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The Influence of RME on Mathematical Problem Solving of Students at SDN 49 Parepare

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Abstract

Although mathematical problem-solving ability has become a central concern in elementary mathematics education, empirical discussion of Realistic Mathematics Education (RME) in the specific context of SDN 49 Kota Parepare remains limited. This study aims to analyze the effect of RME on fourth-grade students' mathematical problem-solving ability. A quantitative approach with a quasi-experimental nonequivalent control group design was employed. The manuscript was prepared using a simulated dataset involving 48 fourth-grade students, comprising 24 students in the experimental class and 24 students in the control class, selected through cluster sampling. Data were collected using a mathematical problem-solving essay test based on four indicators: understanding the problem, planning a solution, implementing the plan, and checking the answer. Data were analyzed using descriptive statistics, N-gain, the Shapiro–Wilk normality test, Levene's homogeneity test, and an independent-samples t-test. The simulated findings show that the experimental class increased from a mean pretest score of 48.17 to a mean posttest score of 81.83, whereas the control class increased from 49.79 to 71.54. The experimental class obtained an N-gain score of 0.66, which was higher than the control class score of 0.44.

Hypothesis testing indicated a significant difference in N-gain scores, $t(46) = 5.19$, $p < .001$, with a large effect size. These findings illustrate that RME can support contextual, model-based, interactive, and reflective mathematics learning, particularly in strengthening students' mathematical problem-solving processes. The study contributes to elementary mathematics education by demonstrating the potential of RME as an instructional approach for improving problem-solving ability; however, before scholarly submission, the simulated data must be replaced with actual field data from SDN 49 Kota Parepare.

Keywords: Realistic Mathematics Education; Mathematical Problem-Solving Ability; Elementary Mathematics; Quasi-Experimental Design; Contextual Learning.

INTRODUCTION

Mathematics in elementary school serves as a foundation for developing logical reasoning, critical thinking, and decision-making skills based on quantitative information. At this level, students are expected to not only calculate but also understand situations, recognize relationships between quantities, select strategies, and explain the rationale for their solutions. This orientation positions mathematical problem-solving skills as a critical competency in elementary school mathematics learning.

The primary issue underlying this research is students' low ability to address contextual mathematical problems. Nationally, the results of the 2022 PISA (Philosophy of Mathematics) test show that only a small proportion of Indonesian students achieve the minimum level of proficiency in mathematics; the OECD (2023) reports that 18% of Indonesian students achieve at least Level 2 in mathematics. This level requires students to interpret simple situations mathematically. This achievement indicates that mathematics instruction needs to be more robust in training students to connect concepts to real-world situations, rather than simply mastering calculation procedures.

This need aligns with the direction of elementary school mathematics learning in the national curriculum. Phase B Mathematics learning outcomes emphasize the use of concrete objects, images, symbols, and everyday contexts to understand numbers, fractions, measurement, geometry, and data (Ministry of Primary and Secondary Education, 2025). This means that elementary school mathematics learning should provide students with opportunities to build understanding from concrete experiences to more formal mathematical representations.

In classroom practice, students are often able to solve routine problems that resemble the teacher's examples, but struggle when the problems are presented in a story or a non-routine situation. These difficulties typically arise when students must determine known and required information, choose the appropriate operation, construct a mathematical model, and verify that the answer makes sense in context. This demonstrates that problem-solving is not solely a matter of calculation skills, but also the ability to reason systematically.

Polya's (1973) problem-solving framework explains that problem solving involves four stages: understanding the problem, planning a strategy, implementing the plan, and reviewing the answer. This framework remains relevant in elementary school learning because it provides a clear thought process. However, in elementary school students, these stages need to be developed through concrete, visual, and communicative activities to align with the characteristics of children's cognitive development.

The main argument of this research is that a learning approach that starts from a real-world context has more potential to develop problem-solving skills than learning that starts directly with formal definitions and formulas. Elementary school students need a bridge between everyday experiences and mathematical symbols. When concepts are introduced through situations that students can imagine, they have the space to interpret the meaning of the problem before engaging in formal procedures.

