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THE EFFECT OF NUMBERED HEAD TOGETHER COOPERATIVE LEARNING MODEL ON STUDENTS' MATHEMATICAL PROBLEM SOLVING ABILITY

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ABSTRACT
This study examines the effect of the Numbered Head Together (NHT) type cooperative learning model on the mathematical problem solving skills of Jambi City Junior High School students. Using a quantitative experimental approach with a Posttest-Only Control Design, this study involved a population of 96 grade VIII students. The sample was taken through Cluster Random Sampling technique, resulting in 65 participants divided into experimental class (VIII B, n=33) and control class (VIII C, n=32). The research instrument in the form of an essay final test was used to measure students' mathematical problem solving ability. Data analysis was conducted using one-party t-test (right side) through SPSS version 29.0. The results showed the average value of students' mathematical problem solving ability in the experimental class (63.33) was higher than the control class (41.44). The independent sample t-test analysis with a significance level of 5% resulted in a significance value (1-tailed) of 0.0005 ($p<0.05$), indicating a significant difference. Based on these findings, it can be concluded that the Numbered Head Together type cooperative learning model has a positive effect on students' mathematical problem solving skills.
Keywords: numbered head together; cooperative learning; problem solving

ABSTRAK
Penelitian ini mengkaji pengaruh model pembelajaran kooperatif tipe Numbered Head Together (NHT) terhadap kemampuan pemecahan masalah matematis siswa SMP Negeri 5 Kota Jambi. Menggunakan pendekatan kuantitatif eksperimental dengan rancangan Posttest-Only Control Design, studi ini melibatkan populasi sebanyak 96 siswa kelas VIII. Sampel diambil melalui teknik Cluster Random Sampling, menghasilkan 65 partisipan yang terbagi dalam kelas eksperimen (VIII B, n=33) dan kelas kontrol (VIII C, n=32). Instrumen penelitian berupa tes akhir esai digunakan untuk mengukur kemampuan pemecahan masalah matematis siswa. Analisis data dilakukan menggunakan uji-t satu pihak (pihak kanan) melalui SPSS versi 29.0. Hasil penelitian menunjukkan nilai rata-rata kemampuan pemecahan masalah matematis siswa pada kelas eksperimen (63,33) lebih tinggi dibandingkan kelas kontrol (41,44). Analisis uji independent sample t-test dengan taraf signifikansi 5% menghasilkan nilai signifikansi (1-tailed) sebesar 0,0005 ($p<0,05$), menunjukkan perbedaan yang signifikan. Berdasarkan temuan ini, dapat disimpulkan bahwa model pembelajaran kooperatif tipe Numbered Head Together berpengaruh positif terhadap kemampuan pemecahan masalah matematis siswa.
***Kata kunci**: numbered head together; pembelajaran kooperatif; pemecahan masalah*

Introduction

Education is a conscious and planned effort to create a learning atmosphere so that students actively develop their potential. According to Tinambunan et al, (2020) education is an important aspect in human life to create better changes and

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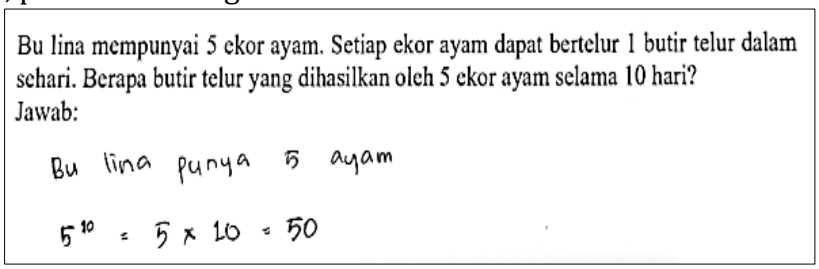
developments in the fields of science and technology. In education, this aspect is summarized in all subjects, one of which is mathematics.

