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The Influence of the Multi Representation Discourse (DMR) Cooperative Learning Model on Students' Mathematical Problem-Solving Ability

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ABSTRACT

This research is motivated by the low mathematical problem-solving ability of students, teacher-centered learning, and the use of ineffective learning models in class VIII of junior high school. This study aims to determine the effect of the Discourse Multi Representation (DMR) learning model on students' mathematical problem-solving ability. This study is a pre-experimental study with the Static Group Comparison Design research design. The research population was all students of class VIII, with randomly selected samples, namely class VIII.1 as the experimental class and VIII.3 as the control class. The research instrument used was a descriptive test of mathematical problem-solving ability. Data were analyzed using the t-test after first fulfilling the requirements for normality and homogeneity tests. The results of the hypothesis test at the significance level (significance = 0.05) showed that (t count = 2.770 > t table = 1.671) and p-value (= 0.004 < 0.05) were obtained, so that (H0) was rejected and (H1) was accepted. Thus, it can be concluded that the Discourse Multi-Representation (DMR) learning model has a significant effect on students' mathematical problem-solving abilities. Substantively, the results of this study indicate that the application of the DMR model can help students understand mathematical problems better through group discussion activities and the use of various forms of mathematical representation, such as verbal, symbolic, and visual. In addition, the DMR model also encourages students to be more active in expressing ideas, discussing, and finding problem-solving strategies together, so that students' abilities in solving mathematical problems are more developed compared to conventional learning.

Keywords: Mathematical Problem Solving; Multi-Representation Discourse Learning Model (DMR); Influence.

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1. INTRODUCTION

Mathematical problem-solving skills are crucial for students; they help them face and resolve various issues they encounter both in learning and in everyday life. The importance of mathematical problem-solving is also emphasized by the National Center for Teaching Mathematics (NCTM), which states that "problem solving is an integral part of mathematics learning, and therefore cannot be separated from mathematics learning" (Khasanah, 2016). Furthermore, problem-solving skills are one of the goals of mathematics learning. Mathematical problem-solving skills are needed so that students can think systematically, logically, and critically in solving life's problems (Jelita et al., 2024). Therefore, students skilled at solving

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mathematical problems are expected to become productive and hardworking individuals. In fact, according to developed countries like the United States and Japan, problem-solving activities can be considered a core activity of mathematics learning in schools (Rahmat & Firmanti, 2017).

The problems here are not only problems in mathematics learning but also problems in daily activities (Rahmat, 2019). This means that problem-solving skills help students use mathematical concepts to solve real-world problems, such as calculating expenses and spending money, managing time, determining distance and travel time, reading data or graphs, and making informed decisions based on available information. Thus, mathematics learning focuses not only on calculation skills but also on training students to think logically, critically, and systematically when facing real-life situations.

According to Polya, problem-solving is an attempt to find a way out of a difficulty and achieve a goal that cannot be achieved immediately. In other words, problem-solving is the process of overcoming a challenging problem or question that cannot be solved with routine procedures that are already known (Rusdi, et al., 2019). Therefore, problem-solving skills are a focus of mathematics learning at all levels of education, from elementary school to college. By studying problem-solving in mathematics, students will develop ways of thinking, habits of perseverance, curiosity, and self-confidence in unusual situations similar to those they will encounter outside the mathematics classroom (Imamuddin, et al., 2019). If students are accustomed to solving mathematical problems, they are expected to be able to think logically when facing real-world problems.

Based on observations conducted by researchers in class VIII of SMP N 1 Rao Selatan on July 23–30, 2025, it was found that the learning process was still dominated by teacher explanations regarding the material and problem-solving steps, followed by the provision of practice questions from the textbook. When students were working on the exercises, only a small number of students were able to solve the problems independently, while some older students still had difficulty in understanding the steps to solve the problems. This situation resulted in low student involvement in the learning process. This was evident from the class conditions where only a few students were actively working on the exercises, while other students tended to rely on friends. Some students seemed to be discussing with their deskmates to get answers, some only passed on their friends' work, some chose to move to find answers from other students, and others were just silent without trying to solve the problems given. This condition indicated that students' mathematical problem-solving abilities were still low and student activity in the learning process had not developed optimally.

In addition, researchers also conducted interviews with eighth-grade mathematics teachers at SMP N 1 Rao Selatan on July 24, 2025. The interviews revealed that many students still experience difficulty in solving problem-solving questions. Students tend to focus on the final result without understanding the correct steps for solving. They also struggle to understand the problem, determine a solution strategy, and double-check their answers. This indicates that students' mathematical problem-solving abilities are still relatively low.

