

THE EFFECTIVENESS OF MATHEMATICS LEARNING THROUGH A REALISTIC MATHEMATICS EDUCATION APPROACH IN ELEMENTARY SCHOOLS

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Abstract

The research aims to analyze the effectiveness of mathematics learning through the realistic mathematics education approach in learning the concept of counting integers in grade VI elementary school students. The research used a quasi-experiment with one pretest posttest design. The research involved 32 grade VI students at SDN 205 Neglasari, Coblong District, Bandung City. The research instrument is in the form of a multiple-choice test that includes addition and subtraction of decimal numbers. Research shows that the RME approach is effective in producing a significant improvement in students' learning completeness in the addition and subtraction of decimal integers, as well as improving mathematical problem-solving, self-efficacy, reasoning, and mathematical literacy. RME encourages students to recognize the practical application of mathematical concepts through real-world contexts and cultural elements, as well as to cultivate creative and imaginative thinking skills so that they can be an important strategy in improving mathematics education in primary schools.

Keywords: Effectiveness; Realistic Mathematics Education; Primary school; Integers

Abstrak

Penelitian bertujuan menganalisis efektivitas pembelajaran matematika melalui pendekatan realistic mathematics education dalam pembelajaran konsep berhitung bilangan bulat pada siswa kelas VI sekolah dasar. Penelitian menggunakan eksperimen kuasi dengan one pretest posttest design. Penelitian melibatkan 32 orang siswa kelas VI di SDN 205 Neglasari, Kecamatan Coblong Kota Bandung. Instrumen penelitian berupa tes pilihan ganda yang mencakup penjumlahan dan pengurangan bilangan desimal. Penelitian menunjukkan pendekatan RME efektif menghasilkan peningkatan yang signifikan dalam ketuntasan belajar siswa dalam materi penjumlahan dan pengurangan bilangan bulat desimal, serta meningkatkan kemampuan pemecahan masalah matematis, self-efikasi, penalaran, dan literasi matematika. RME mendorong siswa untuk mengenali penerapan praktis konsep matematika melalui konteks dunia nyata dan elemen budaya, serta memupuk kemampuan berpikir kreatif dan imajinatif sehingga dapat menjadi strategi penting dalam meningkatkan pendidikan matematika di sekolah dasar.

Kata Kunci: Efektivitas; Realistic Mathematics Education; Sekolah Dasar; Bilangan Bulat

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Introduction

The importance of learning mathematics in elementary school is undeniable, as it has a significant impact on children's cognitive development and future academic success (Engelhardt et al., 2021). Through mathematics education, students can acquire rational, logical, analytical, creative, communication, and problem-solving skills so as to foster students' cognitive patterns (Samritin et al., 2023). Mathematics learning in elementary schools is characterized by the characteristics of implementing learning gradually, following the spiral method, emphasizing an inductive approach, and adhering to the truth of consistency (Saputro, 2021). However, despite these characteristics, there are important obstacles that

have an impact on mathematics learning in elementary schools. The application of less innovative mathematics learning causes students to find mathematics boring, difficult, and challenging to understand (Andre Apriliawan & Putu Parmiti, 2021).

In a preliminary study of grade VI students at one of the elementary schools in the city of Bandung, it was shown that students' low mathematics scores in learning integer operations, especially when performing operations such as addition and subtraction of decimal numbers. Students often have difficulty understanding and operating decimal numbers effectively, which is exacerbated by traditional learning approaches that focus on memorization and mechanical procedures without relating them to real-life contexts. As a result, many students feel that mathematics is irrelevant to their daily lives, resulting in low motivation and unsatisfactory learning outcomes. This gap emphasizes the importance of research on the application of the Realistic Mathematics Education (RME) approach, which emphasizes the use of real situations and cultural elements in mathematics learning. The RME approach is expected to help students connect the concept of decimal numbers with their daily experiences, improve their understanding of the concepts, as well as problem-solving skills, so as to bridge the existing gaps and improve the quality of mathematics education in elementary schools.