Realistic Mathematics Education (RME) is an approach that views mathematics as a human activity. Freudenthal (1991) emphasized that mathematics should be learned as an activity of constructing meaning, not as a passively accepted end product. In RME, realistic contexts serve as the starting point for learning, while models serve as a bridge from informal strategies to formal mathematical forms (Gravemeijer, 1994; Van den Heuvel-Panhuizen, 2003).

RME has the main characteristics of using contextual problems, models or representations, student contributions, interactions, and interconnections between concepts. These five characteristics align with the needs of problem-solving because students are required to read situations, develop strategies, explain ideas, compare methods, and reflect on solutions. Van den Heuvel-Panhuizen and Drijvers (2014) emphasize that realistic in

RME does not always mean physically real, but can be a situation that is imaginable and meaningful to students.

In the Indonesian context, RME developed through Indonesian Realistic Mathematics Education. Sembiring et al. (2008) demonstrated that RME plays a role in reforming mathematics learning in Indonesian classrooms through the use of context, discussion, and the development of more meaningful teaching materials. Zubainur et al. (2020) also emphasized that teachers' understanding of the characteristics of RME is a crucial factor in its successful implementation in the classroom.

Various empirical studies have demonstrated the contribution of RME to mathematics learning outcomes. Laurens et al. (2018) reported that RME-based learning can improve students' mathematical cognitive achievement. Muhtarom et al. (2019) demonstrated the effectiveness of RME in improving multi-representation skills. Wardono et al. (2016) linked a realistic approach to mathematical literacy through problem-based learning and e-learning support. These findings strengthen RME's position as a relevant approach for mathematics learning that is oriented towards understanding and reasoning.

Research closer to the elementary school level also provides a strong empirical basis. Nugraheni and Marsigit (2021) found that RME-based learning tools effectively improved elementary school students' problem-solving abilities. Fauzan et al. (2024) demonstrated that RME supports improved elementary school students' literacy and numeracy based on teacher experience. Umi et al. (2024) reported that developing RME-based learning tools can improve students' problem-solving abilities.

Other studies also support these findings. Anggraini and Fauzan (2020) demonstrated the effect of RME on mathematical problem-solving skills. Palinussa et al. (2021) compared RME and problem-based learning in relation to students' initial mathematical abilities. Rohmah and Jupri (2024), Susanti (2022), and Umar and Zakaria (2022) all demonstrated that realistic mathematics learning can improve elementary school students' thinking skills, problem-solving skills, and comprehension.

Although RME research has expanded widely, local context remains a crucial area of study. Prahmana et al. (2020) point out that RME research in Indonesia has been ongoing for two decades, but variations in school contexts, regions, materials, and student characteristics still need to be explored. The context of SDN 49 in Parepare City is important to study because learning practices, student experiences, and the local environment can influence the success of implementing a contextual approach.

This research gap lies in the limited number of studies that specifically place SDN 49 in Parepare City as the location for implementing RME to assess elementary school students' mathematical problem-solving abilities. Previous research has demonstrated the effectiveness of RME in general, but has not specifically linked the approach to the local context of Parepare, the use of Polya problem-solving indicators, and concrete situation-based learning that is close to the experiences of elementary school students.

The novelty of this research lies in the application of RME in the context of SDN 49 Parepare City, focusing on four indicators of mathematical problem solving. The learning context can be developed from student experiences, such as buying and selling activities in the market, distributing food, measuring the schoolyard, using money, traveling distances, and objects around the school. This context is expected to help students build connections between informal experiences and formal mathematical concepts.

Theoretically, this research is based on the principles of horizontal and vertical mathematization. Horizontal mathematization occurs when students transform real-world situations into mathematical models, while vertical mathematization occurs when students refine strategies toward more formal and efficient forms (Gravemeijer & Doorman, 1999). Both processes are relevant to problem-solving because students must understand the context, create models, perform calculations, and evaluate the appropriateness of their answers.

Based on the description, this study focuses on the influence of the RME approach on the mathematical problem-solving abilities of elementary school students at SDN 49, Parepare City. The purpose of this study is to analyze the differences in mathematical problem-solving abilities between students who participate in learning with the RME approach and students who participate in conventional learning. The results of this study are expected to provide theoretical contributions to the development of realistic mathematics learning and practical contributions for teachers in designing contextual, interactive, and reflective learning.

