

Application of the Metaphorical Thinking Approach to Students' Mathematical Problem Solving Ability

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ABSTRACT

This research was motivated by the problem of low mathematical problem solving abilities in class VIII students at MTs Nuraniyah Nogosaren. This condition is caused by learning methods that predominantly rely on the role of the teacher, and is characterized by student inactivity in the learning process. This research focuses on the application of the metaphorical thinking learning approach as an alternative solution. The main aim of this research is to evaluate the positive impact of applying the metaphorical thinking approach to improving students' mathematical problem solving abilities, compared to conventional teacher-centered learning. The research method used was a quasi-experiment with a randomized control group only research design. The measuring instrument used is a test of mathematical problem solving abilities. The research results showed that the average value of students' mathematical problem solving abilities in the experimental class was 85.735 while in the control class it was 71.625. After testing the hypothesis using the t-test with a significance level of $\alpha = 0.05$ and a confidence interval of 95%, the calculated t value was obtained at 4.066 which exceeds the t table value of 2.015. Thus, it can be concluded that the null hypothesis (H_0) is rejected and the alternative hypothesis (H_1) is accepted. These results indicate that the mathematical problem solving abilities of students who follow the metaphorical thinking approach are higher than students who follow conventional learning on the material.

Keywords: Metaphorical Thinking; Mathematical Problem Solving Ability.

1. Introduction

Mathematics has the most crucial important role in Indonesia, but in reality what we find is that students' mathematics scores tend to be low (Paladang et al., 2018). Based on facts in Indonesia, students' mathematics learning outcomes are categorized as low (Annisa et al., 2021) and from the report on the results of The Trends in International Mathematics and Science Study (TIMSS), Indonesia is ranked 41st out of 45 participants. Setiadi, et al., stated that one of the factors for the low TIMSS results achieved by Indonesia was due to students' lack of training in solving questions that required problem solving (Yanti et al., 2019). This causes students' mathematics scores in Indonesia to be incorrect, including a lack of practice by students in working on HOTS questions (Saputri et al., 2017). Mathematics learning is often focused on theory

only and is less related to everyday life. So, there is a need for an innovative learning approach in training students not only to depend on theory and memorizing formulas, but also to train students to analyze and find solutions to mathematical problems. Mathematical problem solving abilities are important for students to make logical decisions (Maskur, 2016). On the other hand, problem-solving ability is an important aspect in the 4C competency framework (Communication, Collaboration, Critical Thinking, and Creativity) which is often discussed in the context of education in the 21st century era (Lestari et al., 2019). Problem-solving abilities play a central role in preparing students to face the challenges and opportunities in an ever-changing and developing world. The indicators measured in mathematical problem solving abilities are compiling mathematical statements, making conjectures, carrying out mathematical manipulations, and drawing conclusions (Sasmita et al., 2022). In this research, teacher efforts are needed to encourage problem-solving abilities by providing an approach to learning that is able to

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link concepts that are difficult to explain with more concrete concepts. As for efforts to improve students' mathematical problem solving abilities, the metaphorical thinking approach is an alternative solution. put forward conjectures, carry out mathematical manipulations, and draw conclusions (Sasmita et al., 2022). In this research, teacher efforts are needed to encourage problem-solving abilities by providing an approach to learning that is able to link concepts that are difficult to explain with more concrete concepts. As for efforts to improve students' mathematical problem solving abilities, the metaphorical thinking approach is an alternative solution. Put forward conjectures, carry out mathematical manipulations, and draw conclusions (Sasmita et al., 2022). In this research, teacher efforts are needed to encourage problem-solving abilities by providing an approach to learning that is able to link concepts that are difficult to explain with more concrete concepts. As for efforts to improve students' mathematical problem solving abilities, the metaphorical thinking approach is an alternative solution.

The metaphorical thinking approach involves using metaphors, analogies, or similes to help students understand complex mathematical problems by relating them to a more familiar or concrete context. Abstract mathematical concepts are often difficult for students to understand (Albar et al., 2022), because they lie outside their everyday experience. The metaphorical thinking approach also involves the use of symbols or images that describe mathematical problems. In this case, students can visualize problems through pictures or diagrams that are relevant to the mathematical context being studied.