The Realistic Mathematics Education (RME) approach is in line with the independent curriculum at the elementary education level because it emphasizes connecting mathematical concepts with real-life situations, fostering students' problem-solving skills, and improving their self-efficacy (Ulandari et al., 2019a). The emphasis on practical problem-solving, contextual learning, and the integration of real-world scenarios into mathematics education through RME aligns with the goals of the independent curriculum, which aims to build students' intellectual capacity, creativity, and logical thinking in the real world. mathematics education (Patmala et al., 2023).

There are many factors that affect student learning outcomes in mathematics learning in elementary school. The delivery of mathematical content in a deductive and abstract manner is not in line with the relatively concrete and informal thinking stage of elementary school students, further hindering the understanding of mathematical concepts (Fauzi & Chano, 2022). Another challenge is the lack of innovative teaching methods and the difficulty of understanding mathematics is identified as the challenges faced by elementary school students in understanding mathematical theories (Kurniawan & Rivaldi, 2021). Furthermore, the teacher's inability to provide learning materials optimally and the frustration experienced during the learning process resulted in the non-achievement of learning goals (Faizah & Sugandi, 2022). These barriers underscore the need for innovative and engaging approaches to mathematics education in primary schools to address the diverse learning needs and challenges faced by students. Therefore, it is important for teachers to provide appropriate help and support and use appropriate approaches, such as the Realistic Mathematics Education approach, to help students overcome these obstacles and deepen their understanding of integer operations.

In order for students to understand and take an interest in abstract mathematics, it is important to learn basic materials such as the concepts of multiplication and division of integers in elementary school to be conveyed in a meaningful way and show their relevance in solving problems in daily life (Tiarawati & Surakarta, 2024). Not only transferring information about mathematical concepts or formulas from teachers to students, but this learning process must invite students to discover the meaning and benefits of mathematics directly through their personal experiences (Febriyanti et al., 2019).

The *Realistic Mathematics Education* (RME) approach has an important meaning in teaching mathematics in elementary schools. RME is recognized as an effective and flexible approach that affects students' mathematical reasoning, communication skills, and achievement (Palinussa et al., 2021; Tarim & Büyükikiz Kütküt, 2021). RME emphasizes contextual problems, student contributions, interactive, collaborative activities, and aligns with the characteristics of effective mathematics learning (Monika & Ramadan, 2022b). In addition, the development of RME-based teaching methods and materials has proven to be valid, practical, and effective for elementary school students, especially in improving their understanding of mathematical concepts (Halimah & Kurniawati, 2022; Marcellyna & Desyandri, 2022; Widyasari & Nurcahyani, 2021).

Research has shown that the RME approach can significantly improve students' problem-solving skills and mathematical abilities in integer operations (Rudyanto et al., 2019; Nurjamaludin et al., 2021). The RME approach assists students in the transition from concrete to abstract understanding, which is crucial for understanding the concepts and operations of integers (Shanty, 2016). In addition, the use of RME principles in teaching addition and subtraction of integers has been shown to improve students' understanding and mastery (Utami et al., 2021)

These studies collectively contribute to a growing body of research that supports the effectiveness of RME in improving the outcomes of mathematics learning and pedagogy with integer operations in primary schools, thus offering valuable insights for educators. In an effort to improve the quality of learning in elementary schools, this study seeks to improve the mathematics learning outcomes of grade VI students through RME learning. It is hoped that this research will provide a solution to the problem of mathematics learning in elementary schools.

Research Methods

This study is a quasi-experimental research with *one pretest posttest design*. In this design, participants were measured based on outcome variables before and after the intervention, allowing researchers to assess any changes that occurred over time. However, unlike the actual experimental design, there is no control group in this design, thus making it a pseudo-experiment (Sugiyono, 2016). The purpose of this experimental research is to test the effectiveness of the application of RME in Mathematics Learning in Grade VI of Elementary School. The application of RME is an independent variable while student learning outcomes are bound variables. The research design is described as follows:

Table 1. Research Design

Pretest	Treatment	Posttest
O1	X	O2

Description:

X : Implementation of RME in elementary school mathematics learning grade VI

O1 Learning outcomes before RME implementation

O2 : Learning outcomes after RME implementation

The partner institution of this research is SDN 205 Neglasari, Coblong District, Bandung City. The research involved 32 grade VI students. The learning material tested is about the operation of counting decimal numbers. The research instrument used was 10 multiple-choice test questions that tested students' ability in addition and subtraction of

decimal numbers. The questions are designed in the form of the reality of contextual problems and problem solving. For the purpose of achieving learning outcomes, it is determined that the KKM is at a value of 80. Thus, the range of categorization of learning outcomes is set as follows:

