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Comparison of the Effectiveness of Realistic Mathematics Approach and Inquiry Approach in Improving Creative Thinking Ability and Problem-Solving Skills

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Abstract

This quantitative research examines the effectiveness of Realistic Mathematical Education (RME) and Inquiry-Based Learning approaches in enhancing students' creative thinking and problem-solving abilities. A Two two-group pretest-posttest design was used, involving 22 students in the RME group and 20 students in the Inquiry group. Data collection involved questionnaires and written tests. Descriptive analysis and independent sample t-tests were applied to analyse the data. The independent sample t-test for the questionnaire revealed a significant difference between the groups, indicating a higher score for the RME group. The findings indicate that RME is more effective in improving both creative thinking and problem-solving skills, showing smaller variations and better consistency, suggesting that RME may be a more suitable approach for teaching mathematics.

Keywords: Realistic Mathematics Education, Inquiry, creative thinking, problem-solving skills.

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INTRODUCTION

Learning that makes real situations the starting point of learning is the hallmark of the Realistic Mathematics Education (RME) approach. RME is a unique teaching theory for the domain of mathematics. The uniqueness of this approach is that it gives rich and "realistic" situations a prominent position in learning activities (Juandi et al., 2022). The Inquiry Approach is one way to invite students to learn directly by linking learning material with direct events that students have experienced (Hariandi & Cahyani, 2018).

Mathematics learning in schools needs to emphasise the development of students' creative thinking skills, which is one of the characteristics of higher-level thinking. Creative thinking skills are also called creativity, which can ensure the growth of mathematics as a whole (Puspitasari et al., 2018). Problem-solving is a common goal of teaching mathematics, even as the heart of mathematics; problem-solving includes methods, procedures, and strategies, is a core and main process in the mathematics curriculum, and problem-solving is a basic ability in learning mathematics (Thayer. Students ' creative thinking skills and mathematical problem-solving skills can be improved through the presentation of open-ended learning problems. The purpose of giving open-ended problems is to encourage students' creativity and mathematical thinking in problem-solving simultaneously (Tanjung, 2018).

Yuanita et al.(2018) identified the role of mathematical representation as a mediator between mathematical beliefs and problem-solving. They found that the Realistic Mathematics Education (RME) approach successfully improved students' arithmetic problem-solving ability. Ulandari et al.(2019) have conducted trials in class VII junior high school to analyse the effectiveness of learning tools based on a realistic mathematics education approach, as well as improving students' mathematical problem-solving ability and self-efficacy. Based on this analysis, it is recommended that mathematics teachers strive to learn mathematics by using learning tools based on the realistic mathematics education approach. Yayuk et al. (2020) analysed students' creative thinking skills in answering problem-solving questions. The analysis indicates that low-ability students have not shown creative thinking skills in terms of fluency, flexibility, and novelty. Nasution et al. (2022) describe the validity, practicality, and effectiveness of the realistic mathematics-based learning tools developed to improve students' mathematical problem-solving skills and find that the developed realistic mathematics-based learning model is effective.

Laurens et al. (2018) investigated the differences in students' cognitive math achievement after applying RME and conventional learning. They showed that it is important for teachers to empower students' intellectual abilities through RME and games in order to produce meaningful and contextualised learning. Handayani et al. (2018) explained that inquiry-based learning can be used to develop students' mathematical thinking habits. The conclusion is that the mathematical thinking habits instrument is valid and can be used to measure students' mathematical thinking habits. (2019) Improving students' creative thinking skills through a chemo-entrepreneurship-oriented inquiry module (COIM) shows that COIM is effective in improving students' creative thinking skills. Layyina et al. (2021) conducted a study to determine the effectiveness of the inquiry learning model in training junior high school students' creative thinking skills on biotechnology material. They showed an increase in pretest to posttest creative thinking skills test scores on each indicator and was effective. Undari et al. (2023) explained the effectiveness of using student worksheets with a problem-solving approach to students' critical thinking skills in the mathematics subject of building space material. They showed that the average value of students on the pretest was 60.50, and on the posttest, it was 78.85. This shows that there is a change in the average value at the time of the pretest and posttest.