The use of a metaphorical approach is considered more effective than other learning approaches, because students practice solving problems from different points of view, and can develop creative thinking skills by comparing mathematical concepts with everyday life (Rohaeti et al., 2019). Metaphorical thinking is a learning approach that emphasizes students' ability to think metaphorically in connecting problems in everyday life (Anggraeny et al., 2019). The metaphorical thinking approach is basically a learning approach to improve understanding of abstract concepts to become more concrete by comparing two or more problems that have different meanings (Malik, 2017).

In this research, there are several stages in the metaphorical thinking approach, namely: 1)

providing contextual problems, 2) identifying main concepts, 3) using metaphors to illustrate these concepts, and 4) making conclusions (Rohaeti, 2019). Previous research on mathematics learning with a metaphorical thinking approach has covered several research aspects and produced a conclusion. For example, research by Rika Yuliana (2021) on the influence of the metaphorical thinking approach on the mathematical problem solving abilities of class VIII students at SMP Negeri 1 Bandar Lampung for the 2021/2022 academic year. Apart from that, Tezha Kurnia Anggraeny's (2019) research explored the influence of the metaphorical thinking approach on students' critical thinking abilities and emotional intelligence at SMAN 4 Kayuagung.

The results of observations at MTs Nuraniyah Nogosaren in July 2023 show that mathematics learning has not achieved the expected goals. The learning process is less effective, too teacher-centered, and students do not participate enough (Sugandi, 2016), so they cannot develop their ideas or thoughts on the material they have studied. This results in a lack of student practice in using their students' mathematical solving abilities (Kusumawati & Irwanto, 2016). Motivation is also an important factor in achieving learning goals (Nuramdani, 2021). Mathematical problem solving abilities are very relevant for Madrasah Tsanawiyah (MTs) students and have a direct impact on learning outcomes ("Symmetry Pas. J. Res. Math. Learn. Educ.," 2022).

In class VIII MTs Nuraniyah Nogosaren series and series material, the students' daily assessment results were still below the maximum completeness criteria, indicating that many students had difficulty solving story problems. One of the main reasons is students' lack of mathematical problem solving abilities, which causes difficulties in making conjectures, carrying out mathematical manipulations, and drawing conclusions. Students also find it difficult to relate mathematical material to everyday life, and they often see mathematics as a difficult and scary subject (Yelvalinda et al., 2019).

Based on previous research, the metaphorical thinking approach is still rarely used by teachers in improving students' mathematical problem solving abilities. Therefore, this research was conducted in class VIII of MTs Nuraniyah Nogosaren which focused on the application of a metaphorical thinking approach to mathematical problem solving abilities. This research was

conducted to determine the impact of applying a metaphorical thinking approach on the mathematical problem solving abilities of class VIII students at MTs Nuraniyah Nogosaren, compared to the mathematical problem solving abilities of students who took part in conventional learning.

2. Research Methods

This research is a quasi-experiment that uses a randomized control group only design research design. The research subjects consisted of 38 class VIII students at MTs Nuraniyah in the 2022/2023 academic year. Class samples were chosen randomly, class VIII A as the experimental class and class VIII B as the control class. The tool used in this research is a test to measure mathematical problem solving abilities. This test is in the form of descriptive questions given before treatment (pre-test) and after treatment (post-test). The material used was arithmetic sequences and series.

This research design consists of three main stages: preparation, implementation, and completion stages. In the preparation stage, researchers validated the instrument and carried out initial tests before being given a learning method involving sample classes. At the implementation stage, the learning process was carried out in the two sample classes with different approaches. The experimental class uses a metaphorical thinking approach, while the control class uses conventional learning methods. The completion stage involves students from both experimental and control classes in carrying out a final test that measures mathematical problem solving abilities.

3. Results and Discussion

Before learning is carried out according to the Learning Implementation Plan (RPP) with a focus on understanding basic competencies including sequence and sequence material, students are given a pre-test to determine the initial abilities of class VIII students at MTs Nuraniyah Nogosaren. The average pre-test score for mathematical problem solving abilities can be seen in Table 1 below.

Table 1. Average pre-test score for mathematical problem solving abilities.

Class	Pre-test Average
Experiment	53.63
Control	55.63

After learning is carried out according to the Learning Implementation Plan (RPP) with a focus on understanding basic competencies including sequence and series material through contextual problem solving techniques. After carrying out 4 meetings, this research ended the phase by administering a test to measure mathematical problem solving abilities. A descriptive statistical graph of mathematical problem solving abilities can be seen in Figure 1.