Mathematics is one of the important subjects that students must learn and is related to daily activities. According to Linuhung et al, (2016) mathematics learning provided at school must be able to hone students so that they have basic competencies in mathematics in accordance with the general objectives of mathematics learning. One of the objectives of learning mathematics according to Depdiknas (2006) is to solve problems that include the ability to understand, design mathematical models, solve models, and interpret the solutions obtained. The National Council of Teaching Mathematics (NCTM) (2013), states that the objectives achieved in learning mathematics are that students must have five mathematical abilities, one of which is the ability to use mathematical concepts in solving a problem (problem solving).

According to Branca (Putri, 2021) problem solving skills are very important for every student to have because problem solving is a common goal of teaching mathematics, problem solving which 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. In line with the opinion of Zahra (2023) that this problem solving ability must be possessed by students in helping to solve various problems, both in solving mathematical problems and problems in everyday life. Therefore, this ability must be understood and mastered by students at school. But in reality, many students have low mathematical problem solving skills. This statement is in line with Hidayat et al., (2022), which states that students' mathematical problem solving skills are found to be low, this is based on learning that is still dominated by the teacher, as well as low student interest in learning.

Based on observations made at SMPN 5 Jambi City, when students are given problem solving problems, students still ask the teacher what they should do from the problem. This happens because students are still unable to understand the problems contained in the problem, there are even students who only write the final result without writing the solution process. The following are the results of the answers given by students when solving the problems given during the observation, presented in Figure 1:


Bu lina mempunyai 5 ekor ayam. Setiap ekor ayam dapat bertelur 1 butir telur dalam sehari. Berapa butir telur yang dihasilkan oleh 5 ekor ayam selama 10 hari?
Jawab:

Bu lina punya 5 ayam

$5^{10} = 5 \times 10 = 50$

Figure 1: Results of Student Answers during Observation

Based on Figure 1. It can be seen that students are unable to solve problems based on good and correct problem solving steps. Some students think that the problem is difficult to solve because it is different from the example problems given by the teacher. In addition, the low mathematical problem solving ability of students can also be seen from the answers written by students, where the answers do not fulfill all indicators of mathematical problem solving ability.

In addition, interviews conducted with 8th grade mathematics teachers obtained information that students' ability to solve math problems is still lacking when learning mathematics takes place lack of student activity, most students are given problems students just write the results. Students are less able to identify the elements known and asked in a problem, students are even still difficult in planning and determining the steps or ways of working on the problem needed to solve the problem of the problem.

For this reason, efforts are needed to develop students' mathematical problem solving skills. One of them is by using a learning model that is student-centered and can train students' ability to solve problems. One of the student-centered learning models is the cooperative learning model. Cooperative learning model is a learning model in which students work in small groups with different ability levels. In completing their group assignments, each group member must work together and help each other understand the learning material (Gultom, 2022).

Cooperative learning models can be a solution to this problem. Several cooperative models have been successfully used in various classroom environments. The cooperative learning model is a learning concept that includes all types of group work directed by the teacher. Cooperative learning model is a model based on constructivism theory (Jufrida, 2021). One type of cooperative learning model includes the Numbered Head Together (NHT) type. According to Putri (2021), the NHT type cooperative learning model can improve students' mathematical problem solving skills because students act actively and gain their own experience through group activities. The NHT type cooperative learning model is a model that prioritizes student activities to find, manage, and report information from various sources which will eventually be presented in front of the class. According to Widiani (2021), the NHT type cooperative model is a variant of group discussion, where this learning model begins with grouping students into small groups, preparing material, presenting, and giving responses from other groups. This model involves all students physically, emotionally and intellectually.

The use of the right learning model also affects students' problem solving skills. The NHT learning model is part of a cooperative learning model to improve students' problem solving skills. The NHT learning strategy is a strategy that provides opportunities for students to discuss in small groups where each group member gets a different number. In general, the steps of NHT learning are as follows: (1) The teacher divides students into groups or teams of three to five people and assigns numbers so that each student in the group has a different number; (2) The teacher asks questions to students where the questions can vary from specific to general; (3) Students think together to elaborate and ensure that everyone knows the answer; (4) The teacher calls a certain number then students from each group with the same number raise their hands and prepare answers to be delivered to all students (Prayekti, 2019).

