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The effect of the numbered heads together cooperative learning model on students' mathematical understanding in statistic

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Abstract.
Students' low understanding of mathematics is one of the main challenges in the learning process at school. This low understanding is often closely related to the learning methods used by teachers, which are less able to facilitate active involvement and deep understanding of concepts by students. This study aims to analyze the differences in mathematical comprehension abilities between students who learn through the Numbered Heads Together (NHT) cooperative model and conventional learning, and to examine the extent of the influence of the NHT model on students' mathematical comprehension abilities in the experimental class. This study used a quantitative approach with a quasi-experimental method and a nonequivalent pretest-posttest control group design. The population of the study was eighth grade junior high school students, with a cluster random sampling technique. The main instrument was a mathematical comprehension ability test, and the data were analyzed using normality, homogeneity, N-gain, t-test, and paired sample t-test. The results of the study indicate that the Numbered Heads Together (NHT) learning model is more effective in enhancing students' mathematical understanding ability compared to conventional learning.

Keywords:
Mathematical understanding ability; numbered heads together; statistic

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INTRODUCTION

Mathematical understanding is one of the basic competencies in mathematics learning, including the ability to absorb material, remember formulas and concepts, and apply them in simple or similar situations (Hermawan et al., 2021). In the 2013 Curriculum, the objectives of mathematics learning are reflected in the core and basic competencies at each level of education, which shows the importance of mathematical understanding for students. When students understand mathematical concepts, they will develop other mathematical thinking skills (Khoerunnisa & Hidayati, 2022). This indicates that the material taught is not only to be memorized, but it is hoped that students can understand the concept of the material. As conveyed by Marpaung, mathematics will lose its meaning if it is only memorized; with understanding, students can deepen the concept of the material itself (Meidianti et al., 2022).

The importance of students' understanding ability is to understand and interpret learning materials (Safari & Nurhida, 2024). When students do not understand the basic material, they will face various difficulties in understanding the next material, which has the potential to cause continued confusion. This is in line with the view of (Hikmah, 2017), which states that students' understanding in learning is a crucial factor in achieving mathematics learning goals. Students who have an understanding of a mathematical material or concept will be seen from their ability to solve various mathematical problems (Cahani et al., 2021). However, students' mathematical

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understanding abilities are actually still relatively low in understanding mathematical concepts in Indonesia.

The low mathematical understanding ability of students in Indonesia. Judging from the results of the TIMSS (Trend In International Mathematics and Science Study) study in 2019, Indonesia was ranked 54th out of 58 countries with a score of 397, which is still far below the international average score of 500 (Mullis et al., 2020). The 2018 PISA (Programme of International Study Assessment) study showed that Indonesian students' mathematical abilities are still in the low category. Indonesia scored 379, which is still far below the international average score of 489. This score is also still below the achievements of other ASEAN countries, such as Thailand (419), Vietnam (496), and Singapore (569). This year Indonesia is ranked 74 out of 79 participating countries (OECD, 2023). Based on the results of the TIMSS and PISA surveys, it can be concluded that the level of mathematical understanding of Indonesian students is still relatively low.

One of the factors that causes students' low mathematical understanding ability is their negative view of mathematics. Students often consider mathematics as a difficult subject because it is abstract, logical, systematic, and full of confusing symbols and formulas (Buyung et al., 2022). This is in line with Mulyani's research, which shows that students often have difficulty connecting one concept to another and have difficulty applying previously learned concepts, so they experience obstacles in solving problems (Mulyani et al., 2018). This is also similar to the results of preliminary observations conducted at SMP 2 Lembar class VIII, it was found that that the ongoing learning process is still conventional, where teachers have not created a pleasant learning atmosphere and are able to foster students' curiosity about the subject matter. Learning tends to be teacher-centered, so that students appear passive and less actively involved in the learning process. This has an impact on low student motivation to master the material being taught. In addition, teachers have not utilized innovative learning methods or models, such as the Numbered Heads Together (NHT) cooperative learning model, which emphasizes the active involvement of students in the learning process (student-centered) (Fatimah & Syamsudin, 2021). This model can deepen students' understanding of the subject matter, train responsibility, and increase students' self-confidence (Anwar et al., 2018).

