

How Does Realistic Mathematics Education (RME) Improve the Numeracy Skills of Students in Elementary School?

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Abstract

This research aims to determine the impact of realistic mathematics education on the numeracy skills of elementary school students. The population of this study is fourth-grade students in elementary schools in Bandung. The sample in this study consists of 82 students from fourth grade at one of the elementary schools in Bandung. This research uses a positivist paradigm with a quantitative approach. The method used is a pre-experiment. The instrument is a numeracy test comprising 35 questions (multiple choice, complex multiple choice, matching, fill in the blank, and essay). The test material includes geometry and statistics. Data analysis using Microsoft Excel to calculate descriptive statistics and SPSS type 24 to calculate inferential statistics. The results show that the significance of the Wilcoxon test is 0.000. This means there is a difference in the pre-test and post-test scores of numeracy skills of 4th-grade elementary school students. The average pre-test score is 47, and the post-test score is 69. After implementing the Realistic Mathematics Education (RME) approach, students' numeracy skills increased by 22 points. Based on the N-Gain score of 0.42, this improvement in students' numeracy skills is categorized as medium. This study implies the importance of Realistic Mathematics Education in mathematics learning and recommends its consistent application and the development of relevant teaching materials for elementary school students.

Keywords: Realistic Mathematics Education, Numeracy Skills, Mathematics Education

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INTRODUCTION

Numeracy is the ability of individuals to use various concepts, symbols, and mathematics skills in different everyday life situations and contexts. Numeracy is essential for economic competitiveness and informed citizenship in the 21st century (Meisels, 2010). The term numeracy is widely used in several English-speaking countries (Australia, New Zealand, and England). In the United States, the terms used are quantitative literacy and mathematical literacy (Geiger et al, 2015). The terms numeracy, quantitative literacy (QL), and quantitative reasoning (QR) are interrelated concepts with mathematics,

(Vacher, 2014). Numeracy, quantitative literacy (QL), and quantitative reasoning (QR) encompass the ability to understand and apply mathematical principles in real-life contexts, including everyday life, work, and community engagement (Karaali et al, 2016).

Numeracy closely relates to how individuals understand quantitative data and apply knowledge in real-world scenarios. Numeracy is also associated with developing logical thinking in mathematics education (Pratiwi et al, 2024). Numeracy is essential for students as it can enhance problem-solving skills and promote future academic success (Browder et al, 2012), including career opportunities and individual well-being (Abbacan et al, 2025). This is based on the idea that numeracy encourages critical thinking, including creative and systematic problem-solving among students (Gittens, 2015).

Numeracy and mathematics have almost similar meanings, but they are different. According to Wedege (2002), numeracy is seen as a competency encompassing mathematics but differs from formal mathematics taught in schools. Numeracy involves practically applying mathematical knowledge and considering technological and social contexts rather than merely transferring knowledge. In contrast, mathematics is an abstract discipline that develops through specific discourse and logical deductions. Functional mathematics bridges this gap, emphasizing problem-solving in real-world scenarios and developing thinking skills (FitzSimons, 2008). Overall, numeracy is the practical application of mathematical concepts. Mathematics is the theoretical study of numbers and their structures. In contrast, numeracy is the valuable ability to use and understand numbers in everyday life and make decisions based on quantitative data.

Numeracy skills pose a challenge for elementary school students. Indonesian students have low abilities that need to be improved (Asmara & Purnomo, 2023). Numeracy results are reflected in the PISA report. The latest results, in 2022, showed that Indonesia ranked 69th out of 80 participating countries in mathematics with a score of 366. The 2022 PISA results also placed Indonesia below Singapore, Vietnam, Brunei Darussalam, Malaysia, and Thailand. The trend of Indonesia's PISA results from 2000 to 2022 is detailed in Table 1.

Table 1. Trend of Indonesia's PISA Results in Mathematics

Year	Rank	Participating Countries	Score
2000	39	41	367
2003	38	40	360
2006	50	57	391
2009	61	65	371
2012	64	65	375
2015	63	70	386
2018	73	79	379
2022	69	80	366

Based on Table 1, the PISA results in mathematics show that Indonesia's ranking improved from 2018 to 2022 (an increase of 4 ranks), but the score decreased (down by 13 points). This PISA result is still far below the global average of 485 points, meaning there is a difference of 119 points. Research by Fauzi et al (2025) explains that 63% of students are still at level 1 (knowing) in numeracy, indicating that students still have problems with mathematical communication and mathematical processes. The study's results also reinforce the argument from Kemendikbud (2022), which explains that 2 out of 3 students have not achieved the minimum numeracy competence. Several factors that influence students' numeracy skills include students' efforts, language proficiency, teacher support (Cao Thi et al, 2023), curriculum usage, learning strategies, and facilities used in learning (Fauzi et al, 2025), as well as teacher preparation and creativity (Tegeh et al,

2021). According to Ridwan et al (2023), self-efficacy significantly affects students' numeracy skills.