Table 2. Categorization of Learning Outcomes Based on Minimum Completeness Criteria

No	Nilai	Kategori	Keterangan
1.	< 80	Less	Remedial
2.	80 – 86,66	Enough	Graduate
3.	86,67 – 93,32	Good	Graduate
4.	93,33 – 100	Excellent	Graduate

Data processing involves the use of descriptive statistics such as mean, median, and mode, as well as normality, homogeneity, and hypothesis tests. To evaluate the change between pretest and posttest results, *Paired Sample T-Test* analysis is used with the help of SPSS software version 24. To measure how much the increase is, the N-gain formula is used (Bintang Kejora, 2021):

$$g = \frac{(S_{post} - S_{pre})}{(S_{mid} - S_{pre})}$$

keterangan :

g = Average gain score normalized

S_{post} = Posttest scores

S_{pre} = Pretest scores

S_{mid} = Ideal maximum scores

Then the gain value is consulted into the following table for interpretation.

Table 3. N-gain Value Interpretation Guidelines

N-gain interval	Category
$g < 0.3$	Low
$0.3 \leq g \leq 0.7$	Middle
$g > 0.7$	High

Results and Discussion

In the pretest phase, students worked on 10 multiple-choice questions regarding integer counting operations including addition and subtraction of decimal numbers. A total of 32 students worked on the questions without any treatment or treatment and there was no knowledge input provided by the teacher. This pretest aims to find out students' initial ability in integer counting operations. The results of the integer operation pretest are reported as follows:

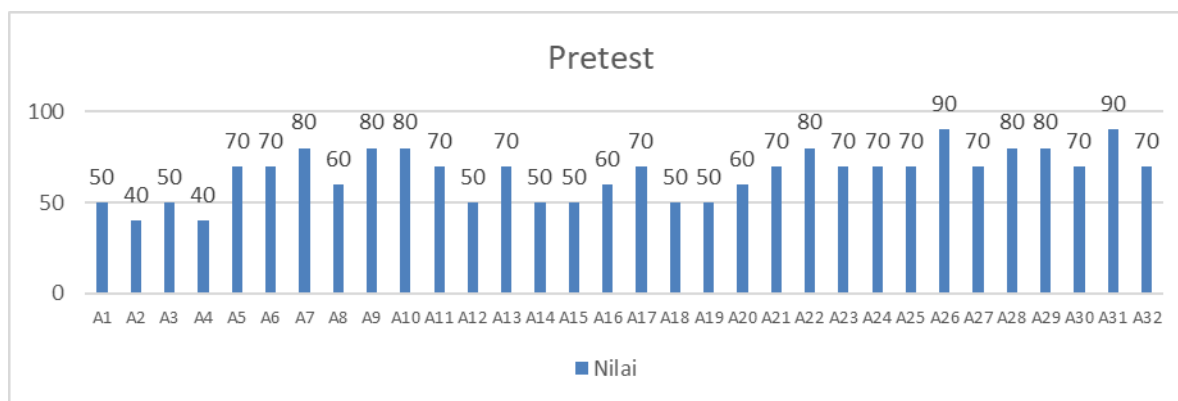


Figure 1. Pretest Stage Learning Outcomes

A total of 24 students obtained poor learning outcomes, 6 students obtained sufficient learning results, and 2 others obtained good learning results. Classically, an average of 65.94 was obtained, which showed learning outcomes in the poor category.