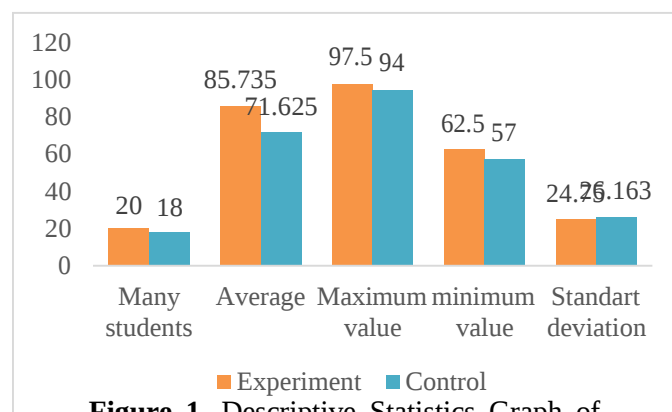


Figure 1. Descriptive Statistics Graph of Mathematical Problem Solving Ability for Class VIII MTs Nuraniyah 2022/2023.

From the data in Figure 1 above, it can be concluded that the average test results for mathematical problem solving abilities in the experimental class are significantly higher than in the control class. This shows that the students' scores in the experimental class were superior to those in the control class. When viewed from the standard deviation, the experimental class has lower variability compared to the control class. For further information regarding the average results of mathematical problem solving abilities for each indicator, see Figure 2.

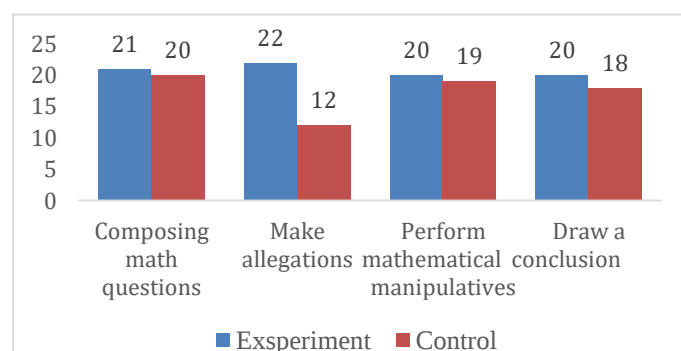


Figure 2. Graph of the Average Score for Each Indicator of Mathematical Problem Solving Ability for Class VIII Students at MTs Nuraniyah Nogosaren 2022/2023.

From the data in Figure 2, it can be concluded that the average score for each indicator of mathematical problem solving ability in the experimental class is consistently higher than in the control class. The results of the average value of mathematical problem solving ability in the experimental class reached 85.735 while in the control class it reached 71.625. This gives an indication that the mathematical problem solving abilities in the experimental class which took learning using a metaphorical thinking approach were significantly higher compared to the control class which took regular learning.

Before carrying out the t test analysis, the research data was tested for normality and homogeneity using the Kolmogorov-Smirnov test with the F test, namely Levene statistics. The results of normality testing can be seen in figure 3.

Figure 3. Data Normality Test

Independent Samples Test									
		Levene's Test for Equality of Variances		t-test for Equality of Means					
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference
Mathematical Problem Solving Ability	Equal variances assumed	,029	,867	4,066	36	,000	15,579	1,692	12,147 19,011
	Equal variances not assumed			4,066	35,936	,000	15,579	1,692	12,146 19,012

The post-test normality test in the experimental class using a metaphorical thinking approach showed a significance value of 0.061 and $\alpha = 0.05$ so that the significance obtained is $0.061 \geq 0.05$, so H_0 is accepted which means the data is normally distributed. Meanwhile, in the control class, without using a metaphorical thinking approach, a significance value of 0.200 and $\alpha = 0.05$ were obtained, so that the significance obtained was $0.200 \geq 0.05$, so H_0 was accepted, meaning the data was normally distributed. SedaThe results for the homogeneity test can be seen in figure 4 below.

Figure 4. Homogeneity Test

Test of Homogeneity of Variance					
		Levene Statistics	df1	df2	Sig.
Mathematical Problem Solving Ability	Based on Mean	1,805	3	72	,154
	Based on Median	1,319	3	72	,275
	Based on Median and with adjusted df	1,319	3	65,395	,276
	Based on trimmed mean	1,726	3	72	,169

The homogeneity test shows a significance value of 0.154 and $\alpha = 0.05$ so that the significance obtained is $0.154 \geq 0.05$, so H_0 is accepted, meaning that the data is homogeneous and the calculation can continue. Next, in this research, the In test was carried out Dependent Samples T-test to see the differences in learning with and without using a metaphorical approach. The test results can be seen in figure 5 below.

