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# SYSTEMATIC LITERATURE REVIEW: THE EFFECT OF METHOD REALITIC MATHEMATICS EDUCATION ON MATHEMATICAL COMMUNICATION

**Fitrah[1a*], Mira Ammelia Amri[2b], Apit Dulyapit[3c]**

[a,b,c] Department of Elementary Education, Jakarta State University, Jakarta, Indonesia

[*a] *E-mail:* fitrah@mhs.unj.ac.id

(*) Corresponding Author
fitrah@mhs.unj.ac.id

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**ABSTRACT**
*Mathematical communication ability is a fundamental competence in 21st-century education that enables students to reason logically, construct mathematical arguments, solve problems, and express ideas through verbal, written, and symbolic representations. This study conducts a* ***Systematic Literature Review (SLR)*** *to examine the impact of Realistic Mathematics Education (RME) on students' mathematical communication ability. The review analyzed* ***five empirical studies*** *published between* ***2020 and 2025****, selected through a systematic screening process based on predefined inclusion and exclusion criteria from major academic databases. The findings consistently indicate that RME improves mathematical communication ability by promoting contextual problem solving, multiple representations, collaborative discussion, and active student engagement. The principles of reality, level, intertwinement, activity, interactivity, and guidance collectively support students in explaining mathematical ideas and constructing meaningful arguments. In addition, several studies reported positive effects on learning outcomes, learning independence, and metacognitive reflection. However, the limited number of studies explicitly focusing on the relationship between RME and mathematical communication ability restricts the generalizability of the evidence. This review contributes to mathematics education by providing a synthesized understanding of current research trends and highlighting RME as a promising pedagogical approach for strengthening students' mathematical communication ability while identifying directions for future research across broader educational contexts.*



## INTRODUCTION

Mathematical communication ability has emerged as a fundamental competence in 21st-century education, equipping students with essential skills to reason logically, construct mathematical arguments, solve problems, and express ideas through spoken language, written language, and symbolic representation. The concept of mathematical

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communication was first introduced by Moseley et al. (1993) and has since developed into a core competency comparable to reading, writing, and arithmetic skills. Within mathematics education, mathematical communication ability enables students to understand concepts, analyze problems, and communicate mathematical reasoning accurately through appropriate representations (Chasanah et al., 2020).

One instructional approach that has been widely associated with the development of mathematical communication ability is Realistic Mathematics Education (RME). RME emphasizes six main principles reality, level, intertwinement, activity, interactivity, and teacher guidance which encourage students to construct mathematical understanding through meaningful real-life experiences and social interaction (Gravemeijer, 1994). By connecting abstract mathematical concepts with authentic contexts, collaborative discussion, and problem-solving activities, RME provides opportunities for students to articulate ideas, justify reasoning, and communicate mathematical thinking more effectively.

Empirical studies consistently demonstrate the positive contribution of RME to mathematical communication ability. Chasanah et al. (2020) reported that RME-based learning improves students' ability to express mathematical ideas through contextual problem-solving activities. Siswantari et al. (2025) further found that the implementation of RME principles enhances mathematical communication by promoting meaningful contexts, dialogic interaction, and structured teacher guidance. Similarly, Palinussa et al. (2021) showed that RME significantly strengthens students' mathematical reasoning and communication, while Astuti et al. (2020) demonstrated improvements in mathematics learning outcomes associated with enhanced mathematical communication ability.

Although these studies provide evidence of the benefits of RME, existing research is predominantly limited to individual empirical investigations conducted in specific educational settings. To date, there remains a lack of comprehensive synthesis that systematically integrates recent evidence on how RME influences mathematical communication ability across different contexts, educational levels, research designs, and learning implementations. Most previous reviews have discussed RME broadly in relation to mathematics achievement or general learning outcomes rather than focusing specifically on mathematical communication ability as the primary outcome. Consequently, the overall pattern of findings, methodological trends, and consistency of evidence regarding the relationship between RME and mathematical communication ability remain insufficiently understood.