Based on the above conditions, to improve students' mathematical understanding abilities, it is necessary to find progressive learning innovations. One effort that can be made is to use the NHT cooperative learning model. The NHT learning Model is a method designed by Kagan to increase student involvement in understanding the subject matter presented in class, as well as influence interaction patterns between them (Pendy & Mbagho, 2020). In its application, students are divided into groups of 4-5 people to improve their learning outcomes (Septrijiwati et al., 2016). According to Anita Lie, the advantages of the NHT learning model are as follows: 1) Facilitates the division of tasks; 2) Facilitates students in carrying out personal responsibilities; 3) Increases the readiness of each student; 4) Facilitates teachers in monitoring; 5) Facilitates deeper discussions; 6) Providing opportunities for smart students to help less smart students (Lestari, 2015). The disadvantages of the NHT learning model include 1) students with low abilities tend to feel panicked and afraid if their number is called by the teacher; 2) there is a possibility that the same number will be called more than once by the teacher; 3) time constraints so that not all group members get the opportunity to be called (Manafe et al., 2022).

The use of the NHT learning model has been proven effective in improving students' mathematical understanding skills. This is in line with Wardhani (2017) that with the NHT type cooperative learning model, students learn to be able to explain and convince when they are challenged to think and give reasons about mathematics and communicate the results of their thinking to others (Wardhani, 2017). Therefore, the NHT type cooperative learning model can be an alternative or the right solution in improving students' mathematical understanding skills. This study aims to determine whether there is a difference in the increase in mathematical understanding skills between students who take part in learning with the NHT model in the experimental class and students in the control class. In addition, this study also aims to determine the extent to which

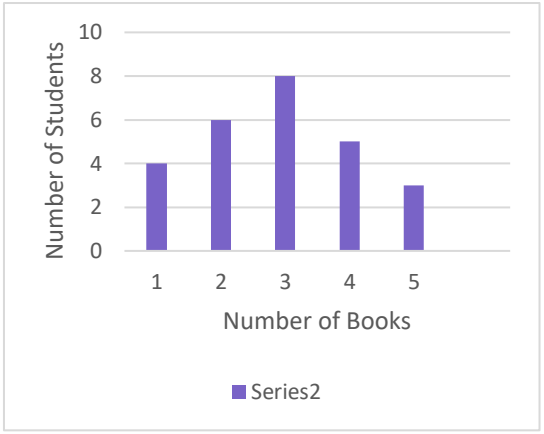
the NHT learning model influences students' mathematical understanding skills. The formulation of the problem is: 1) Is there a difference in students' mathematical understanding skills before and after learning is carried out. 2) Is the increase in mathematical understanding ability of students taught using NHT better than that of students who learn using conventional models?

METHOD

The research approach used in this study is quantitative with an experimental method. (Sugiyono, 2019), the experimental method is a research method that aims to determine the effect of a particular treatment. In this study, the treatment given was in the form of implementing a cooperative learning model of the NHT type, with the research design used being nonequivalent pretest-posttest group design. The population in this study were students of grade VIII, with a sampling technique using cluster random sampling. Class VIII A was designated as the experimental class that would receive learning with the NHT model, while class VIII B was the control class that would receive conventional learning. Before being given treatment, both groups would be given a pretest on the material mean, median, and mode. After learning the statistical material was complete, a posttest would be given to both groups to measure their mathematical understanding.

The research instrument employed in this study was a mathematical comprehension ability test, designed to assess students' understanding of key mathematical concepts. The test consisted of four descriptive questions, each developed to align with specific indicators of mathematical comprehension. These indicators include: (1) restating a concept, (2) classifying objects based on specific properties related to the concept, (3) using or selecting appropriate procedures or operations, and (4) presenting a concept in various forms of mathematical representation. A detailed mapping of the test items and their corresponding indicators is presented in Table 1.

Table 1. Form of mathematical comprehension ability test instrument on statistics material

<table>
<tr><th>Indicator</th><th>Question</th></tr>
<tr><td>Restating a concept</td><td>The bar chart below shows the number of books read by a group of students during a month.
 

Determine the mean, median, and mode of the data on the number of books read by the students.</td></tr>
<tr><td>Classifying objects according to certain properties with concepts</td><td>The table below shows the mid-semester test results from a group of students
<table><tr><td>Mark</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr><tr><td>Frequecy</td><td>2</td><td>3</td><td>4</td><td>5</td><td>3</td><td>2</td><td>1</td></tr></table>.
a. Determine the average of the data above?
b. How many students scored above average?</td></tr>
<tr><td>Using, Utilizing, selecting a particular procedure or operation</td><td>The average weight of 9 UIN Mataram students is 44 kg, if Doni's weight is included in the calculation, the average becomes 44.7. Determine Doni's weight.</td></tr>
</table>

Presenting concepts in various forms of mathematical representation

The table below shows data on the number of children on each Family Card (KK) in East Jelateng Village.

