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Improving Students' Mathematical Representation Ability in Fraction Addition Operations Through the Realistic Mathematics Education Model in Grade IV Elementary School

Shaila Safira, Novianti, Rahmi Wahyuni

Universitas Almuslim, Bireuen, Indonesia
*Correspondence: E-mail: noviyanti@umuslim.ac.id

A B S T RAK

Kemampuan representasi matematis merupakan salah satu kemampuan esensial dalam pembelajaran matematika. Namun, kemampuan representasi matematis siswa masih tergolong rendah, khususnya dalam merepresentasikan konteks soal operasi hitung penjumlahan pecahan ke dalam bentuk verbal, simbol, maupun visual. Tujuan penelitian ini untuk mengetahui peningkatan kemampuan representasi matematis siswa yang memperoleh pembelajaran dengan model Realistic Mathematics Education (RME) dibandingkan dengan siswa yang memperoleh pembelajaran konvensional. Metode penelitian yang digunakan adalah quasi-eksperimen dengan desain nonequivalent control group design. Populasi penelitian adalah seluruh siswa kelas IV salah satu SD Negeri di Kabupaten Bireuen, Aceh tahun ajaran 2025/2026. Sampel penelitian terdiri dari kelas IV/A sebagai kelas eksperimen yang menerapkan model Realistic Mathematics Education dan kelas IV/B sebagai kelas kontrol yang menggunakan pembelajaran konvensional. Teknik pengumpulan data menggunakan tes uraian kemampuan representasi matematis pada materi operasi hitung penjumlahan pecahan. Data dianalisis menggunakan bantuan software SPSS 27.0 melalui uji normalitas, uji Mann-Whitney, uji homogenitas, uji t, dan uji N-Gain. Hasil penelitian menunjukkan bahwa peningkatan kemampuan representasi matematis siswa pada kelas eksperimen lebih tinggi dibandingkan dengan kelas kontrol dengan nilai rata-rata N-Gain sebesar 0,67 pada kelas eksperimen dan 0,42 pada kelas kontrol. Hasil uji independent samples t-test menunjukkan nilai signifikansi 0,004 < 0,05, sehingga dapat disimpulkan bahwa peningkatan kemampuan representasi matematis siswa yang memperoleh pembelajaran dengan model RME lebih baik dari pada siswa yang memperoleh pembelajaran konvensional. Temuan penelitian ini menunjukkan bahwa penerapan model RME

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memberikan kontribusi positif dalam pembelajaran matematika di sekolah dasar karena membantu siswa memahami konsep matematika secara lebih mendalam serta mengaitkannya dengan konteks kehidupan sehari-hari.

A B S T R A C T

Mathematical representation ability is one of the essential skills in mathematics learning. However, students' mathematical representation ability was still relatively low, particularly in representing the context of fraction addition problems into verbal, symbolic, and visual forms. This study aimed to determine the improvement of students' mathematical representation ability through the Realistic Mathematics Education (RME) model compared to conventional learning. This study employed a quasi-experimental method with a nonequivalent control group design. The population of this study comprised all fourth-grade students at one of the public elementary schools in Bireuen Regency, Aceh, during the 2025/2026 academic year. The research sample consisted of class IV/A as the experimental class implementing the Realistic Mathematics Education model and class IV/B as the control class using conventional learning. Data were collected using an essay test of mathematical representation ability on fraction addition operations. The data were analyzed using SPSS 27.0 through normality tests, Mann-Whitney tests, homogeneity tests, independent samples t-tests, and N-Gain tests. The results showed that the improvement in students' mathematical representation ability in the experimental class was higher than that of the control class, with an average N-Gain score of 0.67 in the experimental class and 0.42 in the control class. The results of the independent samples t-test showed a significance value of 0.004 < 0.05, so it can be concluded that the improvement in students' mathematical representation abilities who received learning with the RME model is better than that of students who received conventional learning. The findings of this study indicate that the implementation of the RME model provides a positive contribution to mathematics learning in elementary schools because it helps students understand mathematical concepts more deeply and relate them to real-life contexts.

Keywords:
Realistic Mathematic Education, Mathematical Representation Ability, Arithmetic Operations of Adding Fractions.