To support these findings, researchers analyzed students' answers to a math quiz that included indicators of problem-solving abilities.

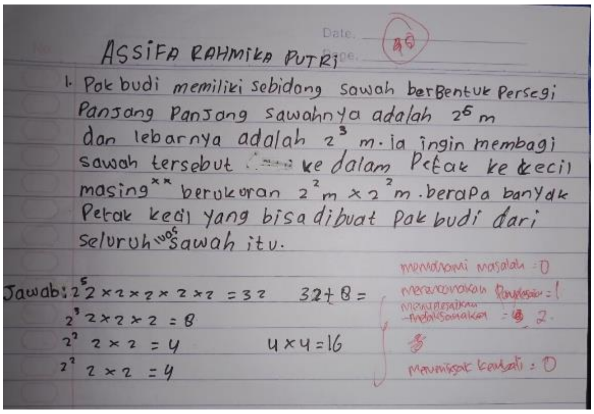

Figure 1. Student Answer Sheets for the First Quiz

Based on the student's answer image, it appears that the student was able to read the information in the problem well. The student wrote down the known data, namely the length of the rice field is 25 m, the width is 23 m, and the dimensions of each small plot are 22 m x 22 m. This indicates that the student did not make any errors in the reading stage.

However, in the comprehension stage, the student did not fully understand the question's intent. The student did not clearly state the actual question, namely, how many small plots can be created from the total area of the rice field. In the transformation stage, the student also failed to create an appropriate mathematical model to determine the number of plots. The student should have first found the total area of the rice field, then divided it by the area of one small plot. The main error was seen in the process skills stage. The student performed an incorrect calculation procedure by directly calculating: $2^5 = 32$, $2^3 = 8$, $2^2 \times 2^2 = 4 \times 4 = 1$ and then writing: $32 + 8 = 40$ or other steps that did not align with the concepts of area and plot division. In fact, it should be: *Area of Rice Field* $= 2^5 \times 2^3 = 2^8 = 256$, and: *Area of one plot* $= 2^2 \times 2^2 = 2^4 = 16$, thus: $256 : 16 = 16$.

The calculation error occurred because the student did not yet understand that solving the problem requires using the concepts of area and division, not simply adding the exponents. During the encoding stage, the student also failed to write a complete and clear conclusion according to the question. Thus, the student's answer indicates that their ability to understand mathematical problem-solving procedures still needs improvement, especially in determining the correct mathematical model and calculation steps.

This problem needs to be addressed through the use of learning models that actively engage students in the learning process. Educators as one of the main components in learning are expected to be able to choose appropriate learning strategies and models so that students have the opportunity to understand problems, find solutions, and develop mathematical problem-solving skills optimally.

According to Nurfaisah et al. (2021), students' low mathematical problem-solving abilities are influenced by the learning models implemented by teachers that do not align with the characteristics of mathematics learning, which requires students to actively think, analyze, and find solutions independently. Therefore, a learning model is needed that can actively engage students in understanding concepts and train them to solve mathematical problems systematically. One learning model that can be used is the Discourse Multi-Representation (DMR) learning model. The DMR learning model is a cooperative learning model that emphasizes the use of various forms of mathematical representation, such as verbal, symbolic, visual, and pictorial representations, in the process of understanding and solving mathematical problems. According to Anjani & Izzati (2023), the DMR learning model was developed to improve students' mathematical problem-solving abilities through heterogeneous group discussions that enable students to understand each other's ideas, explain solution strategies, and build conceptual understanding together.

In its implementation in mathematics learning, the DMR model places students at the center of learning through discussion activities, problem exploration, and the use of various representations in solving problems. Learning begins with presenting a contextual problem, then students work in groups to discuss various solution strategies using different representations. Afterward, students discuss the results of their discussions and provide feedback on other groups' solutions. This process can help students understand mathematical concepts more deeply because they are not limited to one form of solution but also learn to connect various mathematical representations in solving problems. Furthermore, the DMR model can also improve students' learning activities, mathematical communication skills, and critical thinking skills because students are trained to express ideas and defend their arguments in group discussions.

Several previous studies have shown that the Discourse-Multiple Representation (DMR) learning model has a positive impact on mathematics learning. Research conducted by Anjani & Izzati (2023) demonstrated that the application of the DMR model can improve students' mathematical problem-solving abilities compared to conventional learning. Other studies have also shown that the DMR model effectively improves students' mathematical representation skills and learning engagement because students are more active in constructing knowledge through discussions and the use of various mathematical representations. However, most previous studies have focused on specific levels and materials, with a greater emphasis on representation skills or mathematics learning outcomes. Furthermore, research on the effect of the DMR learning model on students' mathematical problem-solving abilities in mathematics at the junior high school level, particularly in grade VIII of SMP N 1 Rao Selatan, is still very limited.