Students' numeracy problems need to be effectively addressed. Various institutions, the government, and schools must provide ways (tools and initiatives) to improve numeracy skills across all age groups (Kaur & Gupta, 2025). According to Meisels (2010), to meet numeracy needs, educators must adopt innovative teaching strategies and seek support to implement more demanding approaches. This can address numeracy issues related to teacher support and creativity, lesson planning, and curriculum use.

Early interventions targeting numeracy skills can positively affect students, especially in problem-solving, but frequent and long-term interventions are also needed for sustainable improvement (López-Pedersen et al, 2022). Realistic Mathematics Education (RME) has successfully enhanced students' numeracy skills, regardless of the teacher's experience level (Fauzan et al, 2024). In elementary school, RME has demonstrated superiority over conventional approaches. The results indicate higher test scores and better conceptual understanding (Fajrin et al, 2024). RME is a teaching approach originally designed and developed in the Netherlands (Van den Heuvel-Panhuizen & Drijvers, 2014) that emphasizes using real-world contexts to teach mathematics (Tong et al, 2022., & Das, 2020). Hence, the RME approach aligns well with the concept of numeracy, which emphasizes mathematical skills in authentic contexts. RME facilitates learning that allows the transition from informal to formal mathematical knowledge through contextual problems (Yilmaz, 2019). This perspective is based on Freudental (1973), who emphasizes that students learn mathematics by interacting with real-world problems and reconstructing their mathematical knowledge with the help of teachers.

Several studies have been conducted regarding the RME approach to students' academic achievements in mathematics. According to Laurens et al (2017), RME can enhance students' cognitive achievements and problem-solving skills compared to conventional teaching methods. According to Tong et al (2022), RME not only improves academic achievement in mathematics but also positively impacts students' attitudes and engagement in mathematics learning. Other studies indicate that RME affects literacy and numeracy (Fauzan et al, 2024), intuition abilities (Hirza et al, 2014), higher-order thinking skills, problem-solving skills, and mathematical literacy (Listyaningrum et al, 2025). Some previous research findings prove that RME is a practical approach to enhancing students' mathematical abilities, including numeracy. This research will examine the impact of the RME approach on the numeracy skills of elementary school students. The numeracy in this research is based on the minimum competency assessment developed by Kemendikbud (2020). The questions in the minimum competency assessment consist of multiple choice, complex multiple choice, matching, fill-in-the-blank, and essay formats that measure students' numeracy skills, allowing them to be categorized into knowing, applying, and reasoning. This study's formulation of questions and student numeracy categories distinguishes it from previous research. This research is an essential part that contributes to education by improving the numeracy skills of elementary school students using the RME approach.

METHOD

This research uses a positivist paradigm with a quantitative approach. The quantitative approach is regarded as a manifestation of the scientific approach in research (Quick & Hall, 2015). It is a systematic way to investigate numerical data, focusing on the measurement and analysis of variables to explain phenomena or answer specific questions (Clarke & Collier, 2015) and examine the relationships between variables (Heddle, 2002). The research method used is pre-experiment. The pre-experiment method aims to

improve experimental design, test validity, and enhance the relationship between theory and practice (Laubmeier et al, 2018). The testing procedure in the pre-experiment method involves statistical and didactic analysis, this testing process allows for formulating working hypotheses and identifying weaknesses in the experimental design (Horáková & Houška, 2014). In this study, students were given a pretest related to numeracy skills, then received an intervention using the RME approach, and at the final stage were given a posttest related to numeracy skills. This is by the pre-experimental design. The population of this research is fourth-grade elementary school students in Bandung. The sample used refers to the purposive sampling technique. The purposive sampling technique is a non-probability method used in qualitative and quantitative research to select informants with specific knowledge or characteristics relevant to the research objectives (Tongco, 2007). The sample in this study involves 82 fourth-grade students from one elementary school in Bandung. The details of the sample can be seen in Table 2.

