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The effectiveness of realistic mathematics education to enhance elementary students' learning outcomes and motivation

Jesi Alexander Alim[1*], Sri Retno Asih[1], Zetra Hainul Putra[1]

[1] Universitas Riau, Pekanbaru, Indonesia

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Abstract

The implementation of mathematics can always be found in everyday life. In mathematics education, the main focus of RME is its approach, which emphasizes using real-life situations in mathematics learning. This study aims to examine the effectiveness of Realistic Mathematics Education (RME) in improving mathematics learning outcomes and motivation among fourth-grade elementary school students. This research is a quantitative study with a one-group quasi-experimental design. The study was conducted in a fourth-grade classroom involving 27 students. Data were collected through pretest and post-test questions. The data analysis used was the paired sample t-test and n-gain test. The study's results indicate a significant difference between the post-test and pretest results in students' learning outcomes and motivation before and after implementing Realistic Mathematics Education (RME). This is based on the paired sample t-test results, which show that the significance value for learning outcomes after the implementation of RME is 0.000 < 0.05, and the significance value for motivation is 0.01 < 0.05. The n-gain calculation also indicates that the effectiveness of implementing Realistic Mathematics Education (RME) falls within the moderate category. Overall, it is concluded that applying realistic mathematics education (RME) is quite practical for teaching and improving fourth-grade elementary school students' learning outcomes and motivation.

* Corresponding Author.
E-mail address: jesi.alexander@lecturer.unri.ac.id (Jesi Alexander Alim)
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1. Introduction

Mathematics makes a significant contribution to enhancing students' intelligence. Besides supporting and developing other sciences, mathematics also plays a crucial role in equipping students with the social skills needed in societal life (Danuri et al., 2023; Primalisa et al., 2018). In this context, mathematics involves mastering concepts and calculation skills, addressing everyday situations, and interacting with others, requiring critical, logical, and analytical thinking abilities. Unconsciously, mathematics is directly linked to daily activities and is often used to solve problems (Farida, 2017; Febriani & Sidik, 2020; Roza et al., 2020). This makes mathematics an essential subject that cannot be separated from any level of education. However, in practice, mathematics is often considered a complex science, leading to it frequently being disliked by students (Prahmana et al., 2021). When students do not enjoy a subject, it affects their performance, resulting in low mathematics achievement (Amilya et al., 2020). This is also evident from the 2018 PISA results, which highlight the low performance

of Indonesian students in mathematics. According to PISA 2018, Indonesia ranked seventh in mathematical literacy. The Indonesian mathematical literacy score was only 379, below the international standard of 489 (OECD, 2019).

Based on the observations conducted during classroom teaching, it was found that most students struggled with mathematics tasks. During the mathematics learning process at SDN 007 Suka Damai, particularly in the fourth grade, it was observed that students had low engagement and difficulty understanding mathematical concepts. Students were passive during lessons, and when allowed to ask questions, none did. However, some students struggled with the material when given exercises, making completing tasks difficult. Only a few students could follow the steps taught by the teacher. Some could memorize the material well but did not fully understand it. Students also had difficulty solving contextual problems and understanding formulas during daily tests, even if the concepts were the same as in practice questions. This passivity led to low achievement in mathematics; as seen from the pra research, students have low learning outcomes and motivation to study.

During mathematics lessons in the fourth grade at SDN 007 Suka Damai, teachers rarely connected students' daily experiences with the lesson content, causing students to struggle with real-life related math problems. Moreover, elementary students' abstract thinking skills are not fully developed. Thus, using teaching methods that can enhance student motivation and encourage learning is crucial. Suitable learning models or approaches should be chosen, such as integrating learning into daily activities for students. Since elementary students think more concretely, relating learning to their daily experiences can help foster learning motivation. Teachers play a vital role in managing classrooms effectively to motivate students to learn.