This gap highlights the need for an up-to-date Systematic Literature Review (SLR) that specifically examines the effectiveness of RME in improving mathematical communication ability. By synthesizing findings from studies published between 2020 and 2025, this review seeks to identify research trends, methodological characteristics, and the extent to which RME contributes to enhancing mathematical communication ability. Unlike previous studies that primarily reported isolated empirical results, this review provides an integrated perspective on current evidence and identifies directions for future research and instructional practice focused explicitly on strengthening mathematical communication ability through RME.

Therefore, this study aims to conduct a Systematic Literature Review regarding the effect of Realistic Mathematics Education on students' mathematical communication ability. The findings are expected to provide a clearer understanding of the effectiveness of RME in fostering mathematical communication ability and offer evidence-based recommendations for researchers and educators seeking to improve mathematics learning through contextual and student-centered approaches.

## METHOD

This study employed the Systematic Literature Review (SLR) method to synthesize empirical evidence regarding the use of Realistic Mathematics Education (RME) in improving students' mathematical communication ability. The review followed a systematic procedure adapted from the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), consisting of identification, screening, eligibility assessment, and inclusion stages to ensure transparency and reproducibility of the study selection process.

The literature search was conducted using four major academic databases: Scopus, Taylor & Francis, Springer, and Google Scholar. To maximize retrieval, a combination of keywords and Boolean operators was used, including:

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("realistic mathematics education" OR "RME") AND ("mathematical communication" OR "mathematical communication ability" OR "mathematical communication skills"). The search was limited to studies published between 2020 and 2025 in English or Indonesian.

The initial search identified articles from the selected databases, which were subsequently screened by removing duplicate records. Titles and abstracts were then reviewed to determine their relevance to the research objective. The remaining studies underwent full-text assessment based on predefined eligibility criteria. Articles were included if they (1) were empirical studies examining the implementation of RME in mathematics learning, (2) explicitly investigated mathematical communication ability as a primary or secondary outcome, (3) were published in peer-reviewed journals, and (4) were available in full text. Articles were excluded if they (1) were conceptual papers, literature reviews, conference abstracts, or editorials, (2) were published before 2020, (3) lacked accessible full text, or (4) discussed RME without explicitly examining its relationship with mathematical communication ability. The detailed selection process, including the number of records identified, screened, excluded, and ultimately included, is presented in the PRISMA flow diagram.

To ensure the credibility of the synthesis, each eligible study was assessed based on methodological quality, including clarity of research objectives, appropriateness of research design, description of participants, transparency of data collection procedures, and consistency between findings and conclusions. Only studies meeting these quality considerations were retained for further analysis.

Data extraction was conducted systematically using a coding framework developed by the researchers. The extracted information included publication year, country or educational context, research design, sample characteristics, educational level, implementation of RME principles, instruments used to assess mathematical communication ability, and key findings. The coded data were then analyzed descriptively and narratively to identify recurring themes, research trends, methodological characteristics, and empirical evidence regarding the effectiveness of RME in enhancing students' mathematical communication ability across different educational contexts.

Through this systematic procedure, the review provides a comprehensive synthesis of recent evidence and offers an evidence-based understanding of how RME contributes to the development of mathematical communication ability, while also identifying gaps and opportunities for future research.

## RESULTS AND DISCUSSION

### RESULTS

The literature search yielded five empirical studies published between 2020 and 2025 that specifically examined the application of Realistic Mathematics Education (RME) to improve students' mathematical communication ability. These studies varied in terms of research design, participants, and educational context but consistently focused on the role of RME in supporting mathematical communication. The synthesis of the selected studies is presented in Table 1, which summarizes the research objectives, methodological characteristics, principal findings, and educational implications of each study.