Table 2. Details of Sample Distribution

	Total	Percentage
Male	34	41,5
Female	48	58,5
Total	82	100

The instrument used in this study is a numeracy skills test consisting of 35 questions, with the types of questions based on the national assessment, namely (multiple choice, complex multiple choice, matching, fill in the blanks, and essay). The material tested on the students is about geometry and statistics. The test was first validated for validity and reliability on 50 fifth-grade elementary school students. The validity test results show scores ranging from 0.295 to 0.613 (valid). The reliability test results show a score of 0.930. This means the reliability is in the very high category. The details of the questions can be seen in Table 3.

Table 3. Details of Question Distribution

Material	Number of Questions
Geometry (characteristics of area and volume)	14
Geometry (characteristics of polygons)	11
Statistics (tables, pictograms, and bar charts)	10
Total	35

The data collection techniques used in this study are 1) administering a pretest to fourth-grade elementary school students related to numeracy skills, 2) providing an intervention over six sessions to students using the Realistic Mathematics Education approach, and 3) administering a posttest to fourth-grade elementary school students regarding their numeracy after receiving the specific intervention.

The data analysis technique used in this study is quantitative analysis using Microsoft Excel and SPSS version 24. Quantitative analysis calculates descriptive statistics (mean, median, mode, standard deviation) and inferential statistics (test of mean differences). The results of the inferential statistics serve as the basis for concluding the research. An analysis of students' numeracy achievement was also conducted. The level of students' numeracy can be seen in Table 4.

Table 4. Student Numeracy Levels and Their Interpretation

Student Numeracy Levels		
Knowing	Applying	Reasoning
0-40	41-75	76-100
Students demonstrate basic skills in recognizing and understanding numerical concepts	Students apply their numerical knowledge in various familiar contexts	Students demonstrate high-level thinking skills in numeracy

The results of the analysis are then interpreted by examining several relevant theories or research.

RESULT AND DISCUSSION

The Realistic Mathematics Education (RME) approach was tested to measure the impact on the numeracy skills of fourth-grade elementary school students. The effect on students' numeracy was tested using a mean difference test. Normality and homogeneity tests were conducted as prerequisites for the mean test. If the data is regular and homogenous, parametric testing (paired sample t-test) is performed. If normality and homogeneity are not met, non-parametric testing (Wilcoxon test) is applied. The results of the normality test of students' numeracy skills can be seen in Table 5.

Table 5. Normality Test of Students' Numeracy Skills

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pretest	.123	82	.004	.960	82	.013
Posttest	.092	82	.084	.970	82	.051

Based on Table 5, the numeracy skill scores of students in the pretest have a significance of 0.004 and posttest have a significance of 0.084. This indicates that the posttest data is normally distributed, while the pretest is not. Since one of the requirements for parametric testing is not met, the difference in means test is conducted using a non-parametric test (Wilcoxon Test). The results of the difference in means test for the pretest and posttest scores can be seen in Table 6.

Table 6. Wilcoxon Signed-Rank Test Results Comparing Pretest and Posttest Scores

	Posttest - Pretest
Z	-7.868 ^b
Asymp. Sig. (2-tailed)	.000

Based on Table 6, the results of the Wilcoxon test on the pretest and posttest scores showed a significance of 0.000. This means there is a difference in the average numeracy scores of students between the pretest and posttest. Therefore, the RME approach impacts the numeracy skills of fourth-grade elementary school students. The average scores of the pretest and posttest can be seen in Table 7.

Table 7. Average Numeracy Scores of Students

Average Numeracy Scores	
Pretest	Posttest
47	69

Table 7 shows that the average score of students' numeracy skills before receiving RME intervention was 47. Meanwhile, after receiving the intervention, the average score increased to 69. The improvement in students' numeracy skills can be seen in Table 8.

Table 8. Improvement in Students' Numeracy Skills

Average N-Gain of Students			
0.42 (Medium)			
N-Gain Category of Students			
	Low	Medium	High
Total	31 (38%)	41 (50%)	10 (12%)

Based on Table 8, the N-Gain score of students' numeracy skills is 0.42. This means that after receiving intervention using the RME approach, students experienced improvement in the moderate category. In detail, 38% of students (N=31) experienced low numeracy skill improvement, 50% of students (N=41) experienced medium numeracy skill improvement, and 12% of students (N=10) experienced high numeracy improvement. The level of students' numeracy skills before and after receiving the RME approach intervention can be seen in Table 9.