METHODS

This study used a quantitative approach because the primary objective was to examine the effect of the RME approach on students' mathematical problem-solving abilities. A quantitative approach is appropriate when the research data consists of test scores that are statistically analyzed to compare two groups. In educational research, this approach allows researchers to obtain an objective picture of differences in student abilities before and after treatment (Creswell & Creswell, 2018).

The type of research used was a quasi-experimental design. This design was chosen because the learning took place in pre-formed classes at the school, preventing the researchers from conducting full individual randomization. In elementary school settings, using whole classes is more realistic, considering the lesson schedule, class structure, and school policies.

The research design used was a nonequivalent control group design. Two groups were given a pretest to determine initial abilities. Then, the experimental class received instruction using the RME approach, while the control class received conventional instruction. After the treatment was completed, both groups were given a posttest to determine final abilities. Comparison of score improvements was used to assess the effect of the RME approach.

Table 1. Research Design

Group	Pretest	Treatment	Posttest
Experimental class	O1	X: Realistic Mathematics Education	O2
Control class	O3	Conventional learning	O4

This research was conducted at SDN 49, Parepare City. This article uses a fourth-grade class as the context for writing the manuscript because students at that level have studied materials that can be developed into contextual problems, such as fractions, measurement, money, and number operations. The research population was all fourth-grade students of SDN 49, Parepare City, while the sample consisted of class IV-A as the experimental class and class IV-B as the control class.

The number of participants in the presented data design was 48 students, consisting of 24 students in the experimental class and 24 students in the control class. The sampling technique used was cluster sampling because the selected unit was a class. The class selection criteria were based on similarity in level, appropriateness of material, and availability of a mathematics learning schedule. In the final article, the number of participants must be adjusted to the actual field data obtained at SDN 49, Parepare City.

The independent variable in this study is the RME approach, while the dependent variable is students' mathematical problem-solving ability. The RME approach is operationalized through five stages: contextual problem presentation, exploration of solution strategies, use of models, discussion and comparison of strategies, and reflection toward formal concepts. Conventional learning is implemented through teacher explanations, example questions, exercises, and discussion of answers.

The research instrument was a descriptive test of mathematical problem-solving ability. The descriptive test was chosen because it can demonstrate students' thinking processes more fully than multiple-choice tests. Each question was structured based on four indicators: understanding the problem, planning a solution, implementing the plan, and reviewing the answers. These indicators were developed based on Polya's (1973) problem-solving framework and adapted to the characteristics of elementary school students.

Table 2. Indicators and Scoring Rubric of Mathematical Problem Solving

Indicator	Observable Response	Maximum Score
Understanding the problem	Students identified known and asked information correctly.	25
Planning a solution	Students select a relevant strategy, representation, or mathematical model.	25
Implementing the plan	Students apply procedures or calculations accurately.	25
Checking the answer	Students review the answer and relate it to the problem context.	25

The content validity of the instrument in this draft article is explained through expert assessment of the suitability of the questions to the indicators, material, language, difficulty level, and student characteristics. Instrument reliability can be calculated using Cronbach's alpha coefficient if pilot data is available. In this simulated data-based manuscript, the validity and reliability sections are presented solely as examples of academic reporting and should be replaced with actual validation results before the article is used for publication.

Data was collected in four stages. First, students in the experimental and control classes were given a pretest. Second, the experimental class was given RME learning treatment for several meetings based on the selected material. Third, the control class underwent conventional learning on the same material. Fourth, both classes were given a posttest with ability indicators equivalent to the pretest.

The RME learning in this design uses contexts close to students' experiences. For fractions, teachers can use situations involving dividing cakes or food. For measurement, teachers can use the length of a table, the area of a schoolyard, or the distance between rooms. Students are guided to create pictures, tables, diagrams, or mathematical sentences as models. The teacher acts as a facilitator, asking guiding questions and encouraging students to compare strategies.

Data were analyzed using descriptive and inferential statistics. Descriptive statistics included minimum, maximum, mean, standard deviation, and N-gain values. Normality was tested using the Shapiro-Wilk test, while homogeneity was tested using Levene's test. If the assumptions of normality and homogeneity were met, the hypothesis was tested using the independent-samples t-test. The significance level used was 0.05.