RT	Family card	Many Children
RT1	6	0
RT2	11	1
RT3	7	2
RT4	9	3
RT5	4	4
RT6	2	5

a. Make the data above in the form of a bar chart?
b. How many families have more than 2 children?
c. How many children are there on average per family?
d. What is the median and mode of the data?

Data analysis techniques in this study include descriptive statistics to provide an overview of students' mathematical understanding abilities, as well as inferential statistics to answer the formulation of research problems. The prerequisite tests used include normality tests and homogeneity tests. Furthermore, for hypothesis testing using the t-test on Pretest and Posttest data and N-Gain.

RESULTS AND DISCUSSION

This study aims to compare students' mathematical understanding abilities between those who were taught using the Numbered Heads Together (NHT) cooperative learning model and those who received instruction through conventional teaching methods. The analysis was conducted to determine whether there were significant differences in students' performance based on the instructional approach used. The results of the statistical analysis, including descriptive statistics and inferential tests, are summarized in Table 2.

Table 2. Descriptive statistics of students' mathematical understanding abilities

	Experimental Class			Control Class		
	Pretest	Posttest	n.Gain	Pretest	Posttest	n-Gain
N	30	30	30	30	30	30
Mean	25.33	63.333	0.5197	25.533	45.87	0.2762
Min	10	35	0.20	5	20	0.10
Max	45	85	0.77	50	60	0.51
Std.deviasi	9.003	14.8332	0.1609	9.9160	12.311	0.1148

In the experimental class, which applies the NHT type cooperative learning model, there are 30 students who took the pretest and posttest. The average pretest score was 25.333 with a minimum score of 10 and a maximum score of 45. The standard deviation in the pretest was 9.0032, indicating a fairly large variation in scores among students.

After the implementation of the NHT model, the average posttest score increased significantly to 63.333. The minimum and maximum scores were 35 and 85, respectively, with the standard deviation increasing to 14.8332. This shows that although there was a significant increase in mathematical understanding, the variation in scores among students also increased.

In the control class, which uses conventional learning methods, there are also 30 students who took the pretest and posttest. The average pretest score was 25.533 with a minimum score of 5 and a maximum score of 50. The standard deviation on the pretest was 9.9160.

On the posttest, the mean score increased to 45.87. The minimum and maximum scores were 20 and 60, respectively, with the standard deviation increasing to 12,311. This shows that although there was a significant increase in mathematical understanding, the variation in scores among students also increased.

To answer the formulation of the problem that has been set, Next, an inferential statistical analysis is carried out on the pretest and posttest data. This analysis will be carried out using SPSS software to obtain more objective results. The results of the inferential statistical test are presented as follows.

Normality Test

A normality test was conducted to determine whether the distribution of the post-test learning outcome data met the assumption of normality, which is a prerequisite for parametric statistical analysis. In this study, the Liliefors test was employed to assess the normality of the data. The statistical decision criteria for the normality test were based on a comparison between the calculated L-value and the critical value from the Liliefors table at a specified significance level. A summary of the normality test results for each group is presented in Table 3.

Table 3. Analysis of normality test results

Data	Experiment	Conclusion	Control	Conclusion
Pretest	0.796	Normal	0.910	Normal
Posttest	0.70	Normal	0.071	Normal
N-gain	0.113	Normal	0.29	Normal

Based on Table 3, the results of the normality test of the pretest and posttest data show that the significance values in the pretest are 0.796 and 0.910, in the posttest 0.70 and 0.071, and in N-Gain 0.113 and 0.29. Since all significance values are > 0.05, this indicates that H_0 is accepted. Therefore, it can be concluded that the data is normally distributed.

Homogeneity Test

The next prerequisite test is the homogeneity test. The homogeneity test is conducted to determine whether the sample comes from a population with the same variance. The calculation of the post-test homogeneity test in the experimental class and control class can be seen in Table 4.

Table 4. Analysis of homogeneity test results

Group	Data					
	Pretest	Conclusion	Posttest	Conclusion	N-Gain	Conclusion
Experiment Control	0.772	Homogeneous	0.158	Homogeneous	0.14	Homogeneous

Based on Table 4, the results of the homogeneity test of pretest and posttest data show that the significance value in the pretest is 0.772, in the posttest is 0.158, and in N-Gain is 0.14. Because all significance values are greater than 0.05, then H_0 is accepted, which means that both variances are homogeneous.