Table 1. Literature Synthesis Results

| Author, (Years) | Title | Method | Research Findings | Implications |
|---|---|---|---|---|
| Chuswatun Chasanah, Riyadi, Budi Usodo (2020) | The Effectiveness of Learning Models on Written Mathematical Communication Ability Viewed from Students' Cognitive Styles | This study applied a Quasi-Experimental approach involving 240 fifth-grade elementary school students in Jebres | The PP model with the RME approach is more effective in improving mathematical communication ability. | The RME-based PP model can be used to improve written mathematical communication ability, considering the variations in students' |

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| Author, (Years) | Title | Method | Research Findings | Implications |
|---|---|---|---|---|
| | | sub-district, Surakarta. | | cognitive styles for learning effectiveness. |
| Siswantari, simon sili sabon, Nur Listiawati, Yendri Wirda, Zukardi, Bambang Riyanto (2025) | Bridging Mathematics and Communication: Implementation of Realistic Mathematics Education Principles for the development of mathematical communication skills | Qualitative Educational Design Research, involving 9 schools in 3 districts, participants: RME experts, education policymakers, school principals, mathematics teachers. | Every RME principle (reality, level, intertwinement, activity, interactivity, guidance) plays a role in supporting mathematical communication through meaningful contexts, dialogic interactions, and structured teacher guidance. | This study supports the widespread adoption of RME; emphasizes the importance of continuous professional development (monitoring, lesson study); suggests the development of digital-based RME teaching materials to strengthen mathematical communication. |
| Anderson Leonardo Palinussa, Juliana Selvina Molle, Magy Gaspersz (2021) | Realistic Mathematics Education: mathematical reasoning and communication abilities in rural contexts | Quasi-experimental design involving 130 students in Central Maluku Regency | RME significantly improves students' mathematical reasoning and communication abilities in an island-based rural context. | RME is recommended as an approach to improve students' mathematical reasoning and communication in remote rural areas. |
| Ningrum Reni Astuti, Gunarhadi, Mintasih (2020) | The effect of RME on mathematics learning outcomes viewed from mathematical communication ability | Quantitative experimental design involving 50 third-grade elementary school students at Kalam Kudus Christian elementary school | The RME method can improve students' mathematical communication ability compared to the scientific model. | RME can effectively improve mathematical communication abilities such as communicating ideas, visual representation, and writing ability. |
| Fitria, H., Surya, E., Simbolon, N. (2021) | Development of realistic mathematical approaches and learning independence on the mathematical communication ability of students at SD Negeri Cot Mauraja | Quasi-experimental design involving 50 students, data collection technique using questionnaires and tests. | The RME approach and learning independence significantly improve mathematical communication ability | The RME method can be applied to improve elementary students' mathematical communication, especially when combined with strategies that encourage learning independence. |

Overall, the reviewed studies demonstrate a consistent positive relationship between the implementation of RME and the improvement of students' mathematical communication ability. Across different contexts, RME

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encourages students to express mathematical ideas more clearly, use multiple representations, explain reasoning systematically, and participate actively in mathematical discussions. Although the instructional designs differ, the studies collectively indicate that contextual learning experiences and interactive classroom activities are central mechanisms through which RME enhances communication skills.

A thematic synthesis of the literature reveals four major patterns. First, RME consistently utilizes meaningful real-world contexts to facilitate conceptual understanding and mathematical communication (Chasanah et al., 2020; Palinussa et al., 2021). Second, exploratory learning activities, collaborative discussions, and guided interactions create opportunities for students to articulate arguments and exchange ideas effectively (Siswantari et al., 2025). Third, the integration of multiple representations including verbal explanations, symbolic expressions, diagrams, and visual models supports students in communicating mathematical concepts more comprehensively (Astuti et al., 2020). Fourth, the effectiveness of RME is strengthened when combined with complementary strategies such as problem posing or learning independence, enabling students to communicate their reasoning with greater confidence and coherence (Fitria et al., 2021).