Yetim Karaca & Ozkaya (2017) conducted a comparison between two classes to analyse the effect of realistic mathematics education on students' self-reports in the 'numbers and operations' unit of grade 5 mathematics, and it was found that the self-reports of students taught according to Realistic Mathematics Education were higher than those of students taught using classical methods. Budiman & Syayyidah (2018) examined the improvement of students' mathematical creative thinking skills using the Model Eliciting Activities (MEAs) approach and showed that the improvement of students' mathematical creative thinking skills using the Model Eliciting Activities (MEAs) approach was better than students using the scientific approach. Djaelani (2019) analysed the effect of the scientific learning approach on students' critical thinking and mathematical problem-solving skills, and there was a significant effect of the scientific learning approach on critical thinking and mathematical problem-solving skills. Research conducted (Wahidin & Sugiman, 2014) showed that the Indonesian Realistic Mathematics Education (PMRI) approach produced better mathematics learning outcomes than the conventional method. Students taught with PMRI showed an increase in achievement motivation, problem-solving ability, and overall learning achievement.

This research focuses on comparing the effectiveness of the realistic mathematics approach and inquiry approach in improving creative thinking ability and problem-

solving skills, and this research offers significant novelty compared to previous research. However, the Realistic Mathematics Approach (RME) and inquiry have been explored separately, both in the context of developing problem-solving skills and in the context of creative thinking skills. Research by Nugraheni & Marsigit (2021) explained that the realistic mathematics teaching materials developed were feasible and effective for improving problem-solving skills, and Prahani et al. (2016) also found learning with the guided inquiry model effective for improving students' problem-solving skills based on multiple representations in high school. Moreover, in the context of creative thinking skills, research conducted by Ismunandar et al. (2020) found that the realistic mathematics learning approach is practical enough to improve students' creative thinking skills as well as Suardana et al. (2019) also explained that the guided inquiry learning model is more effective than the direct learning model in improving students' creative thinking skills. However, there have not been many studies that compare the two approaches directly in improving both skills. This research focuses on comparing the effectiveness of RME and inquiry in the same context, with the main objective of improving creative thinking and problem-solving skills in mathematics learning at the junior high school level.

In addition, this study contributes to the development of an understanding of how the interaction between student characteristics and these two approaches can affect the achievement of relevant cognitive skills. The main objective of this study is to analyse and compare the effectiveness of the Realistic Mathematics approach and inquiry approach in improving students' creative thinking ability and problem-solving skills in mathematics subject at the junior high school level. Thus, this research is expected to provide new insights regarding more effective learning models for mathematics learning in secondary schools, which have not been widely discussed in the previous literature.

METHODS

This research is quantitative research with an experimental design. Experimental research is a study that seeks to find whether there is significant effectiveness between the use of realistic mathematics education approaches and inquiry approaches with students' creative thinking abilities and problem-solving skills. The way that can be done to discuss the problems at hand and test the truth of the hypothesis proposed using the experimental method is the two-group pretest-posttest design, which carries out research in two classes.

The first thing to prepare is the research subject. So, the subjects in this study were junior high school students in grade VIII. This research design uses two classes that are treated differently. Where 1 class uses a realistic mathematics approach, and the other class applies an inquiry approach.

The research instruments used to collect data were a questionnaire using a realistic mathematics approach and an inquiry approach, creative thinking ability test questions, and students' problem-solving skills. The questions used in the test were in the form of a written test of 5 description questions. The reason for using written test questions is to measure students' creative thinking and problem-solving skills. For some indicators of the realistic mathematics approach, indicators of the inquiry approach, indicators of creative thinking ability, and indicators of students' problem-solving skills, where each variable indicator is in Table 1.

