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THE EFFECT OF THE POWER OF TWO METHOD ON MATHEMATICAL REASONING OF 8th GRADE MTs DARUL ABROR KEDUNGJATI PURBALINGGA

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Abstrak

Penalaran merupakan salah satu kemampuan matematika yang harus dikuasai siswa dalam pembelajaran matematika. Akan tetapi dalam kenyataanya, siswa masih memiliki kemampuan penalaran yang rendah. Hal tersebut dibuktikan dengan observasi yang telah dilakukan di MTs Darul Abror Kedungjati. Sehingga dibutuhkan suatu metode pembelajaran untuk meningkatkan penalaran matematis siswa. Tujuan penelitian ini untuk mengetahui pengaruh metode *The Power of Two* terhadap penalaran matematis siswa pada materi Sistem Persamaan Linear Dua Variabel. Populasi penelitian ini adalah seluruh siswa kelas VIII MTs Darul Abror Kedungjati Kabupaten Purbalingga. Teknik sampling yang digunakan adalah *Simple Random Sampling*, sehingga diperoleh sampel kelas VIII C yang berjumlah 28 siswa sebagai kelas kontrol dan kelas VIII F yang berjumlah 28 siswa sebagai kelas eksperimen. Metode pengumpulan data dalam penelitian ini adalah wawancara, tes, observasi, dan dokumentasi. Sedangkan untuk analisis data menggunakan uji normalitas, uji homogenitas, uji *N-Gain* dan uji *t.* Berdasarkan hasil uji *N-Gain*, diperoleh rata-rata 0,8475 pada kelas eksperimen sehingga berada di kategori tinggi. Rata-rata pada kelas kontrol sebesar 0,6454 berada di kategori sedang. Dengan hasil perolehan rata-rata nilai *N-Gain* kelas eksperimen lebih unggul dari kelas kontrol, maka dapat disimpulkan bahwa penerapan metode *The Power of Two* berpengaruh terhadap kemampuan penalaran matematis siswa di kelas VIII MTs Darul Abror Kedungjati Purbalingga.
Kata kunci: Metode *The Power of Two*; Penalaran Matematis; Matematika

Abstract

Reasoning is one of the mathematical abilities that must be mastered by students in learning mathematics. However, in reality, students still have low reasoning abilities. This is evidenced by the observations made at MTs Darul Abror Kedungjati. So we need a learning method to improve students' mathematical reasoning. This study to determine the effect of The Power of Two method on students' mathematical reasoning in two-variable linear equation systems. The population were all students of class VIII MTs Daru Abror Kedungjati, Purbalingga Regency. The sampling technique used was Simple Random Sampling, so a sample of 28 students was obtained from VIII-C as the control class and 28 students from VIII-F grade as the Experiment class. Data collection were

interviews, tests, observation, and documentation. While data analysis used a normality test, homogenity test, N-Gain test, and t-test. Based on the results of the N-Gain test, an average of 0.8475 was obtained in the experimental class in the high category. The average in the control class is 0.6454 in the medium category. The results of obtaining an average N-Gain value for the experimental class superior to the control class, it can be concluded that the application of The Power of Two method in learning affects students' mathematical reasoning abilities in class VIII MTs Darul Abror Kedungjati, Purbalingga.
Keywords: The Power of Two Method; Mathematical Reasoning Ability; Mathematics

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INTRODUCTION

Education is an effort so that humans can develop their potential through a learning process and/or other methods that are known and recognized by society. The 1945 Constitution of the Republic of Indonesia Article 31 paragraph (1) states that every citizen has the right to education, and paragraph (3) confirms that the Government seeks and organizes a national education system that increases faith and piety as well as a noble character in order to educate national life regulated by law. For this reason, all components of the nation are obliged to inform the life of the country which is one of the goals of the Indonesian state (UUD No. 41 2003).

In the education system of the Republic of Indonesia, Number 20 of 2003, one of the compulsory curricula is Mathematics. Kline (Rahmah, 2018) argues that mathematics is not an isolated knowledge that can be perfect on its own but that mathematics is primarily to assist humans in understanding and mastering social, economic, and natural problems. According to (Wanti et al., 2017), mathematics is a process of reasoning, the formation of character and mindset, the appearance of objective, honest, systematic, critical, and creative attitudes, and supporting science in conclusion.