Based on this synthesis, the relationship between RME principles and mathematical communication indicators is summarized in Table 2. as follows:

Table 2. The Relationship Between RME Principles And Mathematical Communication Indicators

| RME Principle | Mathematical Communication Indicator | Function in Learning |
|---|---|---|
| Real context (real world context) | Students are able to explain mathematical problems in the context of everyday life, using appropriate language | Connecting abstract concepts with concrete situations to improve understanding and communication |
| Explorative activity (Guided reinvention) | Students are able to describe solution steps, present ideas, and reason logically | Encouraging students to discover mathematical concepts on their own while practicing argumentation and discussion |
| Mathematics as a language (mathematics as a means of) | Students are able to use symbols, graphs, tables, and verbal representations to convey ideas | Helping students build mathematical language and representation skills as concepts |
| Cooperation and discussion (social interaction) | Students actively discuss, respond to friends' opinions, and provide argument explanations | Facilitating the development of collaborative and reflective communication skills |
| Open-ended tasks / problem solving (modelling and problem solving) | Students construct their own solution strategies, assess friends' solutions, and convey conclusions | Developing critical thinking skills as well as the ability to convey thoughts in writing or orally |

The mapping presented in Table 2 illustrates that each RME principle contributes to different dimensions of mathematical communication ability. Authentic contexts facilitate conceptual explanation, guided exploration strengthens reasoning and argumentation, collaborative interaction promotes discussion and reflection, and modeling activities enable students to transition from informal reasoning to formal mathematical representations.

## DISCUSSION

### Trends in the Use of Realistic Mathematics Education for Mathematical Communication Ability

The reviewed literature indicates an important pedagogical trend in which RME is increasingly recognized not merely as a contextual learning approach but as a comprehensive framework for developing mathematical communication ability. Across the five studies, students were consistently encouraged to construct mathematical meaning through discussion, explanation, representation, and reflection rather than through procedural memorization

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alone. This shift reflects the broader movement in mathematics education toward student-centered learning that emphasizes communication as an essential component of mathematical proficiency.

One of the most consistent findings across the reviewed studies is that contextual learning environments provide meaningful opportunities for students to express mathematical thinking. Chasanah et al. (2020) demonstrated that RME-based problem-posing activities significantly improve written mathematical communication, while Siswantari et al. (2025) emphasized that the principles of reality, interactivity, activity, and teacher guidance collectively strengthen students' ability to communicate mathematical ideas through dialogue and structured interaction. Similarly, Palinussa et al. (2021) reported that RME remains effective in geographically diverse settings, suggesting that authentic local contexts can reduce barriers to mathematical expression and facilitate conceptual understanding.

Another recurring pattern concerns the importance of multiple representations in mathematical communication. Astuti et al. (2020) found that RME encourages students to communicate ideas using visual, symbolic, and verbal forms, thereby strengthening conceptual understanding and explanatory skills. Fitria et al. (2021) further showed that when RME is integrated with learning independence, students become more capable of planning, monitoring, and presenting their reasoning independently. Collectively, these findings indicate that mathematical communication develops most effectively when contextual understanding is accompanied by reflective and self-regulated learning processes.

Although the reviewed studies consistently report positive outcomes, they also highlight variations in the mechanisms through which RME improves mathematical communication. Some studies emphasize contextual problem solving as the primary driver of communication development, whereas others attribute improvements to collaborative interaction, guided reinvention, or the integration of learning independence. These differences suggest that the success of RME depends not solely on the use of realistic contexts but also on the quality of instructional design, teacher facilitation, and opportunities for student interaction.

**Effectiveness of Realistic Mathematics Education in Improving Mathematical Communication Ability**

The effectiveness of RME identified in this review is theoretically supported by Freudenthal's (1991) perspective that mathematics should be viewed as a human activity grounded in meaningful experiences. Guided reinvention and emergent modeling encourage students to reconstruct mathematical ideas actively while explaining and justifying their reasoning. Likewise, Gravemeijer (1994) argued that mathematization develops through interaction and progressive abstraction, making communication an integral element of learning rather than a supplementary outcome.