From the explanation of the NHT type learning model above, the researcher provides reinforcement by including data relating to the model, including "Mardiah (2020), stated that student learning outcomes using the NHT (Numbered Head Together) learning model were 85. While the average student learning outcomes using the Conventional learning model were 73.2. Based on the results of the wicoxon test where in the experimental class the results obtained are a value smaller than Sig. α = 0.05 (0.000 <0, 05), so that Ha can be accepted ". The difference between the research

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conducted by Mardiah and the research that will be conducted by the author is that Mardiah's research examines to see learning outcomes in elementary school students (SD) while in this study to see mathematical problem solving skills in junior high school students. The next relevant research was conducted by Setiyani (2022), with the title "The Effect of OPEN-ENDED Learning Model on Mathematical Problem Solving Ability of Class VIII Students of SMP Negeri 3 Pulosari Pemalang Regency". This research was conducted in 2022, this type of research is experimental research with a pretest and posttest design.

Based on the background that has been explained, this research will describe how the effect of the Numbered Head Together (NHT) type cooperative learning model on students' mathematical problem solving skills is carried out, especially on whole numbers. The research to be conducted is in line with research by Fadhilah (2018), where the difference between previous research and the research to be conducted lies in the type of cooperative learning used. Fadhilah (2018), used the NHT type cooperative learning model which focused on students' mathematical abilities, while the research to be conducted uses the NHT type cooperative learning model which focuses on students' problem solving skills.

Research Methods

This study used an experimental method, with a Posttest Only Control Design research design. By holding a posttest, where each research sample is given a final test. Posttest is used to measure students' mathematical problem solving skills after being treated (Sugiyono, 2018). The research design is as follows:

A : O	X	O
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A : O		O

Description:
A = Samples were taken randomly
X = Treatment given (Independent variable)
O = Pretest / Posttest (Independent variable observed)

This research was conducted in class VII SMP Negeri 5 Jambi City in the even semester of the 2023/2024 school year. The sampling technique in this study was Probability Sampling. Probability Sampling is a sampling technique that provides equal opportunities for each element (member) of the population to be selected as a sample member (Sugiyono, 2018). In this study using Probability Sampling type Cluster Random Sampling. The reason researchers use this sampling technique is because it allows each population (96 students) to be sampled (65 students). In this study, researchers randomly selected two classes, class VIII B (33 students) and class VIII C (32 students). Class VIII B was used as the experimental class to be treated with the NHT type, the syntax of the NHT type cooperative learning model, namely: (1) Delivering objectives and motivating students; (2) Presenting information; (3) Organizing students into learning groups (Numbering); (4) Guiding learning groups (Wuestioning) and (Head together); (5) Evaluation (Answering); and (6) Giving awards. Class VIII C was used as a control class by applying conventional learning methods where learning was still teacher-centered.

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In carrying out this research, in addition to using the right method, it is also necessary to choose relevant data collection techniques and tools. The use of data collection techniques and tools can enable objective data to be obtained. The data collection techniques used in this research are documentation, tests, and observation. The data used in this research is primary data, which is obtained through the instrument of student mathematical problem solving ability test. This test is an essay question designed to measure problem solving skills, namely: (1) Identify the problem; (2) Formulate the problem; (3) Apply the problem solving strategy; and (4) Interpret the results. The test instruments given had previously been validated by mathematics education lecturers and mathematics teachers at SMPN 5 Jambi City.

The data analyzed in this study were the posttest scores of students' problem solving skills in the experimental and control class groups. Data analysis was also carried out based on observation sheets regarding teacher and student activities during the learning process. In this study, statistical methods were used to analyze. There are two statistical analyses used in this study, namely descriptive statistical analysis and inferential statistical analysis to analyze posttest data. Data analysis using inferential statistics is intended to test hypotheses and answer the formulation of the problems posed. For the purposes of hypothesis testing, the assumption test was first carried out, namely the normality and homogeneity tests. The data credibility test was carried out using the data normality test, data homogeneity test and hypothesis test to test the average difference between the experimental class and the control class.