The 2013 curriculum explains that students are expected to be able to apply concepts and know how these concepts can be applied in various situations and students' ability to reason and argue about how the problem can be solved (Winarti,

2015). This is one of the goals of learning mathematics listed in the Regulation of the Minister of National Education of the Republic of Indonesia Number 22 of 2006, reasoning on patterns and characteristics, manipulating in making generalizations, compiling evidence, or explaining mathematical ideas and questions.

Mathematical reasoning is the foundation for obtaining or constructing mathematical knowledge, while mathematics is a means of thinking to examine something logically (Santana, Sunarso, & Mariani, 2022). The importance of mathematical reasoning abilities greatly influences the mathematics learning process they follow. Because students who have good reasoning abilities will easily understand mathematical material, and contrary; students with low mathematical reasoning abilities will find it difficult to understand mathematical material (Santana, Sunarso, & Mariani, 2022). The statement formulated by the Ministry of National Education in 2002 (Nasional, 2002) states Mathematical matter and reasoning are two things that cannot be separated. Mathematical material is understood through reasoning, and reasoning is trained through learning mathematics. So, students studying mathematics need reasoning power to find ideas or knowledge so that students can understand the correct basic concepts of mathematics.

In the analysis process, there are various indicators to test mathematical reasoning abilities, referring to the Technical Guidelines for the Director General of Elementary and Elementary Education Ministry of National Education Number 506/C/Kep/PP/2004 as follows: a) make assumptions; b) perform mathematical manipulations; c) draw conclusions, compile evidence, provide reasons or evidence against the correctness of the solution; d) draw conclusions from statements; e) check the validity of an argument; f) find patterns or characteristics of mathematical phenomena to make generalizations (Hendriana et al., 2018). The results of this analysis will later help develop a strategy or learning method that can correct mistakes that occur in students.

Learning is assistance provided by the teacher so that the process of acquiring knowledge and knowledge can occur, mastering skills and habits, and

forming attitudes and beliefs in students (Izzah & Azizah, 2019). In other words, learning becomes a process to help students improve mathematical reasoning. Through learning mathematics, reasoning abilities play an excellent role in problem-solving. Especially in everyday life, the ability to reason is helpful when solving problems that occur within the personal, community, and other broader social institutions. According to Lehman, the advantages contained in reasoning include broadening beliefs, assuring the truth, explaining (Nursoffina & Efendi 2021) and thinking efficiently (Sumardi, 2002).

According to Al Krismanto (Widayanti, 2010), by studying mathematics, reasoning abilities can be developed when students understand a concept (understanding) or find and prove a principle. An inductive and deductive mindset is developed when finding something or establishing a principle. According to Sulistiawati (Malik et al., 2020) one of the low students' mathematical reasoning abilities is learning mathematics which does not involve student activities.

Based on preliminary observations from researchers on class VIII mathematics teachers at MTs Darul Abror Kedungjati, Purbalingga Regency, Nurul Fajriah, S.Pd., Gr. The results show that students can understand the material presented by the teacher but need help with applying it. This was expressed when students carried out the process of working on the questions. Students had trouble using the material obtained to solve the problems given. This situation shows that students still need to reach the indicators of mathematical reasoning ability in concluding, compiling evidence, and giving reasons or proof of the correctness of the solution.

In addition, students need to be more thorough in working on problems. This also shows that students have yet to be able to check the validity of an argument which is one of the indicators of mathematical reasoning ability. So it can be concluded that students are still low in mathematical reasoning abilities, resulting in students having difficulty applying the understanding obtained to solve problems.

Mathematical reasoning ability is basically influenced by two factors, namely internal and external factors; internal factors are the student's condition, while external factors are learning methods. The method needed is a method that

involves students in learning so that students will try to solve problems independently without the help of the teacher. These conditions make students think about solving problems according to their reasoning. From this reasoning process, students will consider the opinions of other students to expand their sense of solving problems.

From the situation above, The Power of Two methods is an option. This is based on the understanding of The Power of Two in a complete English dictionary; the Power of Two consists of the words Power and Two. Power means strength, while the word two means two, it can be concluded that The Power of Two implies the power of both. This conjecture is based on the relationship between the characteristics of The Power of Two and the factors of mathematical reasoning.

