The Influence of the Realistic Mathematics Education (RME) Approach and Students' Creativity on Mathematical Problem-solving Ability

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Abstrak. This study aims to determine the effect of RME (Realistic Mathematics Education) learning and student creativity on mathematical problem-solving abilities in the topic of systems of linear equations in two variables (SPLDV). This research uses a quantitative approach with a sample of 46 eighth-grade junior high school students. The research method is quantitative with a nonequivalent control group design, consisting of two groups: an experimental group and a control group. The sampling technique used is purposive sampling. The research instruments include essay-type tests and questionnaires, while the data analysis uses two-way ANOVA. The research results lead to the following conclusions: 1) There is an effect of the RME learning model on mathematical problem-solving ability., 2) Student creativity influences mathematical problem-solving ability, 3) There is no significant interaction between the RME learning model and student creativity on mathematical problem-solving ability.

INTRODUCTION

Education is one of the main efforts to improve the quality of human life. Through education, individuals are able to develop various abilities and skills that are useful in everyday life. One of the most important aspects of education is the teaching and learning process, which involves interaction between teachers and students (Rosyada, Sari, & Cahyaningtyas, 2019). This process requires effective methods so that students can properly understand the material being taught. An effective teaching and learning process requires an approach that can be adapted to students' needs and characteristics. Teachers play a central role as facilitators who not only transfer knowledge but also guide students in maximizing their potential. The quality of interaction between teachers and students greatly determines the success of the learning process. Teachers who are able to create a conducive learning environment and provide appropriate guidance can help students understand learning material more easily and apply it in everyday life (Halim & Ahyaningsih, 2019).

To achieve optimal educational goals, innovative teaching methods that adapt to the developments of the times are required. One method that has proven effective is the contextual learning approach, which connects learning materials to real-life situations relevant to students. This enables students to understand the concepts being taught more easily because they can directly see their applications in everyday life. Such an approach not only enhances students' understanding but also develops their critical and creative thinking skills.

The teacher's role in selecting and implementing the appropriate learning method is highly important. Teachers must be able to identify students' learning needs and adapt teaching methods to be more effective. Teacher creativity in developing learning materials and utilizing various learning media also serves as a key factor in creating enjoyable and meaningful learning experiences for students. Education can truly serve as the primary means of improving human quality, in line with the main objectives of the teaching and learning process (Rosyada, Sari, & Cahyaningtyas, 2019).

In the school environment, mathematics is one of the main focuses due to its crucial role in shaping the foundation of students' knowledge. Mathematics teaches logical, analytical, and critical thinking skills that are not only useful for solving mathematical problems but also for facing various challenges in everyday life. The ability to understand basic mathematical concepts is essential, as it serves as the foundation for learning more complex material at higher levels of education (Widana, 2021).

Mathematics learning in schools often faces major challenges due to its abstract nature. Many students struggle to understand concepts that lack tangible forms, which often leads to a lack of interest and motivation in learning. To address this challenge, teachers must develop learning strategies that can bridge the gap between abstract concepts and students' real-life experiences. One effective approach is the use of teaching aids or concrete examples that can help students visualize mathematical concepts (Widana, 2021).

In addition to using teaching aids, it is also important for teachers to create an enjoyable and interactive learning atmosphere. School students generally have short attention spans, so monotonous and unengaging teaching methods can quickly make them bored and lose focus. Teachers need to adopt varied learning approaches that actively involve students, such as educational games, group discussions, and creative projects. In this way, students will be more motivated to learn and gain a better understanding of mathematics. Not only teaching methods need attention, but it is also essential to provide students with sufficient practice. Structured and gradual exercises can help students master basic concepts step by step. Teachers must ensure that students have the opportunity to practice various types of problems, ranging from simple to more complex ones. This will help students develop problem-solving skills and increase their confidence in tackling mathematical problems (Widana, 2021).

The role of teachers in mathematics learning at school is highly significant. Teachers act not only as instructors but also as motivators and facilitators. They must be able to identify students' learning difficulties and provide the necessary guidance and support. Teachers also need to be sensitive to differences in students' abilities and learning styles, and adjust their teaching methods to meet each individual's needs. This ensures that all students can gain a solid understanding of mathematics and feel confident in their learning (Widana, 2021).