Results and Discussion

Description of Mathematical Problem Solving Ability Test Data

Posttest was conducted after learning. The results of descriptive analysis of students' mathematical problem solving ability scores in experimental and control classes can be seen in Table 1. below:

Table 1. Descriptive Statistics of Student Mathematical Problem Solving Ability Test Results

Class	N	Minimum	Maximum	Mean	Std. Deviation
Control	32	12	81	1,44	19,604
Experiment	33	25	87	3,33	23,290

Based on Table 1. it can be seen that the number of students who took the posttest in the control class was 32 students. The lowest score obtained by students was 12 and the highest score was 81, the average student score was 41.44 with a standard deviation of 19.604. In the experimental class, the number of students who took the posttest was 33 students with the lowest score of 25 and the highest score was 87, the average student score was 63.33 with a standard deviation of 23.290. Posttest data analysis output using SPSS version 29.0 for windows.

The results obtained by students are then grouped based on the criteria for interpreting students' mathematical problem solving ability scores. The grouping

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of students' mathematical problem solving ability test results based on the value criteria can be seen in Table 2 below:

Table 2. Student Mathematical Problem Solving Score Criteria

Score	Category	Experiment		Control	
		f	Persentage (%)	f	Persentage (%)
$81 \leq \bar{x} \leq 100$	Very High	11	33,33	1	3,125
$61 \leq \bar{x} < 81$	High	10	30,30	6	18,75
$41 \leq \bar{x} < 61$	Fair	4	12,12	9	28,125
$21 \leq \bar{x} < 41$	Low	8	24,25	10	31,25
$0 \leq \bar{x} < 21$	Very Low	0	0	6	18,75
Total		**33**	**100**	**32**	**100**

Based on Table 2. students' mathematical problem solving ability in the experimental class of 33.33% or 11 students were at very high criteria, 30.30% or 23 students were at high criteria, 12.12% or 4 students were at sufficient criteria, 24.25% or 8 students were at low criteria, and no students were at very low criteria. Meanwhile, in the control class 3.125% or 1 student was at very high criteria, 18.75% or 6 students were at high criteria, 28.125% or 9 students were at sufficient criteria, 31.25% or 10 students were at low criteria, and 18.75% or 6 students were at very low criteria. This shows that the mathematical problem solving ability of students in the control class is spread across all criteria.

In addition, it can also be seen the average test scores of students' mathematical problem solving ability for the achievement of each indicator in Table 3 below:

Table 3. Average Achievement of Each Indicator of Students' Mathematical Problem Solving Ability

No.	Indicator	Average of KPM	
		Experiment	Control
1.	Identifying the problem, students are able to identify the known and questionable elements of a problem	79,54	53,90
2.	Formulating problems, students are able to formulate a solution plan for the steps to be used	60,60	39,84
3.	Applying problem solving strategies, students are able to solve problems based on the steps	67,42	42,18
4.	Interpreting the results of the problem, namely being able to conclude or interpret the results of problem solving	46,21	30,46
Total		**63,44**	**41,59**

Based on Table 3. it can be explained that the average of each indicator of problem solving ability in experimental and control classes is the lowest value of problem solving ability in the fourth indicator, namely interpreting the results of the problem, which is able to conclude or interpret the results of problem solving, the average results obtained are 46.21% and 30.46%. The highest value of

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problem solving ability is in the first indicator, namely identifying problems, where students are able to identify known and questionable elements of a problem, the average results obtained are 79.54% and 53.90%.

Testing Analysis Requirements

This analysis aims to see if there is an effect of the Numbered Head Together (NHT) type cooperative learning model on mathematical understanding skills in class VIII students of SMP Negeri 5 jambi city. The data to be analyzed is the average score of students' mathematical problem solving ability test in the experimental class. The steps taken first are testing normality and homogeneity tests, if both are met then the next step is to test the hypothesis.