Hypothesis Testing

To test the research hypotheses, both the paired sample t-test and the independent sample t-test were employed. The paired sample t-test was used to examine whether there was a significant difference in students' mathematical understanding before and after the learning intervention within each group. Meanwhile, the independent sample t-test was conducted to determine whether students taught using the Numbered Heads Together (NHT) cooperative learning model demonstrated significantly higher levels of mathematical understanding compared to those taught through conventional learning methods. The results of the statistical calculations related to students' mathematical comprehension are presented in Table 5.

Table 5. Paired sample correlation statistics

Pair	N	Correlation	Sig. (2-tailed)
Pair 1: PreE – PostE (Experimental Group)	30	0.757	0.000
Pair 2: PreC – PostC (Control Group)	30	0.749	0.000

Note: PreE = Pretest (Experimental), PostE = Posttest (Experimental), PreC = Pretest (Control), PostC = Posttest (Control)

The results of the paired samples correlation test indicate a significant relationship between the pretest and posttest scores in both the experimental and control groups. As shown in the analysis, the significance value for both Pair 1 (PreE–PostE) and Pair 2 (PreC–PostC) is 0.000, which is less than the conventional alpha level of 0.05. This suggests that there is a statistically significant correlation between students' performance before and after the learning intervention, indicating consistency and a strong linear relationship between the two sets of scores.

Further analysis using the paired samples t-test was conducted to evaluate the mean difference between the pretest and posttest scores within each group. The results, as presented in Table 6, show that both the experimental and control groups experienced significant improvements in their mathematical understanding following the instructional intervention.

Table 6. Results of paired samples t-test

Pair	Mean Difference	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
				Lower	Upper			
Pair 1: PreE – PostE (Experimental)	−20.333	8.070	1.473	−23.347	−17.320	−13.800	29	
Pair 2: PreC – PostC (Control)	−38.000	10.045	1.834	−41.751	−34.249	−20.721	29	

In Pair 1 (PreE–PostE), the mean difference was −20.33 ($p < 0.001$), while in Pair 2 (PreC–PostC), the mean difference was −38.00 ($p < 0.001$). These findings confirm that the learning interventions had a statistically significant effect on students' mathematical understanding abilities in both groups. To further explore the impact of the learning interventions on students' mathematical understanding abilities, an independent t-test was conducted to compare the differences in the posttest scores between the experimental group (NHT) and the control group (conventional learning). The results of this analysis are presented in Table 7, which summarizes the statistical findings regarding the significance of the difference in the score gains between the two groups.

Table 7. Results of the independent t-test

		F	Sig.	t	df	Sig. (2-tailed)
n_gain	Equal variances assumed	6.477	.014	-6.746	58	.000
	Equal variances not assumed			-6.746	52.446	.000

As shown in Table 7, the independent t-test was conducted to compare the score gains between the experimental group, which received the Numbered Heads Together (NHT) cooperative learning model, and the control group, which was taught using conventional methods. The results indicate a statistically significant difference in the score gains between the two groups. Specifically, the Levene's test for equality of variances yielded a significance value of 0.014, suggesting that the assumption of equal variances was violated. Nevertheless, the t-test results (t

= -6.746, df = 58, $p < 0.001$) demonstrate that the mean gain in mathematical understanding was significantly higher for the experimental group compared to the control group.

The negative t-value indicates that the experimental group outperformed the control group in terms of the magnitude of improvement in their mathematical understanding. The very small p-value ($p < 0.001$) confirms that this difference is statistically significant, further supporting the hypothesis that the NHT model was more effective in enhancing students' mathematical understanding than the conventional teaching approach.

The Numbered Heads Together (NHT) cooperative learning model is based on the principle that students will find it easier to understand concepts if they are involved in discussions and collaboration in small heterogeneous groups of 4-5 people (Kusnaeni et al., 2023). The formation of this group not only aims to improve students' knowledge and understanding, but also to develop specific skills, such as the ability to be an active listener during the learning process, the ability to provide clear explanations to group members, and active participation in discussions. Each group is expected to be able to carry out these roles in order to achieve completeness in understanding the material being studied (Putri & Jamaan, 2020).