Based on research that was conducted by (Bella et al., 2019), The Power of Two method can improve mathematical problem-solving abilities, where this ability has the same urgency as mathematical reasoning, which requires students to be active in solving problems. In addition, The Power of Two method can also improve student learning outcomes. This was proven in research conducted by (Ardi et al., 2020). If learning outcomes increase, then this method can also increase mathematical reasoning. Based on previous research, The Power of Two method can be an option for improving mathematical reasoning.

With the Power of Two method, students will be accustomed to giving arguments for each answer and responding to answers given by others so that what is being learned becomes more meaningful. This means it is essential to give time for students to discuss in answering other people's questions and statements with correct and clear arguments (Pugalee, 2001). This becomes part of one of the characteristics of The Power of Two: Students do not only listen to lectures passively but do various things (read, conduct experiments, and discuss) related to learning material.

In addition, it is suspected that there is a link between the steps of The Power of Two and indicators of mathematical reasoning. If students are given the opportunity to use their reasoning skills in making assumptions based on their own experience, they will more easily understand a concept (Burais et al., 2016). From

the explanation above, to improve students' mathematical reasoning abilities, learning methods are needed to enhance mathematical reasoning abilities. This study aims to show the effect of the power of two method on the mathematical reasoning abilities of class VIII students of MTs Darul Abror Kedungjati, Purbalingga.

METHOD

The research was carried out by applying a Quasi-experimental or quasi-experimental type of research. This design has a control group but does not fully function to control external variables that affect the experiment.

The subject of this research is students of 8^{th} grade MTs Darul Abror Kedungjati, Purbalingga Regency. So the population is all students of 8^{th} grade, a total of 227 students. The sampling technique used is Simple Random Sampling, a sample consisting of a number of elements selected randomly, each member of the population has the same opportunity to be selected as the sample. VIII-C grade became the control class and VIII-F grade became the experimental class. Class determination is done by lottery and randomly selected.

The first data collection used was interviews and observations, carried out to collect some of the information needed for research such as student personalities, student abilities, school facilities, and the learning curriculum used by the school teacher.

Next data collection method used is the test instrument. The test method applied is a pretest and posttest, a matter of description. The pretest is intended before learning activities take place to measure the initial student's ability. After the learning activities ended, a posttest was given to see how much the students' final abilities had improved. The researcher compiled four essay questions to measure reasoning ability. Here are four description questions to test mathematical reasoning abilities:

Table 1. ***Pretest and Posttest Questions***

Question Number	Question
1	A parking attendant gets IDR 11,000 from 3 cars and five motorcycles, while from 3 cars and ten motorbikes, he gets IDR 16,000.00. Is it true that the parking fee for one motorbike is Rp.1,000.00 and for one car the parking fee is Rp.3000.00?
2	The age difference between father and son is 30 years. Suppose the sum of the ages of father and son is 42 years. Then, determine the ages of the Father and Son in the next four years!
3	The perimeter of a rectangular plot of land is 52 m. Suppose the width is 6 m shorter than the length. Determine the area of the plot of land!
4	It is known that the price of 2 pairs of pants and four shirts is Rp. 270,000, - while the price of 4 pairs of pants and a shirt is Rp. 190,000,-. If Imron buys a pair of pants and a shirt using Rp. 100,000, - then determine the change that Imron received!

Before the test instrument is used, it is tested for its validity and reliability. The validity test describes whether the instrument used can measure what will be measured, where the validity test result is a valid instrument (legitimate) or invalid (invalid). This study uses the Pearson Product Moment Correlation to determine whether the instrument is valid. The instrument is valid if it gets the calculation results rcount ≥ rtable at a significance level of $\alpha = 5\%$. At the same time, reliability is the consistency of the instrument used. It tested the reliability of mathematical reasoning tests in this study using the Cronbach alpha formula. The instrument is reliable if it gets the calculation results rcount ≥ rtable with a significance level of $\alpha = 5\%$.