The right learning approach, a pleasant classroom atmosphere, sufficient practice, and effective teacher roles are the keys to overcoming challenges in mathematics learning. With these factors in place, students will have a strong foundation in mathematics, which will support them in pursuing higher education and facing various challenges in their lives (Widana, 2021).

One of the approaches that has been widely studied and applied is Realistic Mathematics Education (RME). The RME approach focuses on introducing mathematical concepts through real-life contexts that are closely related to students' everyday experiences. This enables students to more easily understand and apply mathematical concepts in their daily lives. Research conducted by Rosyada, Sari, and Cahyaningtyas (2019) shows that the RME learning model has a positive influence on students' mathematical problem-solving abilities.

Mathematical problem-solving ability is one of the essential skills that needs to be developed through mathematics learning. This ability is not only useful for solving mathematical problems but also for dealing with various challenges in everyday life. Through practicing mathematical problem-solving, students can sharpen their critical and creative thinking skills, as well as improve their reasoning in making decisions (Destiara, Handayani, & Setiawati, 2023).

The RME approach highlights the importance of active student involvement in the learning process. Students are encouraged to explore and discover mathematical concepts through activities that involve solving real-life problems. In RME, the teacher acts as a facilitator who helps students connect their experiences with the mathematical concepts being studied. Through this approach, students not only learn mathematics theoretically but also gain an understanding of how these concepts are applied in everyday life.(Widana, 2021).

One of the main principles of RME is the use of models and teaching aids that help students visualize mathematical concepts. For example, in learning the concept of fractions, students can use concrete objects such as pieces of bread or divided paper. The use of these models not only helps students gain a deeper understanding of concepts but also makes the learning process more engaging and interactive. Students become more motivated to learn and better understand the material being taught (Widana, 2021).

Research conducted by Rosyada, Sari, and Cahyaningtyas (2019) showed that the RME learning model has a positive effect on students' mathematical problem-solving abilities. They found that students taught using the RME approach demonstrated a significant improvement in their ability to solve mathematical problems compared to those taught using traditional methods. This is because the RME approach encourages students to think critically and creatively in solving problems (Rosyada, Sari, & Cahyaningtyas, 2019).

RME also helps students develop higher-order thinking skills. In RME, students are not only asked to memorize formulas or procedures but also to deeply understand concepts and apply them in various situations. Students are encouraged to reflect on their learning process, evaluate different strategies used, and select the most effective way to solve problems. This process helps students develop analytical and critical thinking skills, which are essential in mathematics learning and everyday life (Widana, 2021).

The RME approach also emphasizes collaboration and discussion among students. In RME, students often work in groups to solve problems together. Student discussions help them share understanding and strategies, as well as reinforce concepts that have been learned. Through this collaboration, students also learn to respect others' opinions and develop important social skills for their lives (Widana, 2021).

In the RME approach, teacher creativity becomes very important because this approach relies heavily on the use of real-life contexts and models relevant to students' experiences. Without creativity in designing learning activities, RME may not be effectively implemented. Teachers need to have the ability to identify situations that can be used as learning contexts and develop activities that help students connect mathematical concepts to those situations. As a result, students can more easily understand and apply the concepts they have learned (Widana, 2021).

Teachers also need to have good classroom management skills to effectively implement the RME method. Good classroom management includes the ability to manage time, organize student interactions, and create a conducive learning environment. In RME, students often work in groups and engage in discussions. Teachers must be able to manage classroom dynamics so that every student can participate actively and gain maximum benefit from learning. Effective classroom management also helps ensure that learning takes place in a structured manner and in accordance with the planned objectives (Chisara et al., 2019).

In addition to the challenges related to teacher readiness and creativity, the implementation of RME also requires support from various stakeholders, including schools and the government. Schools need to provide adequate facilities and resources to support the application of this method. For example, schools can provide teaching aids, learning materials, and training for teachers to improve their understanding of RME. Government support is also important, such as through policies that encourage the use of innovative teaching methods and allocate sufficient budgets for education (Elwijaya et al., 2021).