1. INTRODUCTION

Mathematics is a subject taught at every level of education, ranging from elementary school to higher education (Febriani, Sunaryo, & Wahyudin, 2020). Mathematics learning plays an important role in developing logical, systematic, and analytical thinking skills. One of the essential competencies that students need to acquire in mathematics learning is mathematical representation ability, as recommended by the National Council of Teachers of Mathematics (Giriansyah, Pujiastuti, & Ihsanudin, 2022). Mathematical representation ability enables students to express mathematical ideas or problems in various forms, including visual, symbolic, and verbal representations. This ability assists students in simplifying complex problems, making them easier to understand and solve (Novianti & Andriani, 2023). Sutini (2025) stated that representation reflects students' ways of thinking in understanding a problem and functions as a means of problem-solving.

In the learning process, representation provides opportunities for students to interpret, process, and communicate mathematical ideas according to their own ways of thinking. Therefore, mathematical representation ability serves as an important cognitive tool in helping students understand concepts and solve mathematical problems (Sunanti, Sagita, & Anggraini, 2022). Through representation, abstract concepts can be transformed into more concrete forms, enabling students to understand them more easily.

However, in classroom practice, students' mathematical representation ability is still relatively low. Students frequently experience difficulties in transforming mathematical problems into various forms of representation, whether visual, symbolic, or verbal. This condition is caused by the abstract nature of mathematics, which makes it difficult for students to understand and communicate mathematical ideas accurately (Novianti et al., 2025).

The low level of students' mathematical representation ability was reinforced by the results of a preliminary study conducted at an elementary school in Bireuen Regency, Aceh. The findings revealed that only 25% of students demonstrated good representation ability, while 75% still experienced difficulties in representing fraction addition problems into various forms of mathematical representation. Figure 1 illustrates students' mathematical representations at each stage of problem solving.

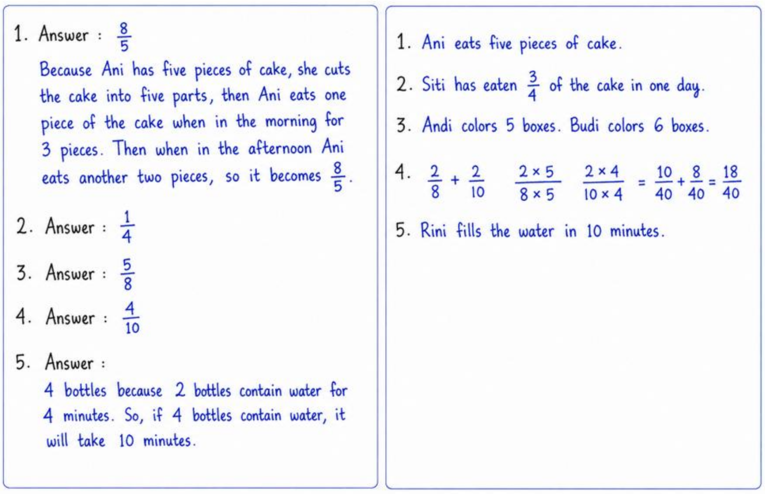

Figure 1. Students' Answer Sheets on Fraction Material

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Based on the students' answer sheets in figure 1, it can be observed that most students were able to understand the questions and obtain the correct answers; however, they were not yet able to clearly describe the solution process. Students who used verbal representation were still unable to explain the solution steps properly. In symbolic representation, students had not written the fractions accurately. Meanwhile, in visual representation, students were not yet able to illustrate the problems or the solution processes appropriately. These findings indicate that students' mathematical representation ability has not developed optimally. One alternative that can be used to improve students' mathematical representation ability is the implementation of the Realistic Mathematics Education (RME) learning model. This approach emphasizes the connection between mathematical concepts and real-life contexts as well as students' experiences, making learning more meaningful (Sugiarti, Jeramat, Jelatu, & Harjo, 2025). In addition, RME encourages students to actively explore, discuss, and reflect on the learning processes they experience.

Several previous studies have examined the implementation of the RME learning model and demonstrated its positive contribution to various aspects of students' mathematical representation ability. Rabbissama, Zulaiha, and Meldina (2024) found a significant effect of the RME model on mathematical representation ability. Furthermore, Agustina, Pranata, and Nugraha (2020) reported that RME was able to improve students' conceptual understanding of fraction addition material. Meanwhile, Sudarma, Laily, and Andini (2022) revealed that RME had a positive effect on students' problem-solving ability.