Several relevant studies related to the application of the Discourse-Multiple Representation (DMR) learning model to mathematical problem-solving abilities have been conducted previously. Research conducted by Rostika & Junita (2017) showed that the DMR model can improve elementary school students' problem-solving abilities in mathematics learning. The study explains that DMR learning helps students become more active in developing mathematical representations when solving problems. Another study conducted by Marni (2023) also showed that implementing the DMR learning model can improve students' mathematical problem-solving skills and improve student learning outcomes. Through this model, students become more active in discussions and are able to understand problem solving through various representations.

Furthermore, research by Safitri et al. (2025) found that the Multi-Representation Discourse (DMR) model was effective in improving students' mathematical problem-solving abilities and self-confidence. This study, using a quasi-experimental design, demonstrated a significant improvement in students' ability to understand problems, plan strategies, and solve them after implementing the DMR model. Furthermore, research conducted by Nurhidayati & Mahpudin (2023) through a Systematic Literature Review (SLR) concluded that the DMR learning model had a positive impact on students' mathematical problem-solving abilities. The results showed that most research related to DMR stated that this model was more effective than conventional learning models in improving students' mathematical problem-solving abilities.

Based on these conditions, a research gap exists: the limited number of studies specifically examining the effect of the Multi-Representation Discourse (DMR) learning model on junior high school students' mathematical problem-solving abilities in the eighth grade. Furthermore, prior research has not yet addressed the application of the DMR model to real-world mathematics learning situations in schools, which indicates students' low ability to understand the steps involved in solving mathematical problems. Therefore, this research is important to be conducted to find out whether the Multi Representation Discourse (DMR) learning model can influence the mathematical problem-solving abilities of class VIII students of SMP N 1 Rao Selatan.

2. METHODS

This study employed an experimental research design using the Static Group Comparison Design (GCD). This design consisted of two groups: an experimental class treated using the DMR learning model and a control class treated using conventional learning. After the treatment, both groups were given a post-test to determine differences in students' mathematical problem-solving abilities. The study population comprised all 115 eighth-grade students at SMP Negeri 1 Rao Selatan, divided into four classes. Two classes were sampled using simple random sampling, designated as the experimental and control classes. Prior to sampling, prerequisite tests were conducted on the population, including normality, homogeneity, and equality of means. These tests indicated that the initial population data were normally distributed, homogeneous, and had similar means.

The research instrument, a mathematical problem-solving ability test in the form of essay questions, had been tested for validity, reliability, difficulty level, and discriminatory power. The instrument test results indicated that the questions used were valid, reliable, had a moderate level of difficulty, and had good discriminatory power. The instrument used in this study was a mathematical problem-solving ability test in the form of descriptive questions. The test instrument was structured based on indicators of mathematical problem-solving ability, which include understanding the problem, planning a solution, implementing the solution, and reviewing answers. Five descriptive questions were used, tailored to the learning material and research objectives. Before being used in the sample class, the instrument was first piloted in a class with similar characteristics to the research class. The pilot test was conducted to determine the quality of the instrument, including validity, reliability, difficulty level, and item discrimination. The pilot class was selected because it had relatively similar abilities to the sample class, in terms of normality, homogeneity, and average student ability.

Validity testing was conducted using the Product Moment correlation. Based on the analysis, all items had validity coefficients ranging from 0.724 to 0.765, which is considered high. This indicates that all items were able to measure mathematical problem-solving ability in accordance with the research objectives and are therefore considered valid and suitable for use. Reliability testing was conducted to determine the level of consistency of the test instrument. The calculation results showed a reliability value of 1.23, which is greater than the value r_{table} = 0.374, thus the instrument is considered highly reliable. Therefore, the instrument has a good level of consistency in measuring student ability.

Furthermore, the difficulty level analysis showed that all items fell into the moderate category, with a difficulty index ranging from 0.66 to 0.69. This means the questions were neither too easy nor too difficult for students. The discriminatory power analysis showed that the questions had good to excellent discriminatory power, with values ranging from 0.36 to 0.44, enabling the questions to differentiate between high-ability and low-ability students. Based on the analysis of validity, reliability, difficulty level, and discriminatory power, all items were deemed suitable for use as a research instrument to measure students' mathematical problem-solving abilities.Data collection was conducted through a posttest on both classes after the treatment was administered. The data obtained were then analyzed using statistical tests, namely the normality test, the homogeneity test, and the hypothesis test using the t-test. The t-test used was the Independent Sample T-Test.