After the items are declared valid and reliable, the questions can be used to test students' initial abilities, the pretest, and test students' abilities after obtaining the method, the posttest. After the research data is obtained, it is continued to analyze the results for the data analysis that will be applied to the research, namely the prerequisite test consisting of the normality test and homogeneity test, and hypothesis testing using the t-test. N-Gain is used to analyze student learning outcomes before and after learning, along with the formula used (Batubara et al., 2014).

$$N - Gain = \frac{S_{Post} - S_{Pre}}{S_{maks} - S_{Pre}}$$

Remarks:

S_{Post} : *posttest value*

S_{Pre} : *pretest value*

S_{max} : ideal maximum value

The average value of N-Gain in the experimental and control class, it will be known whether there is an effect of The Power of Two method on students' mathematical reasoning 8th grade MTs Darul Abror Kedungjati, Purbalingga Regency. Suppose the average N-Gain value in the experimental class is greater than the average N-Gain value in the control class. In that case, the Power of Two method influences students' mathematical reasoning abilities in 8th grade MTs Darul Abror Kedungjati, Purbalingga Regency. According to Hake, the N-Gain category, after being modified by the author.

Table 2. Interpretation of Normalized Gains Value

Normalized Gain Value	Interpretation
-1.00 ≤ N-Gain < 0.00	Decline
N-Gain = 0.00	Permanent
0.00 < N-Gain < 0.30	Low
0.30 < N-Gain < 0.70	Currently
0.70 ≤ N-Gain ≤ 1.00	High

(Sundayana, 2018)

RESULT AND DISCUSSION

The researchers tested questions for class IX F on November, 2022. The formula for finding r_{table} is df = N-2, so df = 26 – 2 = 24 with a significance level of 0.05, then we get r tables, namely 0.388. The results of the research that has been carried out show that the questions are declared valid. The following are the results of the validation test of the test questions as follows.

Table 3. Test Results for the Validity of Mathematical Reasoning Ability Test Instruments

About	r_{count}	$r_{t\ able}$	Information	Interpretation
1	0.589	0.388	Valid	Moderate Validity
2	0.862	0.388	Valid	Very High Validity
3	0.779	0.388	Valid	High Validity
4	0.817	0.388	Valid	Very High Validity

While testing, the reliability of mathematical reasoning tests in this study used the Cronbach alpha formula (Arikunto, 2018). An instrument is said to be reliable or reliable if one's answers to questions are consistent or stable from time to time. Reliable or not, an instrument can be consulted with the price of the r table. The following are the results of the reliability test of the test questions,

Table 4. Output of the Reliability Test of Students' Mathematical Reasoning Ability Test

Cronbach's Alpha	N of Problem
.720	4

Based on the results above, the question 4 description is valid and reliable, so it can be used in research to test students' mathematical reasoning abilities. Furthermore, research on the sample begins on November 12-28, 2022. There are five teaching process meeting times. The first meeting was held to pretest mathematical reasoning abilities, the 2nd to fourth meetings were used for learning, and the fifth meeting was used for the posttest. The learning process in class VIII C uses the conventional method, and VIII F grade is given The Power of Two method. From the research conducted, the results of the pretest and posttest values in the experimental class and control class were as follows.

Table 5. Pretest and Posttest Value

No	Information	Pretest		Posttest	
		E	*C*	*E*	*C*
1	The highest score	22.5	20	95	75
2	Lowest Value	0	5	75	42.5
3	Average	12,23	10.35	86,42	68,30

Based on the Table 5, the *pretest results* in the experimental class averaged 12.23, and the pretest results in *the* control class averaged 10.35. This is in line with research that was conducted by Yuni Aprilianti and Luvy Sylviana Zanthy that the mathematical reasoning pretest obtained had a percentage below 50% which can be said to be very low (Aprilianti & Zanthy, 2019). Then in this research, the *posttest results* of experimental class averaged 86.42, and the posttest results in *the* control class averaged 68.30. The N-Gain test was applied to determine the effectiveness of the treatment given. The N-Gain statistical data for the experimental and control classes are as follows.

Table 6. *N-Gain* Statistical Data

Information	E	C
The number of students	28	28
Highest Score	0.94	0.74
Lowest Score	0.75	0.28
Average	0.8475	0.6454

From the statistical data of 28 students in Table 6, the average gain of the experimental class was 0.8475, with the highest score of 0.94 and the lowest score of 0.75. The average score of 28 control class students was 0.6454, with the highest and lowest scores of 0.74 and the lowest score of 0.28. So it is proven that the treatment in the form of applying The Power of Two method during learning can improve mathematical reasoning abilities.