Table 1. Indicators of Each Variable

Variable	Indicators
1. Realistic Math Approach	1. Understanding contextual problems: The teacher gives a contextual problem (problem), and students are asked to understand the problem. 2. Solving contextual problems Students are individually told to solve contextual problems in the student book in their way. 3. Comparing and discussing answers Students are asked to compare and discuss their answers in small groups. 4. Drawing conclusions Based on the results of group discussions and class discussions, the teacher directs students to conclude.
2. Inquiry Approach	1. Asking questions Encourage students to ask questions that are relevant to the topic being studied. 2. Conjecturing Students are asked to propose hypotheses or conjectures based on their prior knowledge or information. 3. Data collection Students carry out activities to collect information or data relevant to the questions and conjectures they have made. 4. Inference Based on the data collected, students conclude whether the conjecture is true or false.
3. Creative Thinking Ability	1. Fluent thinking Able to generate many ideas or solutions in a short period. 2. Flexible thinking See a problem from multiple perspectives and not be tied down to one way. 3. Original thinking Generate ideas that are new, unique, and different from the norm. 4. Detailed thinking Develop ideas in depth with attention to every aspect or detail.
4. Problem Solving Skills	1. Ability to understand the problem Identify and understand the core of the problem at hand. 2. Ability to plan a solution Formulate appropriate steps to solve the problem. 3. Ability to implement the plan Implement the planned steps effectively. 4. Ability to check back Check and assess the results achieved

The questionnaire used in this study is a closed questionnaire that has available answers so that respondents directly choose the answer choices available. The questionnaire test

uses a Likert scale with four answer options, namely strongly disagree (SD), disagree (D), neutral (N), agree (A), and strongly agree (SA).
The data analysis process uses the SPSS version 25 application and uses two statistical tests, namely the descriptive statistical test and the independent sample t-test. Here is the formula for independent sample t.

$$t = \frac{M_1 - M_2}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}} \quad (1)$$

In this study, M_1 refers to the average value obtained from the Realistic Mathematics approach (RME), M_2 describes the average value obtained from the inquiry approach, S_1^2 and twoS_2^2 each describes the variance of the RME approach and the inquiry approach, n_1 and n_2 indicate the number of samples used in each approach. The last step is to conclude whether there is an influence of the realistic mathematics approach (x_1) and the Inquiry Approach (x_2) on creative thinking skills (y_1) and problem-solving skills (y_2). H1: If the significance value < 0.05, then there is an influence of the independent variable (X) on the dependent variable (Y) or the hypothesis in acceptance. Ho: If the significance value > 0.05, then there is no effect of the independent variable (X) on the dependent variable (Y), or the hypothesis is rejected.

RESULTS & DISCUSSION

Description of Questionnaire Analysis of Realistic Mathematics Approach and Inquiry Approach

The questionnaire of the realistic mathematics approach (X1) consisted of 22 samples with a minimum value of 29, a maximum of 47, an average of 36.55, and a standard deviation of 4.92. Meanwhile, the inquiry approach questionnaire (X2) consisted of 20 samples with a minimum value of 28, a maximum of 49, an average of 36.30, and a standard deviation of 4.61. Although the averages are almost identical at around 36, X1 shows slightly greater variation than X2, which is evident from the higher standard deviation. Overall, the distribution of the two groups' scores is relatively similar, with X1 being slightly more variable than X2.
To determine the comparison between the two, an independent sample t-test was conducted, the results of which showed a significant difference between the X1 questionnaire scores in the RME and inquiry groups. The RME group had a higher average (Mean = 36.55) than the inquiry group (Mean = 36.30), with an average difference of 2.97. The t-test produced a value of t = 2.053 and p-value = 0.047, which is smaller than 0.05, indicating a significant difference. Therefore, it can be concluded that the RME group has a higher questionnaire score than the Inquiry group on variable X1.

Description of Creative Thinking Ability Test Results

In this section, we will describe the creative thinking test results of students from both classes, namely classes that use a realistic mathematics approach and an inquiry approach. At the pretest, the RME class had an average of 2.136 with moderate variation, while the inquiry class was slightly higher at 2.45, with a similar variation. After the posttest, the RME class experienced a significant increase with an average of 8.863 and a smaller variation, while the Inquiry Class recorded an average of 7.70 with a larger

variation. Overall, the RME Class showed higher posttest results and smaller variations than the Inquiry Class. A more complete description is in Table 2.