Empirical evidence reinforces these theoretical foundations. Wijaya (2012) explained that realistic contexts encourage students to explain procedures, justify solutions, and interpret mathematical models, while Paroqi et al. (2020) demonstrated improvements in students' ability to communicate mathematical ideas through graphs, tables, and written narratives. Similar findings were reported by Fauzi and Masrukan (2018), who observed increased classroom discussion and explanation among elementary school students learning through RME. Moreover, the representational transition from everyday language to formal mathematical notation aligns with the communication standards proposed by NCTM (2000), highlighting the importance of connecting multiple forms of representation.

The reviewed literature also suggests that RME positively influences affective dimensions supporting communication. Contextual learning environments make students more confident in expressing ideas because problems are connected to familiar experiences. As reported by Laeli et al. (2025), meaningful contexts increase student engagement and participation, indirectly strengthening classroom communication. Consequently, the benefits of RME extend beyond cognitive achievement to include motivational and participatory aspects that foster richer mathematical dialogue.

Taken together, the evidence demonstrates that RME effectively improves mathematical communication ability through the integration of authentic contexts, collaborative interaction, progressive modeling, and structured

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reflection. Importantly, no reviewed study reported contradictory findings regarding the overall positive contribution of RME, indicating substantial consistency across recent empirical research.

**Practical Implications for Mathematics Education**

The synthesis has several implications for mathematics teaching and curriculum development. First, teachers should intentionally design classroom activities that require students not only to solve problems but also to explain reasoning, justify procedures, compare alternative strategies, and communicate conclusions through verbal, written, symbolic, and visual representations. Such practices position mathematical communication as an explicit learning objective rather than an incidental outcome.

Second, the evidence suggests that contextual problems alone are insufficient without opportunities for meaningful interaction. Effective RME implementation requires structured classroom dialogue, collaborative problem solving, and teacher facilitation that encourages questioning and reflection. Professional development initiatives should therefore support teachers in creating learning environments where communication is embedded throughout mathematical activity.

Third, curriculum developers should integrate mathematical communication into assessment practices by incorporating open-ended tasks, contextual projects, and collaborative activities that evaluate students' ability to articulate mathematical ideas. The reviewed studies consistently indicate that communication develops most effectively when students are provided with opportunities to represent, discuss, defend, and revise their thinking.

Overall, this systematic synthesis demonstrates that RME constitutes a comprehensive pedagogical framework for enhancing mathematical communication ability. The strongest and most consistent evidence highlights the importance of contextual experiences, collaborative dialogue, representational diversity, and reflective learning in fostering students' communication skills. At the same time, variations among the reviewed studies indicate that the effectiveness of RME depends on thoughtful instructional implementation and integration with complementary pedagogical strategies. These findings reinforce the value of RME as an evidence-based approach for promoting meaningful mathematical communication across diverse educational contexts.

## CONCLUSION

Based on the synthesis of the reviewed studies, it can be concluded that the Realistic Mathematics Education (RME) approach effectively enhances students' mathematical communication ability. Across the analyzed literature, RME consistently supports students in expressing mathematical ideas, constructing arguments, using multiple representations, and communicating problem-solving processes through contextual and interactive learning experiences. These findings indicate that RME is an effective pedagogical approach for fostering mathematical communication ability in mathematics education.

However, this review is limited by the relatively small number of eligible studies and the concentration of evidence in specific educational contexts, with most studies focusing on short-term classroom implementations. Therefore, the generalizability of the findings remains limited and should be interpreted with caution. Future research is recommended to investigate the effectiveness of RME across different educational levels, involve more diverse school settings and student populations, and employ more rigorous research designs, such as longitudinal and experimental studies, to strengthen the evidence regarding its impact on students' mathematical communication ability.

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