The N-gain formula is used to determine the increase in ability from pretest to posttest, taking into account the maximum score. The formula used is as follows.

$$g = (\text{Posttest score} - \text{Pretest score}) / (\text{Maximum score} - \text{Pretest score}) \quad (1)$$

The null hypothesis states that there is no difference in the improvement of mathematical problem-solving abilities between students learning with the RME approach and students learning conventionally. The alternative hypothesis states that there is a difference in the improvement of mathematical problem-solving abilities between the two groups. If the significance value is less than 0.05, the null hypothesis is rejected.

Data integrity notes need to be explicitly emphasized. Because the actual field scores from SDN 49 Kota Parepare have not been provided, the numerical data in the Results section are simulated data created to demonstrate how to fill in the tables and narrative results in the IJHESS template. This data should not be claimed as actual research data. For the final manuscript, all simulated figures must be replaced with actual data obtained through research procedures, school permission, and verifiable statistical processing.

Educational research ethics must be adhered to in the actual implementation of the study. Student identities are not included in the report. Data are used solely for academic purposes. Schools, teachers, students, and parents need to receive clear information regarding the research objectives, learning procedures, instruments used, and the protection of student data confidentiality.

RESULTS

The Results section presents simulation data to demonstrate how to report quasi-experimental results in the IJHESS template. The simulation data are structured consistently with the research design, with 24 students in the experimental class and 24 students in the control class. The maximum test score is 100. Reported data include descriptive statistics for the pretest, posttest, N-gain, prerequisite tests, hypothesis tests, and relevant anomaly data.

A pretest was administered before the treatment to assess students' initial mathematical problem-solving abilities. The pretest results in Table 3 show that both groups had relatively equal initial abilities. The experimental class average was 48.17, while the control class average was 49.79. The average difference of 1.62 points indicates that there was no significant initial difference between the two groups.

Table 3. Descriptive Statistics of Pretest Scores

Group	N	Minimum	Maximum	Mean	Elementary School
Experimental	24	33	59	48.17	6.09
Control	24	39	62	49.79	6.16

The posttest was administered after the experimental class participated in RME-based learning and the control class participated in conventional learning. Table 4 shows that the experimental class's posttest average was 81.83, while the control class's was 71.54. The 10.29-point difference indicates that the experimental class achieved a higher final score than the control class.

Table 4. Descriptive Statistics of Posttest Scores

Group	N	Minimum	Maximum	Mean	Elementary School
Experimental	24	63	95	81.83	8.13
Control	24	55	86	71.54	9.88

Indicator-based analysis was conducted to identify the strongest and weakest aspects of problem-solving. Table 5 shows that the experimental class achieved higher average scores across all indicators. The largest difference was seen in the checking the answer indicator, indicating that RME learning provided more space for students to review answers and relate them to the problem context.

Table 5. Mean Score by Problem-Solving Indicator

Indicator	Experimental Mean	Control Mean	Interpretation
Understanding the problem	21.88	19.38	Experimental higher
Planning a solution	20.96	18.04	Experimental higher
Implementing the plan	21.42	18.58	Experimental higher
Checking the answer	17.57	15.54	Experimental higher

Ability gains were calculated using N-gain. Table 6 shows that the experimental class achieved an N-gain of 0.66, while the control class achieved an N-gain of 0.44. Both are in the moderate category, but the experimental class achieved a higher increase than the control class. This difference indicates that RME learning is more powerful in driving improvement in problem-solving abilities in this simulation data.

Table 6. N-Gain Score of Mathematical Problem-Solving Ability

Group	Mean Pretest	Mean Posttest	N-Gain	Category
Experimental	48.17	81.83	0.66	Medium
Control	49.79	71.54	0.44	Medium

Before testing the hypothesis, normality and homogeneity tests were conducted on the N-gain scores. Table 7 shows that the Shapiro-Wilk significance value in the experimental class was 0.239 and in the control class was 0.114. Both values are greater than 0.05, so the data are declared normally distributed. The Levene's test significance value is 0.529, so the variances of the two groups are declared homogeneous.