Normality Test

The normality test of students' mathematical problem solving ability test data is carried out to measure the data to be analyzed whether it is normally distributed or not. In this study, testing the normality of posttest data using One-Sample Kolmogorov-Smirnov statistics assisted by SPSS software version 29.0 for windows with a significant level of 5% ($\alpha = 0.05$). The complete normality test results can be seen in Table 4. below:

Table 4. Noemality Test Results Posttest Data

Class	Learning type	Significant	Decision	Conclusion
Experiment	NHT	0,115	Accept H_0	Normal
Control	Conventional	0,013	Accept H_0	Normal

Based on Table 4. obtained a significant value for the Kolmogorov-smirnov test of the experimental class is 0.115 and the control class is 0.013. The significant value of the experimental class and control class is greater than 0.102 so that H0 is accepted. This means that the distribution of posttest scores in the experimental and control classes is evenly distributed, so it can be said that the posttest scores of the experimental and control classes are normally distributed.

Homogeneity Test

The homogeneity test was conducted to see whether the posttest data of experimental and control class students were homogeneous or not. In this study, the test was carried out using the One Way Anova test assisted by SPSS software version 29.0 for windows. The results of the homogeneity test can be seen in Table 5. below:

Table 5. Homogeneity Test Results of Posttest Data

Statistik Levene	Db1	Db2	Significant	Decision	Conclusion
1,674	1	63	0,200	Accept H_0	Homogent

Based on Table 5. obtained a significant value of 0.200. This shows that the significant value is greater than 0.005 so H0 is accepted. Therefore, it can be concluded that the posttest data in the experimental class and control class have a homogeneous variance.

Hypothesis Test

The results of the calculation of the posttest data hypothesis with the right party t test can be seen in Table 6. below:

Table 6. Results of Posttest Data Hypothesis Test with Right Party t Test

Independent Sample t Test	t_{hitung}	***Sig. (2-tailed)***
Posttest Value After treatment	4,094	0,001

Table 6. shows that the significant value (2-*tailed*) = 0,001. Because this study uses a one-sided hypothesis test (1-tailed) namely the right-sided independent sample t-test, the significant value (2-tailed) must be divided by two to $\frac{0,001}{2}$ = 0,0005. This shows that with an error rate of 5% (α= 0,05) the significant value of 0,0005 < 0,05, it can be concluded that H_0 is rejected and H_a is accepted. This shows that the NHT model has a positive effect on students' mathematical problem solving ability.

Test Results of Students' Mathematical Problem Solving Ability in Experimental and Control Classes

In completing the mathematical problem solving ability test, there are terms that need to be considered in this study, these terms are presented in the following Table 7:

Table 7. Codes used in the stages of mathematical problem solving

Code	Description	Code	Description
K1	Known	K5	Step 2
K2	Asked	K6	Step 3
K3	Formula used	K7	Step 4
K4	Step 1	K8	Conclusion

Table 7. shows the steps that must be fulfilled by the subjects in solving the mathematical problem solving ability test questions. The experimental class showed good results in the understanding of power numbers. At the K1 stage, 100% of students were able to recognize the known data, and at K2, 87.87% of students could identify the question. This success continued at K3 with 90.90% of students understanding the rules of power numbers, as well as 96.96% of students who were able to continue the initial calculation steps at K4. However, at stages K5 to K8, there was a decline, where only 84.84% of students could write the final result in exponent form, and only 66.66% were able to conclude the final result logically. This shows that although the basic understanding was good, there were difficulties in applying and synthesizing the information.

In the second problem, in the experimental class, 81.81% of students were able to recognize the known data, while 75.75% could identify the question. Similar results were seen in K3 and K4, with 78.78% and 69.69% of students able to apply the rules of power numbers and perform the initial steps of the calculation, respectively. However, difficulties began to emerge in K5, where only 66.66% of students were able to describe power numbers. A more significant decline occurred in K6 and K7, where only 45.45% and 39.39% of students were able to convert the numbers to decimals and conclude the final results logically.

This indicates the need for more attention to the application and conclusion aspects.

In the control class, results showed that only 78.12% of students were able to recognize the data in the first problem, with 53.12% able to identify the question. In K3, 59.37% of students understood the rules of power numbers, but only 71.87% were able to continue the calculation in K4. In K5, the success rate of writing the final result in exponent form only reached 65.62%, while 68.75% of students were able to convert to decimal in K6. However, the level of difficulty was evident in K7, with only 40.62% of students successfully converting to KB units, and K8 showed that 59.37% of students were able to conclude the final result logically.