Table 2. Creative Thinking Pretest and Posttest Results

Data	N	Maximum Nilai	Minimum Nilai	Mean	Std. Deviasi	Description
Class. RME	22	3.50	1.00	2.136	0.675	Pretest
Class. Inquiry	20	3.50	1.00	2.45	0.646	
Class. RME	22	10.00	7.00	8.863	0.861	Posttest
Class Inquiry	20	10.00	5.00	7.70	1.454	

The t-test will be used for data analysis. However, the normality test was conducted first as a condition of data analysis. The calculation of the normality test of the pretest and posttest results of creative thinking skills can be seen in Table 3.

Table 3. Normality Test of Creative Thinking Test

Class	Test	Test Statistics	p-Value	Description
Class. RME	Pretes	0.943	0.27	Normal
	Posttest	0.923	0.11	Normal
Class. Inquiry	Pretes	0.931	0.16	Normal
	Posttest	0.951	0.38	Normal

Table 3 shows that the p-value is greater than 0.05 for all pretest and posttest data in the RME class and inquiry class. The p-values for the RME class are 0.27 and 0.11, while for the inquiry class, they are 0.16 and 0.38. Therefore, it can be concluded that the data in both classes follow a normal distribution. After knowing that the data is normally distributed, a paired sample t-test will be conducted to compare the averages of two groups of data to see if there is a significant difference before and after the approach or treatment. The calculation of the paired sample t-test data on the pretest and posttest results of creative thinking skills is in Table 4.

Table 4. Paired Sample T-Test Results

Class	Variable	Mean Difference	t	Sig. (p)	Conclusion
Class. RME	Pre VS Pos	-6.72	-48.56	0.00	Significant
Class. Inquiry	Pre VS Pos	-5.25	-15.38	0.00	Significant

The test results in Table 4 show a significant difference between the pretest and posttest in the RME Class, with a mean difference of -6.72 (p-value 0.00), and in the Inquiry Class, with a mean difference of -5.25 (p-value 0.00). Both classes experienced significant changes, where the RME class showed a greater average decrease than the inquiry class.

Description of Problem-Solving Skills Test Results

In this section, we will describe the test results of problem-solving skills in two classes, namely, classes with a realistic mathematics approach and classes with an inquiry approach. In the pretest, the RME class had an average of 2.022 with moderate variation,

while the Inquiry Class was slightly higher at 2.190 with greater variation. After the posttest, the RME class showed an average of 8.918 with a smaller variation, while the Inquiry Class recorded an average of 7.950 with a larger variation. Overall, the RME class experienced greater improvement and lower variation than the Inquiry class. For more complete data, see Table 5.

Table 5. Problem-Solving Pretest and Posttest Results

Data	N	Maximum Nilai	Minimum Nilai	Mean	Std. Deviasi	Conclusion
Class. RME	22	3.00	1.00	2.022	0.605	Pretest Posttest
Class. Inquiry	20	3.60	1.30	2.190	0.688	
Class. RME	22	10.00	7.00	8.918	0.824	
Class Inquiry	20	10.00	5.00	7.950	1.546	

The t-test will be carried out to analyse the data, but before doing so, it is necessary to test the requirements for the analysis, namely using the normality test. The results of the normality test are shown in Table 6.

Table 6. Normality Test Results Problem-solving

Class	Test	Statistik Uji	p-Value	Description
Class. RME	Pretes	0.924	0.11	Normal
	Posttest	0.919	0.09	Normal
Class. Inquiry	Pretes	0.926	0.12	Normal
	Posttest	0.935	0.19	Normal

The test results in Table 6 show that the pretest and posttest data in the RME class and the inquiry class are normally distributed because all p-values are greater than 0.05. For the RME class, the pretest p-value was 0.11, and the posttest was 0.09, while for the inquiry class, the pretest p-value was 0.12 and the posttest 0.19. Thus, it can be concluded that the data in both classes follow a normal distribution before and after treatment.

After knowing that the data is normally distributed, a paired sample t-test will be conducted to compare the averages of two groups of data to see if there is a significant difference before and after the approach or treatment. Calculate the paired sample t-test test data on the pretest and posttest results of creative thinking skills according to Table 7.