A study by Emilyah (2018) explained that students' disinterest in mathematics correlates directly with their low mathematics achievement. Similarly, Kholil and Safianti (2019) found that mathematics is often perceived as a problematic subject, leading to students' lack of interest, resulting in difficulties in learning and low achievement. This low mathematics ability presents a significant challenge for teachers in creating effective teaching methods that motivate students to develop an interest in learning mathematics, hoping to improve their academic achievement in the subject. As Amik (2018) stated, when students are interested and motivated to learn, it positively impacts their academic performance. Several factors contribute to students' low mathematics learning ability, including a dense curriculum, ineffective learning media, inappropriate teaching approaches, poor evaluation systems, and teachers' inability to motivate students (U. Oktaviani, 2020). The central aspect contributing to the decline in mathematics learning quality is teachers' limited ability to select suitable teaching approaches and inspire student motivation (Ridha Sabrina, Fauzi, 2017).

The approach and motivation aspects significantly impact learning outcomes, especially at the elementary level. Mathematics tends to be abstract, while elementary students' thinking abilities are generally more concrete (Gula & Lovric, 2024; Susanti, 2020). Motivation is a fundamental factor in driving behaviour (Yudharsyah et al., 2017). The internal drive pushes individuals to act according to their desires. Motivation is the fundamental force that drives someone to act. Therefore, actions triggered by specific motivations reflect goals aligned with the underlying motivation (Kusmiarti & Hamzah, 2019). Student motivation in learning is essential because enthusiastic students support effective learning (Emda, 2017). Effective learning can lead to improved student learning outcomes, as shown by research conducted by Bahri et al. (2017), which found that effective learning increases student achievement.

One crucial aspect for teachers to face this challenge is choosing a teaching approach suitable for elementary students' cognitive development level (Abdullah, 2017). Additionally, teachers must inspire students' learning motivation creatively and inspirationally, making students interested and motivated to learn mathematics. Considering these factors and adopting suitable, relevant teaching approaches that inspire student motivation, the quality of mathematics learning at the elementary level is hoped to improve.

To create meaningful and relevant mathematics learning, Realistic Mathematics Education (RME) aims to connect mathematics learning with students' daily lives (Alim, Fauzan, Arnawa et al., 2020; Emilyah et al., n.d.; Purba et al., 2022). RME helps students develop and apply mathematical ideas,

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concepts, and principles in real-life contexts to solve problems (Alim et al., 2021; Alim, Fauzan, Arwana et al., 2020; Alim, Hermita et al., 2020; Ningrum et al., 2023). RME makes mathematics learning more manageable for students by integrating mathematical concepts into daily activities (Widyastuti & Pujiastuti, 2014). Based on the issues presented, the researcher is interested in conducting a study titled "The Effectiveness of Realistic Mathematics Education to Enhance Elementary Students' Learning Outcomes and Motivation."

2. Method

2.1 Design

This research follows a quantitative pre-experimental approach using a quasi-experimental design, specifically the one-group pretest-posttest design. The study involved only one group, the experimental group. Initially, the group underwent a pretest before receiving the treatment, followed by a post-test after the treatment to assess students' learning outcomes and motivation. This research was conducted over four meetings. In the first meeting, students will be given a pretest to assess their abilities. Then, in the second and third meetings, students will receive treatment by implementing PMRI. After the treatment, in the fourth meeting, students will be given a post-test to evaluate the final improvement in learning outcomes and student motivation. The context of PMRI in this study is present at each stage of the learning process, from opening conducting activities to closing. The material studied by the students is about the area of flat shapes, specifically squares and rectangles. In the context of PMRI, students will be taught how to measure the area of flat shapes found in their environment directly using unit squares.

2.2 Participants

The subjects of this study are 27 fourth-grade students from SDN 007 Suka Damai. The researcher selected these subjects because the students' learning outcomes and motivation in mathematics were still low. The students in this class could adapt to the learning activities, as observed by the researcher during the mathematics lessons.

2.3 Instruments

Data was collected using observation, documentation, and pretest-posttest questions, totalling 10 items. Before the test questions were used, they had to meet the normality and homogeneity tests first.

2.4 Data Analysis

Subsequently, an effectiveness analysis was performed to determine the effectiveness of implementing PMRI on students' learning outcomes and motivation. The calculation of student test results uses the following formula.