In the learning process using the Numbered Heads Together (NHT) cooperative learning model, students in the experimental class showed a higher level of activity (Imam et al., 2022). They felt happier and more motivated because the learning atmosphere created was relaxed, open, and based on mutual trust between group members. This provides an opportunity for each student to provide input to each other in order to develop knowledge, attitudes, values, and skills in learning. Each learning session involves discussion, sharing understanding, and correcting each other between group members, which ultimately fosters positive dependency between them. If there are group members who are less motivated in learning, other members will provide support and encouragement to continue to participate actively. Thus, learning can take place more effectively for all group members (Sandratari & Bahfen, 2024).

After the discussion stage is complete, the learning process continues with the presentation of group work results. In this stage, the teacher will draw student numbers to determine who will represent the group in presenting their work results. Each student whose number is selected is responsible for delivering the results of their group discussion (Suarni et al., 2019). At this stage, there is an educational interaction that strengthens student understanding. After the presentation is complete, the teacher will evaluate the results of the student's work that has been submitted in the group worksheet. Students or groups with the best results will be given awards as a form of appreciation (Linawati, 2020). This aims to provide a meaningful learning experience, foster a sense of pride in their achievements, and motivate other group members to continue to increase their enthusiasm for learning and try better in the next opportunity.

On the other hand, in conventional learning models, the role of teachers is more dominant than students. Teachers play an active role in delivering materials directly in the control class, while students only receive information without active involvement in the learning process. In conventional learning, students are not required to find concepts independently, but must be able to construct understanding based on explanations given by the teacher. Based on observations during the study, students had difficulty constructing their understanding independently due to lack of focus during learning and the need for repeated explanations.

During the learning process, only some students actively ask questions, while others tend to be passive and need encouragement from the teacher to be more courageous in asking questions when facing difficulties in understanding the material. When working on student worksheets, they tend to form groups spontaneously. However, the groups formed are different from groups in the cooperative learning model because they are more exclusive, consist of close friends, and show less positive dependence among their members. In this group, only a few students actively seek answers, while others only copy answers from other group members. However, the conventional learning model still has advantages, especially for students with auditory and visual learning styles. Students with a preference for learning through listening and observing will find it easier to understand the material in this model.

The difference between the experimental class and the control class reflects the difference in the average mathematical understanding ability of students. The results of the study showed that the understanding of students in the experimental class was higher than the control class. This indicates a significant influence of the use of the NHT type cooperative learning model in improving student understanding. This finding is in line with research conducted by (Khoiriyah, 2018), which states that the NHT learning model encourages students to be responsible and play an active role in guiding their group members during the learning process. Thus, the NHT type cooperative learning model is proven to be more effective than the conventional learning model, as shown by the difference in the higher average scores in the experimental class compared to the control class.

The increase in mathematical understanding that occurred in the experimental class was not only reflected in the involvement of students during the learning process, but also in the results of data analysis. During the study, students in the experimental class showed a significant increase, both in understanding concepts and in learning activity. In line with research Putri and Jamaan (2020) observations during the study revealed that students were more serious in discussions, more responsible in completing their tasks as individuals and group members, and more optimal in utilizing discussion sessions to improve their understanding. In addition, the use of the NHT learning model also had a positive impact on students' learning motivation. The increase in mathematical understanding of students in the experimental class can not only be seen from the results of observations in the field, but also from data analysis which showed a higher increase compared to the control class.

The pretest and posttest results obtained from one student in the experimental class further support this finding. The student's responses to the four questions, which were designed based on the indicators of mathematical understanding, demonstrated a significant improvement following the implementation of the Numbered Heads Together (NHT) cooperative learning model. These results highlight a notable increase in the student's ability to apply mathematical concepts, classify objects according to properties, select appropriate procedures, and present mathematical ideas in various forms. The detailed progress of the student's understanding is visually represented in Figure 1, which shows a clear upward trend in the accuracy and depth of responses from the pretest to the posttest.