3. RESULT AND DISCUSSION

Data on students' problem-solving abilities were collected using a final test instrument. The test was administered to both sample classes. The test consisted of five essay questions, and students were given 90 minutes to complete them. After the final test, data on mathematical problem-solving abilities for the topic of Relations and Functions were obtained. The test was administered to students in grade VIII.1 as the experimental class using the Discourse Multi-Representation (DMR) model and students in grade VIII.3 as the control class using conventional learning. The final test scores for the experimental and control classes can be found in the appendix.

This final test was attended by 58 students: 29 in the experimental class and 29 in the control class. The final test results were calculated to obtain the mean for both sample classes, which are presented in the problem-solving ability test data calculation table.

Table 2. Problem-Solving Ability Data Calculation Results

Class	Mean	N
Experiment	72,21	29
Control	54,89	29

Based on the table above, it can be seen that there is a difference in the average scores between the experimental and control classes. The average obtained by the experimental class is 72.21. Meanwhile, the control class has an average of 54.89. So, the average in the experimental class is higher than the control class. To draw conclusions from the data obtained from the students' mathematical problem-solving ability test, statistical data analysis was carried out. In the statistical analysis, normality and homogeneity tests were first carried out on both samples. After the samples were normally distributed and had homogeneous variance, the final stage was hypothesis testing.

3.1 Normality Test

The normality test aims to determine whether the sample data is normally distributed. The normality test was performed using the Liliefors test using Microsoft Excel. Data are considered normally distributed if $L_0 < L_{table}$ and the P_{value} is greater than 0.05. The normality test for the sample data can be seen in the following table:

Table 3. Results of the Normality Test for the Sample Class

Class	N	L_0	L_{table}	Information
Experiment	29	0,100291	0,163	Normally distributed data
Control	29	0,135984	0,163	Normally distributed data

Based on the results of the data normality test for both research classes, the experimental class had a value of L0 = 0.100291, while the value of L_{table} = 0.163 at the significance level α= 0.05 with a sample size of 29 students. Because the value of L0 < L_{table}, the data in the experimental class was declared normally distributed. In the control class, the value of L0= 0.135984 and the value of L_{table} = 0.163 were obtained. Because the value of L0 < L_{table}, the data in the control class was also declared normally distributed. Thus, it can be concluded that the research data from both classes, both the experimental and control classes, met the assumption of normality. This indicates that the data distribution in both classes follows a normal distribution, so parametric statistical analysis can be used in the next stage of hypothesis testing.

3.2 Homogeneity Test

Table 3. Results of the Homogeneity Test for the Sample Class

Class	N	F_{count}	F_{table}	Information
Experiment & Control	58	1.5	1.90	Homogeneity

Based on the results of the homogeneity of variance test for the experimental and control classes, a total sample size of 58 students was obtained. The calculation results showed that the calculated F_{count} was 1.5, while the F_{table} value was 1.90 at a significance level of α=0.05. Since the calculated $F_{count} \leq F_{table}$, it can be concluded that the data variances of the two classes are homogeneous. These results indicate that the data in the experimental and control classes have relatively similar levels of diversity. Thus, both groups meet the assumption of homogeneity and are suitable for use in further analysis, particularly in hypothesis testing using parametric statistics.

3.3 Hypothesis Test

The hypothesis test aims to determine whether the mathematical problem-solving ability in the experimental class is better than the mathematical problem-solving ability in the control class. The hypothesis test in this study used the t-test, namely the independent sample t-test. The results of the t-test in both sample classes obtained t_{count} = 20.734 and t_{table} = 1.68. The H_0 testing criteria are accepted with $t_{count} < t_{table}$. While $t_{count} > t_{table}$ H_0 is rejected. So, it can be concluded that there is a significant influence on students' mathematical problem-solving ability through the Multi-representation Discourse learning model in class VIII of SMP Negeri 1 Rao Selatan.