Next, the technique used in analyzing the data is the paired samples t-test to examine the significance of the effectiveness of implementing PMRI in improving student learning outcomes and motivation. The analysis of the difference in data to see the improvement in students' average results in this study is also conducted using the N Gain (g) test to determine the improvement between the pretest and post-test. The results of the data calculations on the gain score are then interpreted into the value (g) in **Table 1**.

Table 1. N-Gain Criteria

No.	N-Gain	Criteria
1	$g \geq 0{,}70$	High
2	$0{,}30 \geq g < 0{,}70$	Moderate
3	$g < 0{,}30$	Low

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3. Results and Discussion

This research examined the effectiveness of implementing Realistic Mathematics Education (RME) to improve learning outcomes and motivation among fourth-grade elementary school students. The study provides lesson material through direct experiences based on real contexts. The research was carried out over four meetings, with the first meeting being a preliminary study. The initial stage of this research involves conducting a preliminary study by giving students a pretest consisting of 10 questions to assess their initial abilities in flat shapes. Subsequently, students will receive treatment by implementing RME over two meetings. Using unit cubes, the material taught includes flat shapes, specifically squares and rectangles.

Figure 1. Students measure the area of flat shapes with square units.

Then, in the fourth or final meeting, students will be given a post-test again. This post-test measures the final results of student learning and motivation after implementing Realistic Mathematics Education (RME). The post-test consists of 10 multiple-choice questions. The results of the post-test and pretest can be seen in **Table 2**.

Table 2. The result of pretest-postest

	Learning Outcomes		Motivation	
	Pretest	Postest	Pretest	Postest
Min.	30	70	58	74
Max.	100	100	84	95

Additionally, the results of students' pretest and post-test scores before and after the implementation of Realistic Mathematics Education (RME) can be seen in the following bar chart in **Figure 2**.

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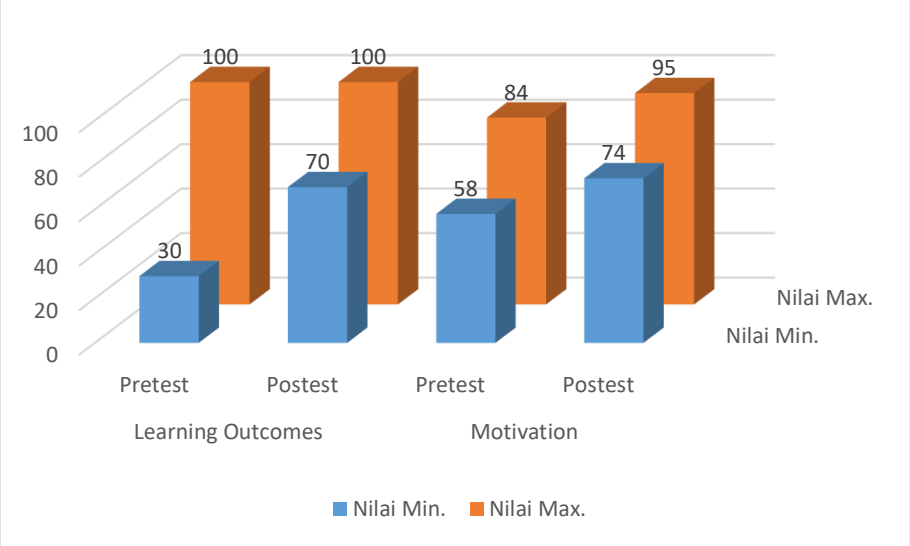

Figure 2. Students' pretest and post-test learning outcomes and motivation

Based on the pretest-posttest results shown in **Table 3** and **Figure 2**, it was found that the lowest score for students' learning outcomes in the pretest was 30, while the highest was 100. For students' motivation in the pretest, the lowest score was 58, and the highest was 84. In the post-test, the lowest score for learning outcomes was 70, and the highest remained 100. Regarding motivation in the post-test, the lowest score was 74, and the highest was 95. These pretest-posttest results clearly show improved students' learning outcomes and motivation after implementing Realistic Mathematics Education (RME). Although the highest score in the pretest and post-test was 100, only one student achieved a 100 in the pretest. Next, after scoring the pretest-posttest results for students' learning outcomes and motivation, a hypothesis test will be conducted to assess the significance of the effectiveness of RME in improving the learning outcomes and motivation of fourth-grade students. However, normality and homogeneity tests will be performed before the hypothesis test. The results of the normality test can be seen in Table 3.