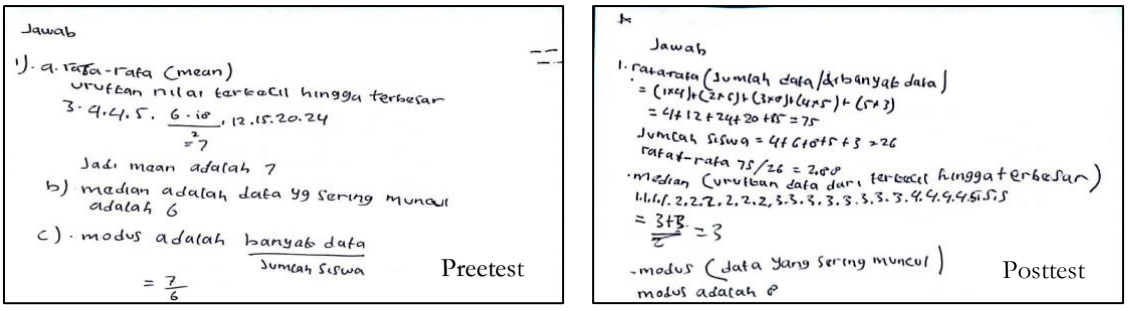


Figure 1. Pretest and posttest responses to question 1 in the NHT class

Based on Figure 1, the students' pretest and posttest responses indicate an improvement in conceptual understanding. Question 1, which assesses the ability to restate a concept, revealed in the pretest that students were unable to accurately articulate the given concepts. This difficulty stemmed from misconceptions in defining mean, median, and mode, which in turn affected the precision of their calculations. However, after the implementation of the Numbered Heads Together (NHT) cooperative learning model, the posttest responses demonstrated a notable improvement in students' understanding. They were able to correctly rewrite the definitions of mean, median, and mode and perform the associated calculations with greater accuracy.

This improvement is further supported by observations made during the learning process, which suggest that students were more motivated when learning was conducted through group discussion. In the NHT model, students are encouraged to engage with the material collaboratively.

Each group received a student worksheet (LKPD) to discuss collectively. Members were assigned head numbers corresponding to the number of questions, and each student was responsible for solving the question associated with their assigned number. The teacher would then randomly call a number, and the student with that number was required to present their group's answer in front of the class. Simultaneously, students from other groups with the same number were also asked to present their answers.

This structure fostered active participation and mutual understanding within and across groups. If an error occurred in a student's response, the teacher provided clarification and guidance to ensure conceptual accuracy. Through this process, students were not merely memorizing definitions but developing a deeper understanding that enabled them to articulate concepts in their own words. Additional response patterns and examples of student improvement are illustrated in Figure 2.

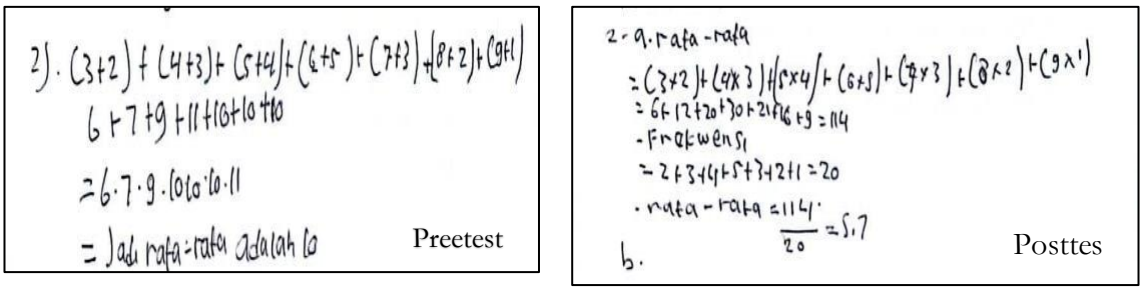


Figure 2. Pretest and posttest responses to question 2 in the NHT class

As shown in Figure 2, the students' responses to question 2 indicate a marked improvement in their conceptual understanding following the implementation of the Numbered Heads Together (NHT) cooperative learning model. Question 2 was designed to assess students' ability to classify objects based on specific characteristics—in this case, the calculation of the mean from tabular data. The pretest results reveal that students struggled to accurately determine the mean, primarily due to difficulties in identifying and defining the relevant data presented in the table. This conceptual gap hindered their ability to carry out appropriate problem-solving strategies.

However, the posttest results demonstrate a significant improvement. After engaging with the NHT learning model, students were able to correctly interpret the tabular data and compute the mean with greater accuracy. Their answers were not only more precise but also aligned with the conceptual focus of the question, indicating a deeper understanding of statistical measures.

This improvement is supported by observations made during instructional sessions in the experimental group, where students consistently exhibited high levels of engagement—particularly during collaborative discussions. The NHT model appeared to foster increased enthusiasm and motivation among students, which contributed positively to their learning outcomes.

Several factors contributed to the observed enhancement in students' conceptual understanding through the application of the NHT model. First, the group discussion format encouraged active participation, requiring students to engage with the content meaningfully in order to contribute to their group's collective task. Second, the structure of the NHT method—where each student is assigned a unique head number corresponding to a specific question—promoted individual responsibility and accountability. Students were aware that they might be called upon to present their answers publicly, which motivated them to gain a thorough understanding of the material.