Before testing the hypothesis, a prerequisite test was carried out; namely, the normality and homogeneity tests, where the data taken were the *N-Gain data of* the experimental class and the control class. The result of the first prerequisite test is the normality test to find out whether the data comes from a normally distributed population (Sugiyono, 2018). The normality test in this study uses the *Kolmogrov-Smirnov formula formula* assisted using the *SPSS 25.0 For Windows program.* The normality test that has been carried out shows that the data is normally distributed. The following is output of the normality test as follows.

Table 7. Tests of Normality

		Kolmogorov-Smirnov [a]			Shapiro-Wilk		
	Class	Statistics	df	Sig.	Statistics	df	Sig.
N_Gain	Experiment	075	28	.200 *	.978	28	.791
	Control	.163	28	054	.751	28	.000

Based on Table 7, it was found that the significance value of the experimental class was. From the predetermined decision criteria, H_0 is accepted, so the experimental class data is normally distributed.

The second prerequisite is the homogeneity test, which is carried out to ensure that the two classes are homogeneous (no significant differences). In this study, the homogeneity test used the Levene test (Sugiyono, 2018) with the help of the SPSS 25.0 For Windows Program and obtained H_0 sign value = 0.164 > a = 0.05, then H_0 was accepted. So it can be concluded that the N-Gain variance of the experimental class is the same as the N-Gain variance of the control class.

Furthermore, the stage after the prerequisite test is carried out is hypothesis testing, the t-test. This t-test was conducted to determine whether the experimental and control classes' average N-Gain differed significantly. In the homogeneity test, it was found that the N-Gain variance of the experimental class = the N-Gain variance of the control class, so the sig value of the t-test refers to equal variances assumed.

The following is the output of the homogeneity and t-test from the SPSS 25.0 For Windows program as follows:

Table 6. Homogeneity and t-test Output

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	
							Lower	Upper
1.991	.164	10.476	54	.000	.20230	.01931	.16358	.24102
		10.476	42.790	.000	.20230	.01931	.16335	.24125

Based on the program SPSS 25.0 output for Windows obtained values sig. (2-tailed) = 0.000 < = 0.05, then H_1 is accepted, meaning there is a difference in the average N-Gain of the experimental and control classes. This research is also supported by previous research, which is also related to the practical application of The Power of Two method in improving mathematics learning outcomes (Ardi et al., 2020). The Power of Two method affects the ability to solve mathematical problems (Bella et al., 2019). Furthermore, The Power of Two method influences the understanding of mathematical concepts (Ratnasari et al., 2019). In the first step of The Power of Two, the teacher asks students one or two questions or problems that require contemplation and thought. The teacher asks students to answer written questions individually so that students will carry out activities of asking conjectures. The activity of making assumptions is an indicator of mathematical reasoning ability. This is the opinion of the research of Listika Burais, M. Ikhsan, and M. Duskri that if students are allowed to use their reasoning skills in making conjectures based on their own experience, students will more easily understand a concept (Burais et al., 2016). Meanwhile, in Silberman's opinion, learning cannot be swallowed as a whole. To remember what has been taught, students must digest it. Real learning will only occur with opportunities to discuss, ask questions, practice, and teach others. This activity is by the steps in The Power of Two method, namely when the teacher asks students to explain to each other and discuss new answers, it will make students perform mathematical manipulations, conclude, compile evidence, and provide reasons or evidence for the correctness of the solution.

From this research and explanation, it can be concluded that The Power of Two Method can improve mathematical reasoning abilities. However, efforts to improve mathematical reasoning abilities use more than The Power of Two method, because various methods can be chosen to improve mathematical reasoning abilities. In addition, various factors can affect mathematical reasoning abilities.

CONCLUSION

The research results show that learning using The Power of Two method can improve mathematical reasoning abilities. This can be seen from the results of the independent sample *t-test*, which obtained a sig (2-tailed) value of 0.000 < 0.05, which means that there is an average difference in mathematical reasoning ability using The Power of Two method and from the test results The N-Gain between the control class and the experimental class. The average N-Gain test result for the experimental class is 0.8575 in the high category, and the control class gets an average N-Gain of 0.6454 in the medium category. These results confirm that the value of N-Gain in the experimental class is far superior to the acquisition in the control class. Thus it can be concluded that the Power of Two method influences the mathematical reasoning ability of the student in class VIII MTs Darul Abror Kedungjati, Purbalingga.

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