Teacher readiness and creativity in implementing the RME method not only influence students' understanding of mathematical concepts but also their learning motivation. Students who learn in a supportive environment with methods relevant to their experiences tend to be more motivated and engaged in learning. Conversely, if teachers lack creativity and the methods used are less relevant, students may feel bored and less motivated to learn (Widana, 2021).

Research by Widana (2021) shows that teacher readiness and creativity have a significant impact on student learning outcomes. Teachers who are well-prepared and creative are able to create a more engaging and enjoyable learning environment, thus motivating students to learn and understand mathematical concepts better. On the other hand, teachers who are less prepared and less creative may face difficulties in achieving the desired learning objectives. The challenges in mathematics learning lie not only in the methods used but also in the readiness and creativity of teachers in implementing these methods. Teacher readiness and creativity largely determine the success of mathematics learning, especially in approaches such as RME that require the use of real-life contexts and models relevant to students' experiences. These challenges can be overcome so that mathematics learning can be more effective and provide maximum benefits for students (Widana, 2021).

Research by Hasyanah et al. (2023) shows that the use of engaging learning media, such as RME-based comics, can increase student motivation and interest in learning. Such learning media not only make students more interested in learning but also help them better understand the material being taught. The use of innovative learning media can be one solution to improve the effectiveness of mathematics learning. The goal of mathematics learning is not only for students to solve routine problems but also for them to apply mathematical concepts in various real-life situations. Mathematics learning that is oriented towards problem-solving can help students become better prepared to face future challenges (Wulandari, Dantes, & Antara, 2020).

Effective mathematics education must also be able to maximize students' potential. Students with strong mathematical understanding will find it easier to study other scientific disciplines. Therefore, the RME approach and the development of student creativity become highly relevant. A contextual RME approach can make mathematics more comprehensible, while student creativity allows them to find innovative solutions to the problems they face. The combination of both can significantly enhance mathematical problem-solving abilities (Hasyanah et al., 2023).

RESEARCH METHODS

The researcher conducted this study using a quantitative approach with a Non-Equivalent Control Group Design. The population in this study consisted of students from class VIII C and VIII D at SMPN 4 Karanganom, Klaten Regency. The sample was selected using non-probability sampling (purposive sampling), meaning the sample was chosen based on certain considerations, and not every member of the population had an equal chance of being selected. In this study, the sample consisted of class VIII C students as the control group and class VIII D students as the experimental group. The experimental group received treatment in the form of material explanation using the RME learning method, while the control group did not receive such treatment.

The instruments used in this study were written tests in the form of essay tests for both the pre-test and post-test, as well as questionnaires to determine students' level of creativity. The essay test is a type of test used to measure learning progress, in which the test takers are asked to provide answers in the form of explanations. In this case, the essay test instrument was used to assess students' mathematical numeracy literacy skills. Furthermore, the scoring of this research instrument was carried out using a scoring guide. The researcher used an assessment rubric in which the scores were categorized as follows: score 1 (Poor), score 2 (Fair), score 4 (Good), and score 5 (Very Good).

RESULTS AND DISCUSSION

This study aims to determine the effect of the Realistic Mathematics Education (RME) learning model and students' creativity on the mathematical problem-solving ability of eighth-grade students at SMPN 4 Karanganom. The findings obtained reflect the research that has been carried out. The collected data were then analyzed to interpret the results. The following presents an explanation of the observations on students' creativity, the initial data, and the results of the students' pre-test.

The results of the observation on students' creativity levels were obtained through the calculation of creativity questionnaires administered to both the experimental and control classes during the learning process. The indicators measured in this study were as follows: 1) Knowledge is experienced, learned, and discovered by students, 2) Students engage in activities to understand the learning material (constructing understanding), 3) Students communicate their own ideas, and 4) Students think reflectively. Based on the explanation of the pre-test results in classes VIII C and VIII D, the total pre-test scores showed that class VIII C achieved an average score of 56.09, while class VIII D achieved an average score of 54.48. The average pre-test score of class VIII C was slightly higher than that of class VIII D. Therefore, class VIII D was designated as the experimental group, while class VIII C was designated as the control group. Furthermore, each class was also divided into two groups based on their creativity levels, namely high creativity and low creativity groups.