The posttest phase began with the provision of RME model learning treatment to students as many as 4 meetings. The first encounter studies the addition and integer lines. In the second meeting study subtraction and integer lines. In the third meeting study integer multiplication. And at the fourth meeting he studied the division of integers. The steps in learning using the RME Model begin with the mathematization process. The mathematization step involves several stages (Kurniawati, 2015): (1) Starting the problem from the real-world context, (2) Identifying mathematical concepts that are relevant to the student's previous learning experience and arranging the problem according to the mathematical concept, (3) Gradually, reducing the complexity of real-world situations through the process of formulating assumptions, generalizations, and formalization. The goal of this process is to transform real-world problems into more structured mathematical problems, (4) solve the resulting mathematical problems, and (5) return mathematical solutions into real-world contexts, including identifying the limitations of the resulting solutions. After the treatment, students worked on 10 multiple-choice questions regarding integer counting operations. The results are reported as follows:

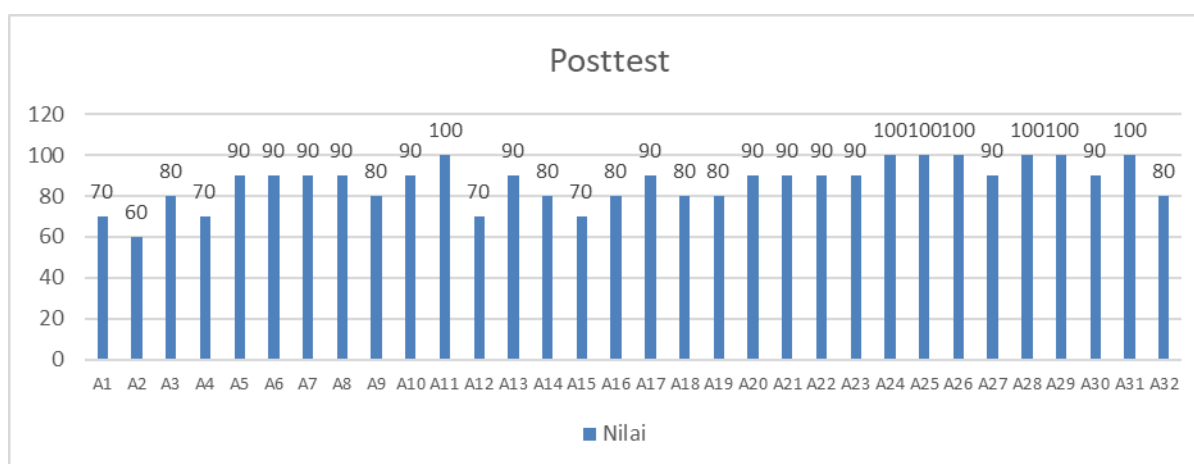


Figure 2. Posttest Stage Learning Outcomes

A total of 5 students obtained poor learning results, 7 students obtained sufficient learning results, 13 students obtained good learning results, and 7 other students obtained very good learning results. Classically, an average of 86.56 was obtained, which shows the learning results in the sufficient category.

The results of the pretest student learning outcomes were 65.94, while the posttest student learning outcomes were 86.56. This shows an increase in the average learning outcomes. To further strengthen the results of the analysis, a non-parametric test hypothesis test was carried out with *the Wilcoxon Signed Ranks Test*. Non-parametric tests are used because the results of normality tests and homophobicity tests show data that are not normally distributed and are not homogeneous. The hypotheses tested include:

- H0 : There is no difference in the average learning outcomes of students by applying the RME learning method to grade VI students
- Ha : There is a difference in the average student learning outcomes by applying the RME learning method to grade VI students

The hypothesis test shows the results of *the Wilcoxon Signed Ranks Test* with the result of Asymp. Sig. (2-tailed) = 0.000. This indicates that Ha is accepted and H0 is rejected. The results of the analysis are reported as follows:

Table 4. Nonparametric Hypothesis Test

Test Statistics ^a	
	posttest - pretest
Z	-4.951 ^b
Asymp. Sig. (2-tailed)	.000

The results of the Normalized Gain test with an N-gain value of 0.64 showed a significant increase in learning outcomes, in the moderate improvement category with a percentage of 64%. This indicates that the application of the Realistic Mathematics Education (RME) approach has a clear positive impact on students' understanding and ability to count integers. The significant difference between the pretest and posttest scores shows that before the implementation of RME, students' understanding of the material is still limited, but after the implementation of RME, there is a noticeable improvement in learning outcomes. The RME, which emphasizes real-world context and practical relevance, helps students relate mathematical concepts to their everyday experiences, increasing engagement and motivation to learn. These results confirm the effectiveness of RME in deepening the understanding of mathematical concepts, improving problem-solving skills, and making learning more meaningful for students, which can ultimately bring positive changes in the quality of mathematics education in elementary schools.