However, a more in-depth review of these studies indicates that the existing research has not yet been comprehensive. Studies on mathematical representation ability have not been specifically associated with fraction addition material. On the other hand, research on fractions has mostly focused on conceptual understanding or problem-solving abilitiy. The study conducted by Nurhayanti, Hendar, and Kusmawati (2022) showed that the implementation of the Realistic Mathematics Education (RME) approach was effective in improving students' conceptual understanding of fractions. Therefore, the integration of the RME approach with mathematical representation ability in the context of fraction addition operations has not been thoroughly investigated.

This limitation highlights a gap in the existing literature, resulting in a lack of comprehensive understanding of how mathematical representation ability can be developed contextually in elementary mathematics learning. Therefore, this study aims to determine the effect of implementing the Realistic Mathematics Education (RME) learning model on improving elementary school students' mathematical representation ability in fraction addition operations.

2. METHOD

This study employed a quantitative approach. The research method used was a quasi-experimental design, specifically the nonequivalent control group design. The study involved two classes: an experimental class and a control class. The research design used in this study is presented in Table 1.

Table 1. Quasi-Experimental Design

Class	*Pretest*	Treatmen	*Posttest*
Experimental	O_1	RME	O_3
Control	O_2	Convensional	O_4

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This study was conducted during the second semester of the 2025/2026 academic year at one of the public elementary schools in Bireuen Regency, Aceh. The participants of this study were fourth-grade elementary school students, consisting of 23 students aged approximately 9-10 years. The samples in this study were students from classes IV/A and IV/B. The sampling technique used was purposive sampling.

The research instruments consisted of test instruments and learning instruments. Data were collected through pretests and posttests. The test instruments had previously been examined for validity, reliability, difficulty level, and discrimination index.

Each class received different learning treatments. Class IV/A, as the experimental class, was taught using the Realistic Mathematics Education (RME) approach, while class IV/B, as the control class, received conventional learning. Before the treatments were administered, both classes were given a pretest. After the learning process was completed, a posttest was administered to both classes. The pretest and posttest data were analyzed statistically to determine the improvement in students' mathematical representation ability.

The data analysis techniques used in this study included descriptive statistics, inferential statistics, and normalized N-gain analysis. The pretest, posttest, and N-gain data were first tested for normality and homogeneity to determine the appropriate statistical test. If the data were normally distributed and homogeneous, differences between groups were analyzed using an independent samples t-test. However, if the data were not normally distributed, a non-parametric test, namely the Mann-Whitney U test, was employed. The test results were interpreted based on the established significance level.

3. RESULT AND DISCUSSION

The data used in this study were obtained from the pretest and posttest scores. Data processing was carried out using SPSS 27.0 software.

Pretest Data Analysis of Mathematical Representation Ability

Before the implementation of the learning treatments, students' mathematical representation ability was measured through a pretest. The pretest results described the students' initial abilities and served as a basis for comparison after the learning process. The descriptive statistics of the pretest results for both classes are presented in Table 2.

Table 2. Descriptive Statistics of Pretest Scores

Class	N	Mean	Std. Dev
Experimental	23	11,39	8,62
Control	23	12,26	6,13

Based on Table 2, the experimental class obtained a mean pretest score of 11.39, while the control class obtained a mean score of 12.26. These results indicate that both classes had relatively comparable initial abilities.

After obtaining the pretest data on students' mathematical representation ability in both the experimental and control classes, the next step was to conduct preliminary analyses to ensure the validity of the data before hypothesis testing. The first analysis conducted was the normality test. The results of the normality test are presented in Table 3.

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Tabel 3. Results of the Pretest Normality Test for the Experimental and Control Classes

Class	*Shapiro Wilk*			
	Statistik	Df	Sig.	Conclusion
Experimental	0,901	23	0,027	Not Normal
Control	0,953	23	0,334	Normal

Based on the Shapiro-Wilk test results in table 3, the significance value of the pretest data in the experimental class was 0.027 < 0.05, indicating that H_0 was rejected and the pretest data in the experimental class were not normally distributed. In contrast, the significance value for the control class was 0.334 > 0.05, indicating that H_0 was accepted and the pretest data in the control class were normally distributed. Since one group of data did not meet the assumption of normality, the difference between the pretest scores of the experimental and control classes was analyzed using the nonparametric Mann-Withney test. The results are shown in Table 4.

Table 4. Results of the Pretest Difference Test for the Experimental and Control Classes

	Mathematical Representation Ability
Mann-Withney U	222,500
Wilcoxon W	498,500
Z	-,927
Asymp. Sig. (2-tailed)	0,354
conclusion	H_0 Accepted

Based on Table 4, the Asymp. Sig. (2-tailed) value obtained was 0.354. Since this value was greater than the significance level of 0.05 (0.354 > 0.05), H_0 was accepted.