Table 7. Results of Paired Sample T-Test for Problem Solving

Class	Variable	Mean Difference	t	Sig. (p)	Conclusion
Class. RME	Pre VS Pos	-6.89	-41.47	0.00	Significant
Class. Inquiry	Pre VS Pos	-5.76	-20.17	0.00	Significant

The test results in Table 7 show a significant difference between the pretest and posttest in the RME class with a mean difference of -6.89 (t -41.47, p-value 0.00) and in the inquiry class with a mean difference of -5.76 (t -20.17, p-value 0.00). Both classes showed significant changes between the pretest and posttest, with the RME class experiencing a larger average decrease than the Inquiry Class.

Comparison of the Effectiveness of Realistic Mathematics Approaches and Inquiry on Posttest Results of Creative Thinking and Problem Solving Skills.

The analysis used to determine the comparison of the effectiveness of the two approaches to creative thinking and problem-solving skills is an independent t-test analysis. Where previously, the normality test had been carried out on the posttest data of creative thinking ability and problem-solving skills from each approach. Furthermore, the independent t-test will be conducted directly to analyse and compare the effectiveness of the two approaches to variables Y1 (Creative Thinking) and Y2 (Problem Solving). The calculation of the independent t-test test of the post-test data of creative thinking skills between the realistic mathematics approach and inquiry is based on Table 8.

Table 8. Independent T-Test Results

Variable	Group	N	Mean	Std. Deviasi	Std. Error Mean
Creative Thinking (Y1)	RME	22	8.863	0.861	0.183
	Inquiry	20	7.700	1.454	0.325
Problem Solving (Y2)	RME	22	8.918	0.824	0.175
	Inquiry	20	7.950	1.546	0.345

Based on the data in Table 8, the RME group obtained higher results on both variables, namely Creative Thinking (Y1) and Problem Solving (Y2). The averages for RME were 8.863 for creative thinking and 8.918 for problem-solving, respectively, with lower variation compared to the Inquiry group, which had averages of 7.700 and 7.950 on the same variables. The lower variation in RME indicates better consistency, while Inquiry shows greater variation. Overall, RME proved to be more effective in improving creative thinking and problem-solving than Inquiry.

Discussion

This study revealed that the Realistic Mathematics (RME) approach was more successful in improving students' creative thinking and problem-solving skills compared to the Inquiry approach. These results are in line with the findings from various previous studies that also highlighted the effectiveness of RME. For example, research by Salafudin et al. (2021) found that students' responses to the RME approach increased by 75%, and students' activities in the learning process by applying the Realistic Mathematics Education (PMR) approach were classified as good. (2018) said that the application of the Mandailing culture-based realistic mathematics learning model is effective in teaching students mathematical problem-solving skills. Research (2019) added that RME can improve students' creative thinking and problem-solving skills than students who use ordinary learning. Similar findings were also found by (2019), which states that RME is effective in improving students' creative thinking skills.

On the other hand, many studies support the effectiveness of the Inquiry approach, such as those conducted by Widia et al. (2021), which showed that guided inquiry learning tools are effective in improving students' activities and creative thinking skills. This study found that the variation of results in the Inquiry group was greater, indicating that although Inquiry can improve learning outcomes, its impact is more dependent on the active participation and understanding of individual students. Similar

findings were also found by (2020), who concluded that the learning process using the ISC learning model is very effective in improving students' critical and creative thinking skills. Research by Karamustafaoğlu & Pektaş (2023) showed that inquiry-based STEM activities planned in an out-of-school learning environment improved students' creative problem-solving skills and STEM awareness.

Although the Inquiry approach proved effective in developing critical thinking skills, the RME approach provided more stable and significant results in improving students' creativity and problem-solving skills. Thus, although both approaches have their respective advantages, RME proved superior in improving students' creative thinking and problem-solving skills in this study.

CONCLUSION

The Realistic Mathematics Approach (RME) proved to be more effective than the Inquiry approach in improving students' creative thinking and problem-solving skills. Although the two groups' questionnaire results were similar, the RME group showed higher scores and smaller variations, indicating a better level of consistency. The creative thinking and problem-solving test results also showed a more significant improvement in the RME group, with a clear average difference. These findings support the use of RME in mathematics learning and are expected to contribute to the development of more efficient teaching strategies. However, further research is needed to explore other factors that may affect the effectiveness of both approaches.

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