Table 9. Level of Students' Numeracy Skills Before and After Receiving the RME Approach Intervention

	Knowing	Applying	Reasoning
Pretest	26 (31.71%)	56 (68.29%)	0 (0.00%)
	82 (100%)		
Posttest	2 (2.44%)	52 (63.41%)	28 (34.15%)
	82 (100%)		

Based on Table 9, before receiving the intervention, 31.71% of students (N=26) were at the knowing level. This means that students demonstrated basic ability in recognizing and understanding numerical concepts. Meanwhile, 68.29% of students (N=56) were at the applying level. This means that students applied their numerical knowledge in various familiar contexts. No students were at the reasoning level. After receiving the RME intervention, 2.44% of students (N=2) were at the knowing level. This means that students demonstrated basic ability in recognizing and understanding numerical concepts. 63.41% of students (N=52) were at the applying level. This means that students applied their numerical knowledge in various familiar contexts. 34.15% of students (N=28) were at the reasoning level. The results in Table 9 indicate that the RME approach impacts numeracy skills, as evidenced by changes in numeracy levels.

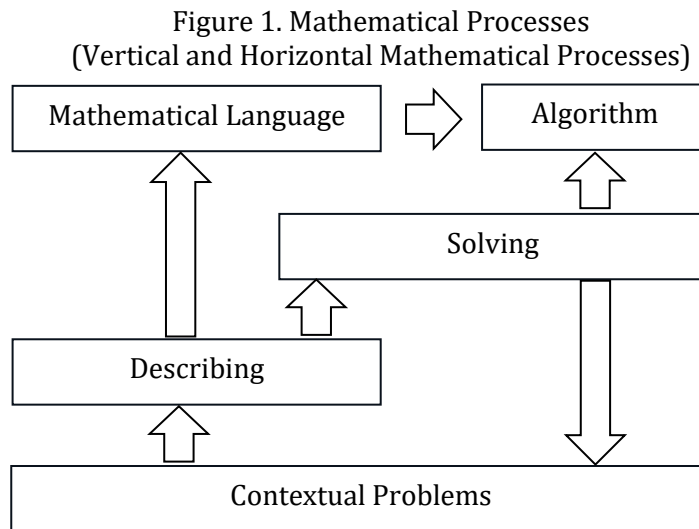
DISCUSSION

Numeracy skills are an essential foundation that must be provided to students to succeed in various aspects of life in the future. Numeracy is not just about counting but also about providing students with understanding, reasoning, and applying mathematical concepts in different real-world contexts. Before receiving the RME intervention approach, 26 students were at a knowledge level. At this level, students could only identify and use simple quantitative information. Students often face difficulties with long story problems, even when related to real-world contexts. According to Boonen et al (2016), many struggle to solve complex story problems semantically, highlighting the need for enhanced training in reading comprehension skills in mathematics education. Teachers have identified reading comprehension as a significant difficulty for students in solving math story

problems, with standardized testing and text complexity as contributing factors (Pearce et al, 2013). Students at this stage struggle to translate informal, real-life representations into formal mathematical expressions. This is closely related to mathematical communication. According to Rusell & Ginsburg (1984), students with mathematical difficulties struggle with formal mathematical aspects despite having adequate informal mathematical knowledge. Research by Fauzi et al. (2025) also explains that students' low mathematical literacy is caused by their difficulties in mathematical communication. This difficulty arises because mathematics instruction often does not involve aspects of students' everyday lives (informal mathematics) in formal mathematics teaching at school, meaning that mathematics learning is taught directly using formal language consisting of symbols and numbers (Mulia, 2018). Ultimately, this impacts students' difficulties in understanding the language.