Realistic Math Education (RME) has been shown to be effective in improving students' integer numeracy skills in elementary school. The findings and results of this study confirm and corroborate the research of Kurniawati (2015) which explains the increase in student learning completeness in integer addition and subtraction material through the RME method. By incorporating real-world contexts and cultural elements into mathematics learning, RME encourages students to recognize the practical application of mathematical concepts (Andriani et al., 2023). In addition, the results of Ulandari et al's (2019) research show that learning

materials based on the RME approach significantly improve students' mathematical problem-solving skills and self-efficacy which encourages improved learning outcomes.

The RME approach not only improves calculation accuracy but also improves students' critical thinking skills, problem-solving skills, and mathematical reasoning (Lestari et al., 2023). Research shows that RME can significantly improve students' mathematical literacy skills, especially when adjusted to student demographics (Ariati et al., 2022). In addition, the use of RME-based worksheets and teaching materials has proven to be very important in improving students' reasoning and mathematical understanding (Erita et al., 2022). By prioritizing learning through practical application and problem-solving rather than memorization, RME fosters students' creative and imaginative thinking skills so as to produce a deeper understanding of mathematical concepts (Kusmaryono & Maharani, 2021). As such, RME has become a valuable approach to elementary school mathematics education, encouraging the improvement of numeracy skills, as well as a deeper understanding and appreciation of mathematics among students.

Criticism of Realistic Mathematics Education (RME) in improving students' integer numeracy skills in elementary school suggests that although RME emphasizes real-world context and practical application of mathematics, sometimes RME lacks focus on basic computing skills. According to Juandi et al (2021) the emphasis on problem-solving in authentic situations may not provide students with enough practice in basic arithmetic operations, thus leading to potential gaps in their integer calculation abilities. In addition, Andriani et al (2023) stated that cultural and contextual elements integrated into RME learning may have varying relevance and effectiveness in different student populations, potentially hindering the universal application of this approach.

Critics related to the application of RME in mathematics in elementary schools also raised concerns about the potential of RME to prioritize conceptual understanding over procedural smoothness, which could have an impact on the speed and accuracy of students in performing integer calculations (Lestari et al., 2023). Quite clearly, while RME offers valuable benefits in developing mathematical reasoning and application, critics highlight the importance of balancing real-world relevance with a strong foundation in basic calculation skills to ensure comprehensive mathematical proficiency among elementary school students.

The discussion of the Realistic Mathematics Education (RME) approach, especially regarding the balance between conceptual understanding and procedural fluency of basic mathematics, has been emphasized in the research of Fauzi et al (2021) which criticized RME which focuses more on conceptual understanding than procedural fluency in integer mathematical calculations in elementary schools has significant implications for mathematics teaching practices at the basis. Educators must carefully consider how to strike a balance between fostering deep conceptual understanding and ensuring students develop efficient procedural skills in mathematics. By addressing these criticisms, teachers can improve their teaching strategies to effectively combine conceptual understanding and procedural fluency, thereby improving students' overall math proficiency. Meanwhile, the existing literature, scientifically and coherently, states that the RME approach is effective in improving student learning outcomes, including mathematical problem-solving skills, self-efficacy, reasoning, and mathematical literacy (Amir et al., 2021; Sarumaha & Rizkianto, 2022; Monika & Ramadan, 2022a). Therefore, in the rapidly developing scientific revolution, further investigation is essential to optimize the integration of conceptual understanding and procedural fluency within the framework of RME to ensure a comprehensive and balanced mathematics education for primary school students.

Another view argues that Realistic Mathematics Education (RME) is a teaching approach that emphasizes the connection of mathematical concepts with real-world situations, making learning more meaningful for students (Fitriya et al., 2023). This approach is in line with Piaget's theory of child development, especially in the concrete operational stage (ages 7-11), where children begin to think logically and can manipulate objects mentally. Piaget's theory suggests that children at this stage benefit from hands-on experience and real examples to understand abstract concepts (Bujuri & Ilmu, 2018).