Posttest Data Analysis of Mathematical Representation Ability

The posttest administered to students in both the experimental and control classes aimed to determine students' mathematical representation ability after participating in learning activities with different treatments throughout the study. The descriptive statistics of the posttest scores are presented in Table 5.

Table 5. Descriptive Statistics of Posttest Scores

Class	N	Mean	Std. Dev
Experimental	23	36,47	11,79
Control	23	28,73	10,30

Based on Table 5, the experimental class obtained a mean posttest score of 36.47, while the control class obtained a mean score of 28.73. These results indicate that the experimental class achieved higher scores than the control class. Furthermore, a normality test was conducted. The results are presented in Table 6.

Table 6. Results of the Posttest Normality Test for the Experimental and Control Classes

Class	***Shapiro Wilk***			
	Statistik	Df	Sig.	Conclusion
Experimental	0,898	23	0,023	Not Normal
Control	0,965	23	0,570	Normal

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Based on the Shapiro-Wilk test results in table 6, the significance value of the posttest data in the experimental class was 0.023, while that of the control class was 0.570. Since the significance value in the experimental class was smaller than 0.05 (0.023 < 0.05), H_0 was rejected, indicating that the posttest data in the experimental class were not normally distributed. Meanwhile, the significance value in the control class was greater than 0.05 (0.570 > 0.05), indicating that H_0 was accepted and the posttest data in the control class were normally distributed.

Because one group of data did not meet the assumption of normality, the difference between the posttest scores of the experimental and control classes was analyzed using the nonparametric Mann-Withney test. The results are presented in Table 7.

Table 7. Results of the Posttest Difference Test for the Experimental and Control Classes

	Mathematical Representation Ability
Mann-Withney U	165,500
Wilcoxon W	441,500
Z	-2,178
Asymp. Sig. (2-tailed)	0,029
Conclusion	H_0 Rejected

Based on Table 7, the Asymp. Sig. (2-tailed) value obtained was 0.029. Since this value was smaller than the significance level of 0.05 (0.029 < 0.05), H_0 was rejected and H_1 was accepted.

Normalized N-Gain Analysis

Based on the results obtained from the experimental and control classes, the normalized N-gain values were calculated to determine the improvement in students' mathematical representation ability after the learning process. The results of the normalized N-gain calculation are presented in Table 8.

Table 8. Normalized N-Gain of the Experimental and Control Classes

Class	N	Mean	SD
Experimental	23	0.66	0.26
Control	23	0.42	0.31

Based on Table 8, the average N-gain score in the experimental class was 0.66, while the control class obtained an average score of 0.42. According to the N-gain criteria, both classes were categorized as moderate. Subsequently, the N-gain data were used for the normality test. The results are presented in Table 9.

Table 9. Results of the N-Gain Normality Test for the Experimental and Control Classes

Class	*Shapiro Wilk*			
	Statistik	Df	Sig.	Conclusion
Experimental	0,917	23	0,057	Normally Distributed
Control	0,962	23	0,511	Normally Distributed

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Based on Table 9, the results of the Shapiro-Wilk normality test indicated that the significance value of the N-Gain data in the experimental class was 0.057, while that of the control class was 0.511. Since both significance values exceeded the significance level of 0.05, the N-Gain data in both classes were considered to be normally distributed. As the assumption of normality was fulfilled, the statistical analysis was continued with a homogeneity test to determine the equality of variances between the groups. The results of the homogeneity test are presented in Table 10.

Table 10. Results of the Homogeneity Test

	Levene Statistic	Df1	Df2	Sig.	Conclusion
Nilai *Based On Mean*	0,104	1	44	0,748	H_0 Accepted

Based on Table 10, the results of the homogeneity test showed a significance value of 0.748. Since the significance value was greater than the significance level of 0.05 (0.748 > 0.05), H_0 was accepted, indicating that the variances of the two groups were homogeneous. Therefore, the data met the assumptions required for further analysis using the independent samples t-test. The results of the N-Gain difference test between the experimental and control classes are presented in Table 11.