Table 3. Normality test result

	Class	Shapiro-Wilk Sig.	Result
Learning Outcomes	Pretest	0.051	Normal
	Postest	0.112	Normal
Motivation	Pretest	0.054	Normal
	Postest	0.114	Normal

Based on the normality test criteria, where 0.051 > 0.05 and 0.112 > 0.05, it is concluded that the data for learning outcomes are normally distributed. Similarly, the significance value (2-tailed) obtained for the motivation was 0.054 for the pretest and 0.114 for the post-test. Based on the normality test criteria, where 0.054 > 0.05 and 0.114 > 0.05, it is concluded that the data for motivation are normally distributed. Overall, it is concluded that the data for learning outcomes and motivation are normally distributed and can proceed to the homogeneity test stage.

Table 4. Results of the homogeneity test

	Sig.	Result
Learning Outcomes	0.06	Homogenous
Motivation	0.18	Homogenous

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Based on **Table 4**, the homogeneity test results yielded a significance value greater than 0.05. The average significance value obtained from the homogeneity test is sig. 0.06 > 0.05 leads to the conclusion that the data from the learning outcomes classes are homogeneous. The homogeneity test results yielded a significance value greater than 0.05. The average significance value obtained from the homogeneity test is sig. 0.18 > 0.05 leads to the conclusion that the data from the motivation classes are homogeneous.

Then, after the data met the normality and homogeneity test criteria, the data could proceed to hypothesis testing. The hypothesis test was conducted to determine the effectiveness of Realistic Mathematics Education (RME) in improving learning outcomes and the effectiveness of RME in enhancing students' learning motivation. The paired samples t-test was performed using SPSS version 23 software. If the significance value (sig.) is more significant than 0.05, then the null hypothesis (H0) is accepted, and the alternative hypothesis (Ha) is rejected. Conversely, if the significance value (sig.) is less than 0.05, then H0 is rejected, and Ha is accepted. The results of the paired samples t-test can be seen in **Table 5** below.

Table 5. The result of the paired sample t-test

	Sig.	Result
Learning Outcomes	0.001	H_0 Rejected
Motivation	0.000	H_0 Rejected

Based on the paired sample t-test results, the significance value obtained is 0.001 < 0.05, indicating that he is accepted and H_0 is rejected. It can be concluded that there is a significant difference in the average learning outcome between students after the implementation of Realistic Mathematics Education (RME). Based on the paired sample t-test results, the significance value obtained is 0.000 < 0.05, indicating that he is accepted and H_0 is rejected. It can be concluded that there is a significant difference in the average learning motivation of students after the implementation of Realistic Mathematics Education (RME). Next, an N-Gain calculation was conducted to determine the extent of the improvement in students' learning outcomes and motivation before and after the implementation of Realistic Mathematics Education (RME). The results of the N-Gain calculation can be seen in **Table 6**.