After being divided, in the experimental class, mathematics learning was carried out using the Realistic Mathematics Education (RME) model, which encouraged students to be more enthusiastic about learning through solving contextual problems collaboratively in group discussions, with the teacher acting as a facilitator. Meanwhile, in the control class, learning was conducted using conventional methods, where the teacher played a more dominant role in directing the learning process.

The mathematics material taught in this study was the system of linear equations in two variables (SPLDV), which was delivered to both the experimental and control groups. The study was conducted over three meetings. The first meeting began with the administration of the pre-test and the distribution of the creativity questionnaire in both the experimental and control classes, aimed at measuring students' initial abilities before treatment was given. After that, the session continued with the delivery of material on the basic concepts of SPLDV. In this session, the experimental class received instruction integrated with the Realistic Mathematics Education (RME) approach.

In the second meeting, students in the experimental class were taught how to solve a system of linear equations in two variables (SPLDV) using the substitution method, with the application of the Realistic Mathematics Education (RME) learning model, while the control class was taught using the conventional method without any treatment.

In the third meeting, students in the experimental class were taught how to solve SPLDV using the elimination method with the RME learning model, whereas the control class continued to be taught using the conventional method without treatment. At the end of the meeting, both the experimental and control classes took the post-test to measure the improvement in their understanding and ability to solve problems related to the system of linear equations in two variables (SPLDV).

The learning process in the experimental class was more active compared to the control class due to the application of the Realistic Mathematics Education (RME) learning model. This model not only made it easier for the researcher to deliver the material but also helped students better understand the lessons and feel more comfortable with the classroom atmosphere.

In the experimental class, the researcher taught the material on the elements of a system of linear equations in two variables (SPLDV). The delivery of the material was carried out in several stages: 1) Students were asked to understand the given problem, 2) Students were asked to solve the problem in their own way, 3) Students compared and discussed their answers in small groups, and 3) Students drew conclusions related to the problems that had been solved. Overall, the implementation of learning using the Realistic Mathematics Education (RME) model in the conducted sessions can be categorized as effective.

After the experimental class was taught using the RME model, both the experimental and control classes took the post-test. The results showed that students in the experimental group achieved an average post-test score of 70.25, while students in the control group obtained an average score of 67.42.

To examine the effect of using the Realistic Mathematics Education (RME) learning model and students' creativity on mathematical problem-solving ability, a two-way ANOVA test was applied. Before conducting the test, prerequisite analyses were carried out, namely the normality test and the homogeneity test of the data. The following presents the data on students' mathematical abilities obtained from validated test items.

TABLE 1. Students' Mathematical Ability Data

Learning Method	Score	Creativity (B)	
		High (B1)	Low (B2)
Non RME (VIII C)	Highest Score	90	80
	Lowest Score	50	40
	Average	67,2	56,7
RME (VIII D)	Highest Score	90	90
	Lowest Score	70	60
	Average	71,4	65,6

Before conducting further analysis, a normality test was carried out to ensure that the post-test data presented in Table 1 for both the experimental and control classes were normally distributed. The normality test was conducted to determine whether the data followed a normal distribution, as parametric statistical tests such as ANOVA require normally distributed data. Since the sample in this study consisted of 46 students, the normality test was performed using the Shapiro-Wilk test, which is appropriate for small to medium sample sizes ($n < 50$). The decision rule for this test is as follows: if the significance value (sig) in the Shapiro-Wilk column is less than 0.05, then the data are considered not normally distributed. Conversely, if the significance value (sig) is greater than 0.05, the data can be considered normally distributed.

TABLE 2. Normality Test Results (Shapiro-Wilk)

Test of Normality						
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Standardized Residual for problem solving ability	.129	32	.191	.969	32	.462

The results of the normality test showed that the pre-test and post-test data in both groups (experimental and control classes) were normally distributed, with a significance value greater than 0.05, namely 0.462 in the Shapiro-Wilk test. This indicates that the data did not show any significant deviation from a normal distribution. Thus, it can be concluded that the data obtained in this study were normally distributed and met the requirements for further analysis using parametric statistical tests.