Third, and equally important, this model facilitated the development of students' interpersonal and social skills. Students were required not only to master their own question but also to comprehend and support the solutions presented by peers within and across groups. This interactive process allowed students to categorize and relate mathematical concepts more effectively, helping them to identify the relationships between different types of data and problem contexts.

In summary, the implementation of the NHT cooperative learning model significantly enhanced students' ability to classify mathematical data based on defined properties, as evidenced in their improved performance on question 2. This supports the broader claim that collaborative, structured learning environments can foster deeper mathematical understanding. Additionally, the outcomes of students' responses to question 3, which assesses the indicators of employing, utilizing, and selecting specific procedures or operations, are presented in Figure 3.

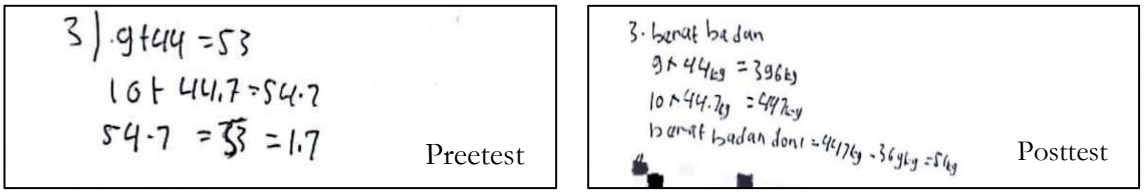


Figure 3. Pretest and posttest responses to question 3 in the NHT class

As illustrated in Figure 3, students' responses to question 3 demonstrate a noticeable improvement in their conceptual and procedural understanding following the instructional intervention using the Numbered Heads Together (NHT) learning model. Question 3 was designed to assess students' ability to use, utilize, and select appropriate mathematical procedures or operations in problem-solving contexts. The pretest responses indicate that students encountered difficulty in selecting and applying the correct mathematical operations. Specifically, many students failed to use multiplication correctly to determine the total body weight before performing addition, resulting in inaccurate answers. This suggests a lack of procedural fluency and an incomplete understanding of the sequence of operations required to solve the problem effectively. After receiving instruction through the NHT model, the posttest results show a substantial improvement. Students demonstrated the ability to choose appropriate operations and execute the procedures accurately, leading to correct solutions. This improvement reflects not only enhanced computational skills but also a deeper understanding of the logical structure of the problem.

This outcome is further supported by classroom observations during the experimental sessions. The implementation of the NHT model, which emphasizes structured group collaboration and individual accountability, appeared to engage students more actively in the learning process. Each student was assigned a head number corresponding to a specific problem in the student worksheet (LKPD), which they were responsible for solving and later potentially presenting to the class. This format required students to understand the procedures thoroughly—not just to complete their own problem, but also to support their peers' learning within and across groups.

Moreover, the presentation phase—where the teacher randomly called head numbers and students explained their answers—encouraged students to not only apply the correct procedures but also articulate their reasoning. In doing so, students practiced justifying their choice of operations and defending their problem-solving strategies. This process fostered both mathematical communication skills and deeper conceptual understanding. In conclusion, the findings from Figure 3 confirm that the use of the NHT model significantly enhanced students' ability to appropriately select and apply mathematical procedures in solving contextual problems. This indicates the model's potential to develop both individual accountability and collaborative problem-solving skills in mathematics education. Additionally, the results of students' responses to question number 4, which assesses the indicator of presenting concepts in diverse forms of representation, are presented in Figure 4.