The Realistic Mathematics Education (RME) approach in mathematics learning in elementary school prioritizes real context to help students understand mathematical concepts, including the addition and subtraction of integers and decimals. The implementation of RME in class VI students for decimal integers, begins by presenting relevant everyday situations, such as managing pocket money or measuring recipe ingredients, to illustrate addition and subtraction. Teachers invite students to explore the problem independently or in small groups, using tools such as drawings, diagrams, or concrete manipulatives. Students are then encouraged to find appropriate completion strategies and discuss the results. The next stage is formalizing, where students formalize their understanding by introducing more abstract mathematical notation and procedures. Through this cycle, students are expected to be able to relate mathematical concepts to real situations, understand the steps to solve, and apply their knowledge flexibly.

The success of Realistic Mathematics Education (RME) learning in teaching integer counting in grade VI elementary school children is greatly influenced by several key factors. First, engaging students in a real-world context that is meaningful and appropriate to their experiences can increase their motivation and interest in learning mathematics (Papadakis, 2021). Second, providing broad opportunities for students to explore and manipulate concrete materials or visual representations during the learning process facilitates their conceptual understanding of counting integers (Widhi, 2022). Third, fostering a collaborative learning environment where students can discuss and share their strategies for solving math problems will promote deeper understanding and support the development of critical thinking skills (Rosmawati & Nur'aeni, 2022). By addressing these factors, RME can effectively develop students' numeracy skills while also increasing positive attitudes toward math.

RME provides a space for teachers to share opportunities for students to engage in problem-solving activities that require logical thinking and the application of mathematical concepts in practical contexts (Wigati et al., 2020). By connecting mathematical ideas with real-life scenarios, RME supports children's cognitive development by fostering critical thinking skills, solving problems creatively, and developing a deeper understanding of mathematical concepts (Kusmaryono & Maharani, 2021). Research by Riyadi & Fathoni (2022) shows that the implementation of RME in elementary schools has a positive impact on students' imagination, creative thinking skills, and overall mathematical achievement. Therefore, integrating RME into the curriculum for elementary school students can improve their mathematical literacy and cognitive development by providing a solid foundation for mathematical abstract thinking in the context of their daily experiences.

The research on Realistic Mathematics Education (RME) learning using integer counting in grade VI elementary school students faces certain limitations that should be considered by researchers. These limitations may include challenges in generalizing findings due to variations in learning approaches, student backgrounds, and school contexts. Additionally, measuring the long-term impact of RME on a student's mathematical ability in addition to calculating integers may require long-term study, which can consume a lot of

resources and time. The implications of these limitations highlight the importance of carefully designing research methodologies that take into account the diverse learning environment and characteristics of students. Further researchers in this field can benefit from the use of a mixed-methods approach to capture the quantitative and qualitative aspects of the student learning experience. In addition, investigating the effectiveness of specific learning strategies within the framework of RME and exploring the role of teachers' professional development in implementing RME practices can provide valuable insights for improving mathematics education in primary schools.

Conclusion

Realistic Math Education (RME) has been shown to be effective in improving students' integer numeracy skills in elementary school. With the results of the *Wilcoxon Signed Ranks Test* with the result of Asymp. Sig. (2-tailed) = 0.000 and an N-Gain value of 0.64, it shows that there is an increase in learning outcomes by 64%. Research shows that this approach results in a significant increase in students' learning completeness in integer addition and subtraction materials, as well as improving mathematical problem-solving, self-efficacy, reasoning, and mathematical literacy. RME encourages students to recognize the practical application of mathematical concepts through real-world contexts and cultural elements, as well as to cultivate creative and imaginative thinking skills. Nonetheless, there have been criticisms of the RME that highlight concerns about limitations in focusing on basic computing skills and possible prioritization over conceptual understanding over procedural fluency. However, RME proponents assert that this approach is in line with Piaget's theory of child development and can provide more meaningful learning for students. The success of RME is influenced by factors such as real-world context, concrete experiences, collaborative learning environments, and problem-solving opportunities. Limitations in RME research include challenges in generalizing findings and measuring long-term impacts, but careful research methodologies and mixed-methods approaches can help overcome this. Future research may focus more on specific learning strategies within the framework of RME and the role of teachers' professional development in applying RME practices to improve mathematics education in primary schools.

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