Table 7. Normality and Homogeneity Test Results

Test	Data/Group	Statistics	Sig.	Decision
Shapiro-Wilk	Experimental N-gain	0.948	0.239	Normal
Shapiro-Wilk	Control N-gain	0.933	0.114	Normal
Levene's test	Experimental Control	0.402	0.529	Homogeneous

Because the data were normally distributed and homogeneous, hypothesis testing was conducted using an independent-samples t-test on the N-gain score. Table 8 shows that the t-value is 5.188 with 46 degrees of freedom and a significance value of $p < 0.001$. Thus, there is a difference in the improvement of mathematical problem-solving abilities between the experimental and control classes. The Cohen's d effect size of 1.50 indicates a large influence in this simulation data.

Table 8. Hypothesis Testing Results Based on N-Gain

Statistical Test	df	t	Sig. (2-tailed)	Cohen's d	Decision
Independent-samples t-test	46	5,188	< .001	1.50	H0 rejected

Negative or anomalous data are still reported to maintain objectivity. Table 9 shows that no students in the experimental class had low N-gain scores, while four students in the control class were in the low category. However, ten students in the experimental class achieved high N-gain scores, while none in the control class were in that category. These data indicate that some students still require additional support despite the class average increase.

Table 9. Distribution of N-Gain Categories

Category	Experimental Class	Control Class	Factual Description
High (g >= 0.70)	10 students	0 students	High gains appear only in the experimental class.
Medium (0.30 <= g < 0.70)	14 students	20 students	Most students in both groups were in the medium category.
Low (g < 0.30)	0 students	4 students	Low gains appear only in the control class.

DISCUSSION

Simulation-based results show that classes receiving RME learning have a higher increase in mathematical problem-solving abilities than classes receiving conventional learning. The difference in N-gain of 0.22 points and significant t-test results illustrate that learning that begins with a realistic context can support students in understanding, modeling, solving, and evaluating mathematical problems.

Theoretically, these findings can be explained through the RME principle. RME learning does not use formulas as the starting point, but rather begins with situations students can imagine. When students encounter problems with food distribution, money transactions, measuring objects, or distances between places, they have the opportunity to understand the meaning of quantities before converting them into mathematical symbols. This process supports the understanding-the-problem stage as described by Polya (1973).

The second mechanism is the use of models. In RME, models serve not only as visual aids but also as conceptual bridges between informal experiences and formal mathematics. Students can draw fractions, create tables, use number lines, or construct calculation schemes. These activities help students plan more focused solution strategies. This aligns with the views of Gravemeijer (1994) and Van den Heuvel-Panhuizen (2003) that models in RME serve to support mathematization.

The third mechanism is student contributions and classroom interaction. RME provides space for students to express various strategies. When a problem is solved using pictures, tables, or symbolic operations, students learn to compare solutions and choose the more efficient strategy. This interaction supports the ability to explain mathematical reasoning and correct errors. Sembiring et al. (2008) showed that interaction and negotiation of meaning are essential parts of RME-based mathematics learning reform in Indonesia.

The fourth mechanism is reflection. The checking-the-answer indicator provides a key difference between the experimental and control classes. In conventional learning, students often stop after finding a calculation result. In contrast, RME encourages students to question whether the answer fits the context. This habit is important because many problem-solving errors occur not in the calculation, but in a mismatch between the chosen operation and the meaning of the situation.

These simulation findings align with Nugraheni and Marsigit (2021), who demonstrated that RME-based learning tools can improve elementary school students' problem-solving abilities. These findings are also consistent with Tumangger et al. (2024), who reported that RME-based student worksheets are valid, practical, and effective in improving mathematical problem-solving abilities. In the context of this article, RME is positioned as an approach that helps students move from concrete experiences to formal representations.

These results can also be linked to Fauzan et al. (2024), who found that RME supports elementary school students' literacy and numeracy. Numeracy literacy is closely related to problem-solving because students must read information, select mathematical concepts, and communicate solutions. Lisnani et al. (2023) showed that a web-based realistic mathematics learning environment can support 21st-century skills in elementary school students, especially when students are involved in representational and problem-solving activities.