Before receiving the RME intervention approach, 56 students were at the applying level. At this level, students could only perform basic mathematical operations in context. Students have understood various simple problems and applied them to formal mathematical language. However, students still often struggle to understand the mathematical relationships of the given problems. Elementary school students lack mathematical connection skills when solving problems (Kenedi et al, 2019). According to Jailani et al (2020), students have difficulty making mathematical connections when solving problems, especially in areas such as different representations, part-whole relationships, and interrelations among mathematical procedures. Students have also not been able to evaluate the correctness of data. This is related to critical thinking skills and higher-order thinking. Several research findings have shown that students have low essential thinking abilities. (Nuryadi et al, 2024., & Incikabi et al, 2013). Students struggle to analyze problems, write answers systematically, and maintain focus while solving non-routine problems (Maharani et al, 2019). According to Trisnani et al (2024), elementary school mathematics teachers in Indonesia face challenges in integrating critical thinking, including time and resource limitations and deficiencies in pedagogical knowledge. As a result, mathematics learning in the classroom often presents symbolic concepts and the formal language of mathematics that can sometimes be difficult for students to understand. Other research also found very low HOTS scores among students at various education levels (Ichsan et al, 2019). The lack of HOTS involvement in learning is the key reason students struggle to complete HOTS questions in mathematics. The learning process should involve thinking processes to solve HOTS problems, which include systematic steps such as creating meaning, forming opinions, and drawing conclusions (Bakry & Bakar, 2015).

Based on the various issues described previously, the intervention of the RME approach is crucial. RME has five key characteristics in addressing the encountered problems, namely (1) using real-world contexts, (2) developing models to transform original situations into mathematical problems, (3) students reproducing guided mathematical concept formation, (4) student-teacher interaction, and (5) viewing mathematics as an integrated subject (Bray & Tangney, 2016., & Clements & Sarama, 2013). In the RME concept, there is a process of mathematization. Students transform real-life (contextual) problems into formal mathematical problems using what is known as horizontal mathematics. Students abstract concepts with symbols and solve problems using various models or algorithms called vertical mathematics (Yilmaz, 2020). The vertical mathematical process involves abstracting concepts in the world of symbols and then solving problems using alternative models or algorithms to find relevant algorithms (Treffers, 1991). The process of mathematization is a way for students to learn mathematics by connecting it to the real world. The process of mathematization can be seen in Figure 1.



According to Figure 1. The process of mathematization (vertical and horizontal) is essential to enhancing abilities in mathematics, including numeracy. Horizontal mathematical modeling connects mathematics with reality, while vertical mathematical modeling develops the depth and formality of mathematical thinking. Both work together to ensure that students not only calculate but also understand, apply, and reason mathematically in various situations. The reality in the process of mathematization must be contextual, as this will help students understand the concepts taught. Contextual problems can encourage engagement, motivate students (Widjaja, 2013), and serve as a conceptual anchor for understanding and remembering mathematical ideas (Reinke, 2020). According to Bray and Tangney (2016), RME increases student engagement by enhancing students' interest and motivation by using meaningful real-life situations and mathematization. Teachers must actively involve students in interpreting the context and establishing clear connections with mathematical concepts (Widjaja, 2013). Thus, the process of mathematization (vertical and horizontal) can be well developed.

RME views mathematics as an individual activity rather than as a body of knowledge that has been established (van Zanten & van den Heuvel-Panhuizen, 2021). This is highly relevant to the development of students in elementary school, and the impact of the RME approach is effective in enhancing the numeracy of elementary school students. Several studies also show the effect of the RME approach, such as Tong et al (2022), which explains a significant difference between mathematics learning outcomes and the level of achievement criteria for skills in solving real-world problems related to mathematics curriculum content. Lestari et al (2024) also explain that the RME approach is practical for mathematics learning, emphasizing contextual activities centered on students. According to Sugiman & Kusumah (2010), it clearly states that RME improves cognitive achievement and problem-solving skills compared to conventional methods. It is even better than other approaches, such as Think Pair Share (TPS) (Ardiyani et al, 2018). This study has limitations, namely a small sample size, which affects the generalisation of the research. Overall, this study's findings highlight the importance of a contextual and student-centered learning approach in basic mathematics education. Future research should focus on a broader sample and examine the long-term effects of RME in various cultural and curricular contexts, especially in schools with limited resources.

CONCLUSION

The results of this study indicate a significant difference in students' numeracy scores between the pretest and posttest. After receiving the RME intervention, students' numeracy scores improved, with a gain (N-Gain) of 0.42 (medium category) or an average

increase of 22 points. Changes also occurred in students' numeracy levels (knowing, applying, and reasoning). In the pretest, 26 students were at the knowing level, 56 were at the applying level, and no were at the reasoning level. After receiving the RME approach intervention, two students were at the knowing level, 52 at the applying level, and 28 at the reasoning level. The RME approach's intervention significantly improves elementary school students' numeracy skills. This study recommends that schools and teachers integrate RME more broadly and consistently into the elementary school mathematics curriculum, supported by developing teaching materials relevant to students' contexts.

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