The results of the study indicate that the mathematical problem-solving abilities of students taught using the Discourse Multi-Representation (DMR) learning model are better than those taught using conventional learning. This is evident from the average score of students in the experimental class of 72.20, which is higher than the average score of the control class of 54.8. This difference is not only seen descriptively but is also reinforced by the results of inferential analysis through hypothesis testing using the t-test. Based on the calculation results, it was obtained that the t-test results in both sample classes obtained t_{count} = 20.734 and t_{table} = 1.68. The testing criteria for H_0 are accepted with $t_{count} < t_{table}$. While $t_{count} > t_{table}$ H_0 is rejected. Thus, it can be concluded that the DMR learning model has a significant effect on improving students' mathematical problem-solving abilities. Theoretically, the success of the DMR model in improving students' mathematical problem-solving abilities can be explained by the model's main characteristics, which emphasize the use of various representations in understanding mathematical concepts (Mulyati, 2016). In the learning process, students do not only rely on one form of representation, such as symbols or numbers, but are also trained to use other representations such as images, graphs, tables, and verbal explanations. This is in line with constructivism theory, which states that knowledge is actively constructed by students through meaningful learning experiences (Nurjamilah et al., 2025). By involving various forms of representation, students can construct a deeper understanding of mathematical concepts, making it easier for them to solve problems.

Furthermore, the DMR model provides ample space for students to discuss and exchange ideas with their group mates (Matin et al., 2022). This discourse activity allows for clarification, elaboration, and reflection on students' thinking. When students express their opinions and listen to the opinions of others, they indirectly practice critical and logical thinking skills, which are essential for solving mathematical problems (Fristadi & Bharata, 2015). Thus, learning is no longer teacher-centered but shifts to student-centered learning (Hutajulu et al., 2026).

The results of this study align with research conducted by Sitorus (2023), which states that implementing the Multi-Representation Discourse model can improve students' mathematical problem-solving abilities. In his research, Sitorus found that students learning with the DMR model showed significant improvements in understanding problems, planning solution strategies, and evaluating the results obtained. In addition, other studies also show that the use of multiple representations in mathematics learning can help students connect abstract concepts with real contexts, thereby improving conceptual understanding and problem-solving abilities (Tyaningsih et al., 2025).

This research contributes to the development of the DMR learning model, specifically for eighth-grade junior high school students at SMP Negeri 1 Rao Selatan in the 2025/2026 academic year. This study not only tests the effectiveness of the DMR model in general but also examines its implementation in real-world classrooms with diverse student characteristics. Although the results demonstrate a positive impact of the DMR model, several limitations warrant consideration. One major limitation is the initial implementation phase, where students were unfamiliar with the DMR learning steps (Rizmawati et al., 2024). This resulted in suboptimal learning during the initial meeting, as students were still adapting. Furthermore, time constraints were also a challenge, as the DMR model requires a longer time allocation for each learning stage, particularly for group discussions and student presentations (Banjarnahor et al., 2023). Another limitation is that this study was conducted in only one school with a limited sample size, so generalization of the results requires caution. The implications of this research are quite significant for the world of education, particularly in mathematics learning. First, the DMR learning model can be used as an effective alternative learning model to improve students' mathematical problem-solving abilities. Teachers are expected to implement this model consistently with careful planning to obtain optimal results. Second, the use of various representations in learning needs to be emphasized more, as it has been proven to help students understand mathematical concepts more deeply. Third, schools need to provide support for learning innovation, for example through teacher training related to the application of innovative learning models such as DMR.

Furthermore, future researchers are advised to expand this study with a broader scope, both in terms of sample size and variety of learning materials. This research could also be combined with other variables such as learning motivation, critical thinking skills, or mathematical literacy to obtain a more comprehensive picture of the effectiveness of the DMR model. Thus, it is hoped that the DMR learning model can continue to be developed and make a significant contribution to improving the quality of mathematics learning in Indonesia.

4. CONCLUSION

Based on the research that has been conducted, the results of the analysis of students' mathematical problem-solving ability test data using the t-test obtained ($t_{count} = 2.770$) and ($t_{table} = 1.671$), so that ($t_{count} > t_{table}$). Thus, it can be concluded that the Discourse Multi Representation (DMR) learning model has a significant effect on the mathematical problem-solving ability of eighth-grade students of SMP Negeri 1 Rao Selatan. This influence is seen during the learning process, where students become more active in understanding, discussing, and solving mathematical problems through group discussion activities and the use of various forms of mathematical representation. The characteristics of the DMR model which emphasizes heterogeneous group cooperation, exchange of ideas, and the use of verbal, symbolic, and visual representations are able to help students understand mathematical problems more deeply. Through the DMR learning steps, students are trained to identify important information in problems, compile mathematical models, determine solution strategies, and re-explain the results obtained. Furthermore, the discussion process in the DMR model provides students with the opportunity to understand each other's opinions and correct misunderstandings, thereby developing students' critical thinking and mathematical problem-solving skills better than in conventional learning, which tends to be teacher-centered. Therefore, the DMR learning model can be an effective learning alternative for improving students' mathematical problem-solving abilities.

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