Table 11. Results of the N-Gain Difference Test of the Experimental and Control Classes

Levene's Test for Equality of Variances						
Score		F	Sig.	t	Df	Sig. (2-tailed)
	Equal variances assumed	0,104	0,748	3,057	44	0,004
	Equal variances not assumed			3,057	43,450	0,004
				Conclusion		H_0 rejected

Based on the data analysis presented in Table 11, the Sig. (2-tailed) value obtained was 0.004. Since the value was less than 0.05 (0.004 < 0.05), H_0 was rejected and H_1 was accepted. Thus, the research hypothesis stating that the improvement in students' mathematical representation ability through the RME model was better than that achieved through conventional learning was accepted.

The improvement in students' mathematical representation ability occurred because the RME learning model facilitates meaningful learning by connecting new material with students' prior knowledge and experiences. Through the presentation of real-life contextual problems, abstract mathematical concepts can be linked to concrete experiences, enabling students to better understand mathematical contexts. One of the main strengths of RME lies in the use of contextual problems as the starting point of learning activities. By presenting situations relevant to students' daily lives, students are encouraged to think critically and actively engage in concept construction.

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Furthermore, the findings of Setioningsih et al. (2025) indicated that the implementation of real-life situations in RME contributed to the improvement of students' understanding of mathematical concepts. These findings are consistent with the study conducted by Febriana (2023), which showed that the improvement of students' mathematical conceptual understanding through the Realistic Mathematics Education (RME) approach was supported by the use of contextual problems and students' active involvement in reconstructing formal mathematical concepts. Through the RME approach, students develop a better understanding of mathematical concepts because learning is connected to situations close to their daily lives and encourages them to actively construct mathematical concepts (Muchtar, Hendriani, & Fitriani, 2020). This is because the problems provided were derived from experiences familiar to students, thereby promoting active engagement and creating more meaningful learning experiences. This approach emphasizes not only the final outcomes but also the students' thinking processes in understanding mathematical concepts.

The findings of this study are consistent with the view of National Council of Teachers of Mathematics (2000), which states that representation is an essential process in mathematics learning because it plays a significant role in helping students understand, organize, and communicate mathematical ideas. In addition, the findings are in line with the study conducted by Ramadhani, Wulandari, & Kusumastuti (2025), which revealed that the RME approach significantly improved students' mathematical representation abilitiy. Based on the analysis results, the posttest scores of students in the experimental class demonstrated a greater enhancement than those in the control class, with an average increase of 13 points. These findings indicate that the implementation of the RME approach had a significant effect on students' mathematical representation ability.

The study conducted by Putri, Isrok'atun, & Kurnia (2017) also found that learning through the Realistic Mathematics Education (RME) approach led to greater improvement in students' mathematical representation abilities compared to conventional learning. Furthermore, Sumarni, Makki, & Wahyuningsih (2025) reported that the RME approach was effective in enhancing students' understanding of mathematical concepts. Similarly, Saputra, Wahyuni, & Ayu (2024), as well as Amrina & Kusmaharti (2024), found that the RME approach had a significant effect on students' mathematical problem-solving abilities. These findings suggest that mathematical representation ability is closely interconnected with other mathematical competencies developed through contextual learning. In addition, Novianti &Wayudi (2024) reported that students who participated in realistic mathematics learning supported by Canva media demonstrated greater improvement in mathematical communication skills than those who received conventional instruction. Collectively, these findings reinforce the view that the RME approach contributes not only to the enhancement of students' mathematical representation abilities but also to the development of broader mathematical competencies.

Nevertheless, previous studies have generally focused on improving students' conceptual understanding, mathematical problem-solving abilities, and mathematical communication skills. In contrast to previous research, the present study specifically investigates the improvement of students' mathematical representation abilities in fraction addition at the elementary school level. Therefore, this study provides a more specific empirical contribution regarding the effectiveness of the Realistic Mathematics Education (RME) approach in developing students' mathematical representation abilities, particularly in fraction addition learning at the elementary school level.

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4. CONCLUSION

Students' mathematical representation abilities taught through the Realistic Mathematics Education (RME) model showed greater improvement compared with those taught through conventional learning. Based on the analysis results, the experimental class obtained an N-Gain score of 0.66, which was higher than the control class score of 0.42. This finding indicates that the improvement in students' mathematical representation abilities through the RME model was significantly higher than that achieved through conventional instruction. For future implementation, the use of the RME model should be carefully considered in relation to the characteristics of the learning material and students' needs. If the model is considered less appropriate for certain learning contexts, alternative instructional models that are more suitable may be employed to support the improvement of students' mathematical representation abilities.

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