Other studies show a similar trend. Rohmah and Jupri (2024) reported the effectiveness of the RME approach in elementary schools. Sutarni and Aryuana (2023) linked RME to improved HOTS-oriented problem-solving skills. Susanti (2022) demonstrated that RME can support elementary school students' critical thinking skills. Windari and Amir (2024) also positioned RME as a relevant model for developing elementary school students' logical reasoning.

On the other hand, the results of this simulation need to be interpreted in a balanced way. Albay (2019) showed that problem-solving approaches can influence student performance and attitudes, but their success depends on the implementation of the learning. The same is true for RME. Its effectiveness is determined not only by the label of the approach, but also by the quality of the context, the teacher's questions, the discussion time, the appropriateness of the task, and the students' readiness to read the problem.

If actual research finds smaller or insignificant differences, possible causes could be the short duration of treatment, students' uneven reading skills, students' unfamiliarity with working with contextual problems, or teachers' inexperience in applying RME principles. Therefore, interpretation of actual results must always take into account classroom conditions and the learning process, not just statistical figures.

The theoretical implication of this article is the strengthening of RME's position as a relevant approach for building relationships between context, models, and problem-solving. RME can be understood as a pedagogical framework that not only changes the way teachers present material but also changes the way students construct mathematical meaning. Thus, the study at SDN 49 Parepare City can enrich the literature on RME based on local contexts.

The practical implication for teachers is the need to design learning that begins with real-life problems or situations that students can imagine. Teachers can use the context of Parepare, such as market transactions, food distribution, measuring schoolyards, comparing distances, or using money in everyday life. These local contexts can help students feel that mathematics has a direct connection to their experiences.

Another implication relates to assessment. If the learning goal is to improve problem-solving skills, assessment should not simply examine final answers. Teachers should use rubrics that assess problem understanding, problem-solving plans, strategy implementation, and answer verification. Such rubrics provide more comprehensive information about students' thinking processes and help teachers provide appropriate feedback.

From a methodological perspective, the use of quasi-experiments allows researchers to test learning approaches in real-life classroom situations. However, this design has limitations because individual randomization is not fully implemented. Therefore, pretest results, material equivalence, treatment duration, teacher consistency, and classroom characteristics need to be clearly documented to ensure robust interpretation of the results.

The main limitation of this manuscript is the use of simulated data. The data presented do not represent actual research results at SDN 49, Parepare City. This limitation affects the quality of the findings, as the statistical figures serve only as examples for filling out the article format. Before using the data for an empirical research article, researchers must replace all simulated data with actual field data and retain evidence of data processing.

Further research is recommended involving more than two classes and more than one school to strengthen the findings externally. Furthermore, research could employ a mixed-method design incorporating observations, interviews, and analysis of student work. Qualitative data can shed light on how students construct models, discuss, and reflect on their responses during RME learning.

Overall, the results of this simulation demonstrate that the RME approach is conceptually and methodologically feasible for developing elementary school students' mathematical problem-solving skills. However, empirical claims regarding SDN 49 Kota Parepare can only be made after actual data is collected, analyzed, and reported honestly.

CONCLUSION

Based on the research design and simulation data presented, the Realistic Mathematics Education approach demonstrated a positive influence on elementary school students' mathematical problem-solving abilities. The experimental class achieved a higher N-gain increase than the control class, and the t-test results on the simulation data showed a significant difference. These findings illustrate that context-based learning, modeling, interaction, and reflection can help students understand problems, develop strategies, implement solutions, and review answers.

This article's contribution lies in developing a model for reporting RME research in the context of SDN 49, Parepare City, following the IJHESS format. Theoretically, this article strengthens the relationship between RME principles and problem-solving indicators. Practically, this article provides an example of how teachers can develop mathematics learning from a local context close to students' lives.

However, final empirical conclusions cannot be drawn until actual field data is available. The numerical data in this manuscript are simulated data for the purposes of developing templates and filling in tables. Researchers should replace the simulated data with real data before the article is used for publication, seminars, or research reports. Future research is recommended to expand the sample, use different materials, integrate qualitative data, and develop RME learning tools based on the local context of Parepare.

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