Table 6. N-Gain result

	N-Gain	**Category**
Learning Outcome	0.57	Moderate
Motivation	0.44	Moderate

Based on the results of the N-Gain calculation in **Table 6**, it is found that the N-Gain value for the learning outcome is 0.57, which falls into the "moderate" category. Meanwhile, the N-Gain value for the motivation is 0.44, also falling into the "moderate" category. Based on the N-Gain results, it is concluded that there is an improvement in students' learning outcomes and motivation before and after the implementation of Realistic Mathematics Education (RME). Based on the findings of this research, the implementation of realistic mathematics education (rme) has been shown to enhance student learning outcomes. Rme is an instructional approach in mathematics focusing on student activities grounded in factual and contextual situations (Islam, 2022). In this approach, students are viewed as individuals with knowledge and experiences gained through interaction with their environment. Students reconstruct mathematical concepts by exploring various problems from everyday life and mathematical contexts (munir & sholehah, 2020). Through RME, students develop logical, creative, and critical thinking (Alim, Fauzan Arnawa, et al., 2020; Laurens et al., 2017). Rme provides contextual learning experiences for students, making learning interactive and engaging (Alim et al., 2021; Hozaima & subaidi, 2023). It allows teachers to provide real-world experiences, which help students better understand the taught concepts. This aligns with the research findings that RME improves student learning outcomes compared to traditional methods.

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The research findings also reveal that by implementing RME in the learning process, efforts can be made to enhance student motivation. Contextual learning experiences through RME attract and hold students' attention, motivating them to engage actively in learning (Nuraina et al., 2021). When students become interested in learning, they play an active role in learning (Alim et al., 2023; Napitupulu et al., 2021; C. Oktaviani et al., 2022, 2024). To enhance student motivation in the learning process, mathematics education needs to deliver from abstract characteristics to real contexts (Purnamatati et al., 2023). Through the application of RME, real-world contexts can be integrated into teaching. Motivation can be defined as the mental capacity that drives and directs human behaviour, making it crucial in the learning process. Teachers are, therefore, challenged to create engaging learning experiences (Aini et al., 2016; Ajeng Gelora Mastuti, Abdillah, 2022). As educators, teachers must continually train and innovate to create engaging mathematics education for students. As found in this research, implementing RME in learning can enhance student motivation and learning outcomes. Similar research conducted by Rimadani and Badarudin (2024) found that implementing RME can be an effort to improve student learning outcomes. Purnamatati et al. (2023) revealed that applying RME in education can motivate students to learn. Similar findings were reported by Apriana (Apriana, 2021) on the effectiveness of realistic mathematics in improving student learning outcomes. Laurens et al. (2017) also found that realistic mathematics can enhance students' cognitive thinking abilities. Overall, implementing RME in education can be a strategy to improve student learning outcomes and motivation. Teachers can consider adopting RME to enhance the quality of elementary school mathematics education. In conclusion, applying RME in education can effectively enhance student learning outcomes and motivation. Teachers can consider adopting RME to improve the quality of elementary school mathematics education.

Realistic Mathematics Education (RME) effectively improves students' learning outcomes and motivation. Therefore, teachers must adopt a more contextualized teaching approach, where mathematical concepts are connected to real-life situations relevant to students' daily lives (Febriani & Sidik, 2020). Implementing RME allows students to understand and apply mathematical concepts (Adel, 2020; Hozaima & Subaidi, 2023). The results of this study imply that the application of RME can enhance the quality of mathematics learning in elementary schools. This could encourage schools to use more RME-based teaching materials and strategies, which allow students to actively participate in solving real-world problems actively, thereby improving their ability to learn mathematics and achieve better learning outcomes (Apriana, 2021; Jannah et al., 2017; Nuraina et al., 2021; Ramadhani & Caswita, 2017). This study also suggests that RME can be one of the solutions to increase students' learning motivation (Ningrum et al., 2023; Nuraina et al., 2021). The study shows that implementing RME impacts learning outcomes and influences affective aspects such as motivation, which is crucial in supporting successful mathematics learning.

4. Conclusion and Recommendations

Based on the findings of the research conducted, it is concluded that the implementation of Realistic Mathematics Education (RME) has a significant impact on improving students' learning outcomes. Implementing RME also significantly influences the increase in students' learning motivation. The N-gain results also indicate that the effectiveness of RME in enhancing student's learning outcomes and motivation falls within the moderate category. Overall, implementing RME is quite effective in improving students' learning outcomes.

Based on this, it is recommended that teachers apply RME in their teaching to enhance students' learning outcomes and motivation. The implementation of RME in this study is still in the moderate category. Therefore, it is suggested that the application of RME be developed by designing more varied and contextual materials and employing more interactive teaching approaches to boost students' motivation and learning outcomes further.

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