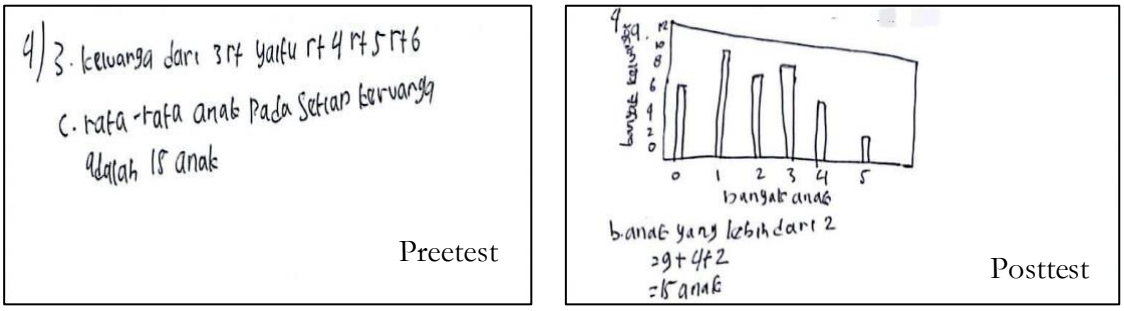


Figure 4. Pretest and posttest responses to question 4 in the NHT class

Based on Figure 4, the pretest and posttest answers of students show an increase in understanding of the concept. In the results of answer number 4, which measures the indicator of presenting concepts in various forms of representation, it can be seen that in the pretest students were not yet able to change or present concepts in other forms of representation, so that the answers given were incomplete. However, in the posttest, students showed an increase in ability by successfully presenting concepts in other forms appropriately and correctly. This is supported by the experience during the learning process using the nht learning model where when dividing groups and giving head numbers and giving LKPD, students must complete questions according to the head numbers they get and then discuss them with their group members. After that, the teacher calls one of the numbers to present the results of cooperation in their group. Each group member must understand the answer to be presented, while representatives from other groups with the same number also convey their answers. Through this process, students can learn to convey mathematical concepts in verbal, numeric, symbolic, and visual forms, thereby increasing their understanding of the concepts being learned.

The description is supported by the results of statistical analysis of pretest and posttest data processed using the paired sample test and independent t-test, which aims to test the hypothesis regarding the increase in mathematical understanding abilities in students in the experimental class and control class and there is a significant difference in the increase in students' mathematical understanding abilities . The results of the analysis show that H_0 is rejected and H_a is accepted, which indicates that the increase in mathematical understanding abilities of students who take part in learning with the NHT cooperative model is more significant than students who receive learning using conventional methods. This is in line with Afifah (2019) showing that the NHT cooperative learning model plays a role in improving student learning outcomes.

The level of influence of the NHT cooperative learning model on students' mathematical understanding abilities is in the large category. This shows that in addition to being influenced by the application of the NHT learning model, there are other factors that contribute during the learning process. These findings are supported by the empirical data obtained, where the differences in learning outcomes between students in the experimental class and the control class are not intentional results, but are a consequence of the application of different learning methods. In addition , differences in mathematical understanding abilities are also influenced by various other factors, such as teacher skills in managing the class, students' academic abilities, individual characteristics of students, and other supporting factors in the learning process (Suhailah et al., 2025).

This finding is further strengthened by the results of observations during the learning process, which show that there are other factors that contribute to improving students' mathematical understanding. One of the main factors is basic abilities and previous learning experiences. Students who have good basic abilities and adequate learning experiences, coupled with a willingness to try during the learning process, tend to find it easier to develop their understanding. This process is further strengthened by the application of the NHT cooperative learning model, which has an impact on improving students' understanding in the experimental class compared to the control class. These results are in line with research conducted by (Hevriansyah & Megawanti, 2017), which states that learning outcomes are influenced by students'

abilities and the learning environment. Group learning makes it easier for students to recall previously learned material, especially when supported by a strong basic understanding before learning new concepts, such as statistics material. Thus, learning becomes more effective and meaningful.

CONCLUSIONS

Based on the findings presented, it can be concluded that the implementation of the learning interventions led to a statistically significant improvement in students' mathematical understanding. This conclusion is supported by the results of the paired sample t-test, which indicated a significant increase in posttest scores compared to pretest scores in both the experimental group, which received instruction through the Numbered Heads Together (NHT) cooperative learning model, and the control group, which received conventional instruction. Furthermore, the magnitude of improvement was greater in the experimental group. This is evidenced by the results of the independent sample t-test, which demonstrated a statistically significant difference in the gain scores between the two groups, with the NHT group achieving a higher average increase. These findings suggest that the NHT model is more effective in enhancing students' mathematical understanding compared to traditional instructional approaches.

Theoretical and practical implications of this study highlight the potential of cooperative learning strategies, particularly NHT, in fostering deeper conceptual understanding in mathematics education. Educators are encouraged to adopt collaborative models such as NHT to promote active student engagement and improve learning outcomes. Additionally, curriculum developers may consider integrating such approaches into instructional guidelines to support meaningful learning experiences. However, this study has several limitations. First, the research was conducted within a limited sample and specific educational context, which may affect the generalizability of the results. Second, the study focused solely on short-term learning outcomes, without examining long-term retention or transfer of understanding. Future research is recommended to involve larger and more diverse populations, and to investigate the sustained effects of cooperative learning strategies over time.

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