In the second problem in the control class, 65.62% of students recognized the known data, while 50% could identify the question. Only 43.75% of students successfully applied the rule of power numbers in K3, and in K4, only 34.75% worked on the first step of the calculation. In K5, only 31.25% of students were able to describe the power numbers, and the success rate in converting to decimal form in K6 was very low, only 18.75%. Finally, only 25% of students were able to logically conclude the final result in K7. Overall, the control class showed lower results than the experimental class, with many students struggling at each stage.

Based on descriptive data analysis, mathematical problem solving ability in the experimental class (using the Numbered Head Together model) showed higher results than the control class. In the experimental class, 33.33% of students or 11 students were at very high criteria, 24.25% or 8 students at low criteria, and no students at very low criteria. This is because the NHT model encourages students to be ready in the learning process through thinking together in groups. In contrast, in the control class only 3.125% or 1 student achieved very high criteria and 18.75% or 6 students were at very low criteria, because teacher-centered learning makes students tend to be passive.

In terms of each problem solving indicator, the experimental class showed a higher average score than the control class. The highest indicator in both classes was identifying problems (experimental 79.54%, control 53.90%), while the lowest indicator was interpreting problem results (experimental 46.21%, control 30.46%). The low ability to interpret the results is because most students still have difficulty understanding the answers they get, making it difficult to convey the interpretation results obtained in their groups.

In its implementation, the NHT model has systematic stages where the teacher presents the material first, then students are given LKPD which is adjusted to the indicators of mathematical problem solving ability. Students think together to ensure that each group member understands the answer, so that they are ready when their number is called randomly for presentation. In contrast, conventional learning is more teacher-centered with students recording material and working on problems according to examples, making learning less interactive although more efficient in terms of time.

The result of t-test (independent sample t-test) shows a significant value (1-tailed) of 0,0005 < 0,05, which proves that H0 is rejected and Ha is accepted. This shows that the NHT model has a positive effect on students' mathematical problem solving skills. The experimental class students showed better ability in identifying

the elements of the problem and re-examining the results, although they were still lacking in writing the steps of the solution systematically. This is in line with the research of Mardiah (2019), Ummi (2018), and Setiyani (2022) who found a positive effect of the NHT model on mathematical problem solving ability.

The effectiveness of the NHT model is evident from the success of students in solving two test questions. In the experimental class, for the first problem, students showed high success in recognizing data (100%), understanding questions (87.87%), applying rules (90.90%), and preliminary calculations (96.96%). The second problem also showed good results with percentages above 69% for each stage. While in the control class, the percentage of success was lower with an average of below 80% for the first problem and below 65% for the second problem. These results are in line with Silitonga's research (2024) which found that each stage of the student problem solving process with NHT learning was better than conventional learning.

The NHT model is proven to be better than conventional learning because it provides opportunities for students to develop problem-solving skills through thinking together, increases student activity, and encourages personal responsibility. Students can share ideas and encourage the implementation of personal responsibility with their group in completing the LKPD. Thus, the NHT model can be an effective learning alternative for educators to create more active mathematics learning, increase student responsibility, and better develop mathematical problem solving skills.

Conclusion and Suggestion

Based on the results of data analysis, it can be concluded that the Numbered Head Together (NHT) type cooperative learning model has a positive effect on students' mathematical problem solving skills. This is evidenced from two aspects: first, the success of experimental class students in solving whole number test questions is better with an average of above 80% in the early stages of work, compared to the control class which is below 80%; second, the results of descriptive analysis show that the average value of mathematical problem solving ability of experimental class students (63.33) is higher than the control class (41.44), and strengthened by the results of the independent sample t-test which obtained a significant value (1-talled) of 0,0005 < 0,05 at a significant level of 5%.

Future researchers are expected to pay attention if they want to examine the treatment of the NHT model in Cooperative Learning, they should be able to plan the learning well so that there is no commotion of students in preparing answers in front of the class which does not interfere with the learning atmosphere of other classes.

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