Figure 5. Independent Samples Test

Independent Samples Test									
		Levene's Test for Equality of Variances		t-test for Equality of Means					
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference
Mathematical Problem Solving Ability	Equal variances assumed	,029	,867	4,066	36	,000	15,579	1,692	12,147 19,011
	Equal variances not assumed			4,066	35,936	,000	15,579	1,692	12,146 19,012

The results of the Independent Samples Test obtained a significance value of $0.000 \leq 0.05$ then H_1 is accepted. The results of data analysis show that the calculated t value (4.066) exceeds the t table value (2.015). Based on data analysis, the null hypothesis (H_0) is rejected and the alternative hypothesis (H_1) is accepted. The conclusion that can be drawn from this Independent Sample T-test is that there are differences in learning with and without students using a metaphorical approach. In this case, it is shown by the results of tests on mathematical problem solving abilities that follow learning with a metaphorical thinking approach that are higher than those who take regular learning in class VIII at MTs Nuraniyah Nogosaren.

The results of this study are in line with findings from previous research. Investigated by K.G.D Yanti in 2019, the findings showed that the use of a metaphorical thinking approach was able to provide a significant increase in students' mathematical problem solving abilities. Furthermore, Nova Fransiska in 2022 also supported these findings by emphasizing that students who apply a metaphorical thinking approach in learning mathematics tend to have higher problem-solving abilities and mathematical resilience compared to those who follow conventional learning in control classes.

(Mustopa, 2016) conducted research that showed differences in achievement and improvement in mathematical representation abilities of students who took learning with a

metaphorical thinking approach compared to students who took conventional learning. This finding is consistent with previous research by Ani Adella (Rafita & Suryanti, 2020), which found that the understanding of mathematical concepts of students who were involved in learning based on a metaphorical thinking approach in the experimental class was significantly better than students who studied with a deductive learning approach in the control class. Furthermore, research by (Sodikin & Hartatiana, 2015) confirmed that the average score of students' conceptual understanding ability after applying the metaphorical thinking approach tends to reach a high level. Thus, this set of findings consistently supports the effectiveness of metaphorical thinking approaches in improving students' understanding and achievement in mathematics. The metaphorical thinking approach turns out to have a broader positive impact, not only limited to students' mathematical abilities, but also influences their motivation and learning outcomes.

In addition, learning through a metaphorical thinking approach indirectly gives students experience in the metaphorical thinking process which involves six stages, namely connecting, relating, exploring, analyzing, transforming, and experience mathematical concepts. This approach, known as CREATE, helps students understand these concepts better. Thus, these findings indicate that the metaphorical thinking approach has the potential to improve students' mathematics learning outcomes, as well as encourage them to engage in deeper creative and metaphorical thinking processes.

The results of this research confirm the previous findings presented above, which consistently show that the metaphorical thinking approach has the potential to improve various aspects of students' mathematical abilities. More specifically, the results of this study confirm that the metaphorical thinking approach can have a positive impact on students' mathematical problem solving abilities.

Thus, the conclusion that can be drawn is that students who are involved in learning with a metaphorical thinking approach tend to have a higher level of mathematical problem solving ability compared to those who take part in conventional learning in class VIII MTs Nuraniyah Nogosaren in the 2022/2023 academic year. This approach greatly influences effective strategies for improving students' mathematical achievements in the future.

4. Conclusions

The results of this research indicate that the average score for students' mathematical problem solving abilities using a metaphorical thinking approach is 85.735, while students who take conventional learning have an average of 71.625. Therefore, the null hypothesis (H_0) is rejected, and the alternative hypothesis (H_1) is accepted. It can be concluded that the average test of mathematical problem solving abilities of students who use a metaphorical thinking approach is higher than those who take part in regular learning in class VIII MTs Nuraniyah Nogosaren in the 2022/2023 academic year.

Using a metaphorical thinking approach in learning can be an effective choice for improving mathematical problem solving abilities, especially in the context of rows and series. Teachers must prepare well and effectively so that learning using this approach can run smoothly. And further research can explore the application of the metaphorical thinking approach to improve mathematical abilities in other fields.

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