better but also increases motivation and reduces anxiety. However, it is important to note that the successful implementation of RME relies heavily on support from educators and an appropriate curriculum. To ensure that RME implementation is successful, it is necessary to develop contextual learning materials and teacher training in a thorough manner. Subsequent research aims to investigate technology integration and RME adaptation in many educational fields.

CONCLUSION

Overall, this review shows that the Realistic Mathematics Education approach can significantly improve students' mathematical literacy skills. RME not only supports conceptual understanding but can also create a more positive learning experience for students. Further research is needed to explore effective RME implementation strategies and to understand how cultural and social contexts influence learning outcomes.

It is recommended that educators and curriculum developers consider integrating the Realistic Mathematics Education (RME) approach into mathematics instruction in schools, as this can enhance students' understanding of mathematical concepts through relevant and real-world contexts. To support this integration, it is essential to conduct training sessions and workshops for educators on the implementation of RME, which can improve teachers' understanding of effective teaching strategies and how to apply this approach in the classroom. Additionally, further research should be conducted to

explore the impact of RME on various age groups and educational backgrounds, as this could provide deeper insights into the effectiveness of this approach across different contexts.

Although this systematic review shows that the Realistic Mathematics Education (RME) approach consistently improves students' mathematical literacy in Indonesia, it is important to highlight the limitations of the regional scope of the studies analyzed. All of the articles reviewed come from the context of Indonesian education, which has its own cultural characteristics, curriculum, and education system. Therefore, there are several important implications regarding the generalization of the findings: 1. Cultural and Systemic Factors: The education system in Indonesia emphasizes contextual learning and problem-solving based on everyday life, which is highly aligned with RME principles. Cultural values, the role of teachers, and curriculum structure in Indonesia may influence the effectiveness of RME implementation. This may differ in countries with different education systems, learning cultures, or societal expectations. 2. Generalization of Findings: Findings from studies in Indonesia provide strong evidence that RME is effective in the local context. However, caution is needed when generalizing these results to other countries without considering adaptations to local cultural and educational system contexts. Further research involving cross-national contexts would be valuable to test whether similar patterns of success are found outside Indonesia. 3. Recommendations for Further Research: Comparative studies or replication of research in other countries are needed to identify the key factors influencing the success of RME. Additionally, in-depth qualitative research can explore how cultural and systemic factors mediate the implementation and outcomes of RME.

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