After the data were confirmed to be normally distributed, the next step was to test the **homogeneity of variance** between groups. The homogeneity test aims to ensure that the variances between the experimental and control groups are not significantly different, which is an important requirement for conducting an analysis of variance (ANOVA). In this study, the homogeneity test was carried out using **Levene's Test**, as it is more robust against violations of the normality assumption compared to other homogeneity tests.

TABLE 3. Homogeneity Test Results (Levene's Test)

Levene's Test of Equality of Error Variances[a,b]

		Statistic	df1	df2	Sig.
Problem Solvig Ability	Based on Mean	.124	3	28	.945
	Based on Median	.127	3	28	.943
	Based on Median and with adjusted df	.127	3	25.918	.943
	Based on trimmed mean	.128	3	28	.943

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

The results of the homogeneity test showed that the significance value was greater than 0.05, which means that the variances between the experimental group and the control group were homogeneous. This indicates that there was no significant difference in variances between the two groups, thus fulfilling the assumption of homogeneity of variance and allowing the analysis to proceed with a two-way ANOVA test.

Since both groups of data were normally distributed and had homogeneous variances, a two-way ANOVA analysis was conducted to determine the significance of the differences in mean scores between the groups. This analysis aimed to examine the direct effects of two different factors, namely: (1) the effect of the RME learning model on students' mathematical problem-solving ability, (2) the effect of students' creativity on their mathematical problem-solving ability, and (3) the interaction effect between the learning model and students' creativity on mathematical problem-solving ability.

The ANOVA analysis was carried out at a significance level of $\alpha = 0.05$, and the results are presented in Table 4 below.

TABLE 4. Two-Way ANOVA Test Results

Tests of Between-Subjects Effects

Dependent Variable: Problem Solving Ability

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1284.375[a]	3	428.125	8.059	.001
Intercept	184528.125	1	184528.125	3473.471	.000
Learning Model	153.125	1	153.125	2.882	.001
Creativity	1128.125	1	1128.125	21.235	.000
Learning Model * Creativity	3.125	1	3.125	.059	.810
Error	1487.500	28	53.125		
Total	187300.000	32			
Corrected Total	2771.875	31			

a. R Squared = ,463 (Adjusted R Squared = ,406)

Two-Way ANOVA Test Results

Based on the results of the two-way ANOVA test at a significance level of α = 0.05, the following findings were obtained:

1. Effect of Learning Model
   The analysis showed that there was a significant effect of the learning model on mathematical problem-solving ability, with a significance value of 0.01 (sig < 0.05). This indicates that students who were taught using the Realistic Mathematics Education (RME) model had better mathematical problem-solving skills compared to students who received conventional instruction.
2. Effect of Student Creativity
   Student creativity also had a significant effect on mathematical problem-solving ability, with a significance value of 0.0001 (sig < 0.05). This suggests that students with higher levels of creativity tend to have stronger problem-solving skills than those with lower creativity.

3. Interaction between Learning Model and Student Creativity
   The analysis further revealed that the interaction between the learning model and student creativity did not have a significant effect on mathematical problem-solving ability, with a significance value of 0.810 (sig > 0.05). Thus, it can be concluded that although both the learning model and creativity individually influence problem-solving ability, their effects are independent and do not interact with each other.

CONCLUSIONS

Based on the results of the normality test, homogeneity test, and two-way ANOVA, it can be concluded that:

1. The Realistic Mathematics Education (RME) learning model has a significant effect on students' mathematical problem-solving ability, with students taught using this model demonstrating better performance compared to those taught through conventional learning methods;
2. Student creativity also has a significant influence on mathematical problem-solving ability, with students who have a high level of creativity showing better results;
3. There is no significant interaction between the learning model and student creativity in influencing mathematical problem-solving ability, which means that both factors operate independently.

This study provides an important contribution to the understanding of how learning models and student creativity can enhance mathematical problem-solving skills.

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