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THE EFFECT OF NUMBERED HEADS TOGETHER (NHT) ON ELEMENTARY SCHOOL STUDENTS' MATHEMATICAL PROBLEM-SOLVING ABILITY IN GEOMETRY

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ABSTRACT

Within the framework of mathematics learning at the elementary school level—particularly in geometry—many students still struggle to fully understand the material and experience difficulties in problem-solving. They often focus on achieving the final answer without a deep understanding of the problem-solving process. This study aims to examine the effect of the cooperative learning approach, specifically the Numbered Heads Together (NHT) model, on the mathematical problem-solving abiities in geometry of fifth-grade students at a state elementary school in Central Jakarta. The research employs a quantitative method with a quasi-experimental design. Data were gathered through a test comprising 10 essay questions. The analysis involved tests for normality, homogeneity, and hypothesis testing. Post-test scores exceeded pre-test results, demonstrating the effectiveness of the NHT model. The significance value of the t-test ($p < 0.005$) indicates that H_0 is rejected and H_1 is accepted, showing that the NHT model significantly influences fifth-grade students' mathematical problem-solving ability.

Keywords: Elementary School Students, Numbered Heads Together, Problem Solving

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PRELIMINARY

Mathematics is a subject used all over the world that supports the growth of modern technology and helps people solve everyday problems (Latifah & Afriansyah, 2021). In mathematics education, mathematics is often perceived as a more complex, monotonous, and difficult-to-understand subject (Putri et al., 2021). Consequently, it is essential to explore strategies for fostering students' competencies in solving mathematical problems. Students are challenged to solve problems that require steps and strategies to get at solutions. These steps and strategies are acquired through problem-solving, which are a primary goal of mathematics education (Anggraini et al., 2021).

According to the National Council of Teachers of Mathematics (NCTM) as cited in Destiana (2020), the objectives of mathematics education include: (1) problem-solving, (2) reasoning and proof, (3) connections, (4) communication, and (5) representation abilities. Among these goals, learning how to solve problems is especially important for students. The importance of problem-solving abiities is further supported by expert opinions. For instance, Cooney, as cited in Mulyanti et al., (2018), emphasizes that problem-solving are essential for students because they support analytical thinking in everyday decision-making and encourage critical thinking when encountering new situations.

Similarly, Iswara & Sundayana (2021)s argue that it is essential that students develop problem-solving ablities since (a) problem-solving is a general goal of mathematics instruction, (b) it encompasses methods, procedures, and strategies that form the core processes of the mathematics curriculum, and (c) it is a fundamental skill in learning mathematics. Furthermore, Mulyadi & Mislaini (2023) assert that solving problems is a basic human activity, as individuals inevitably face challenges in life. Teaching students to solve problems enables them to make more rational decisions in daily situations.

Referring to the significance of mathematical problem-solving abiities, this competency should ideally be understood and mastered by students within formal education settings (Siswanto & Meiliasari, 2024). Nevertheless, reality shows that many students are yet to develop strong competences in mathematical problem-solving, particularly in the topic of geometry.

According to the researchers' observations in the fifth-grade classroom at one of school in central Jakarta, SDN CBT (the name of the school is a pseudonym), as well as input from the classroom teacher indicating students' weak problem-solving ablities in geometry. This phenomenon becomes more apparent when students are presented with problem-solving tasks. Students often rely on teacher guidance, frequently asking for instructions on how to begin solving the problems. This phenomenon occurs because students have not yet fully developed the ability to interpret the problems embedded in the questions, leading to challenges in solving them. Some students even provide only the final answer without including the steps or processes involved. Additionally, some students perceive the questions as overly complex because they differ from the examples provided by the teacher. The low level of mathematical problem-solving abilities among students is further reflected in their performance, with the majority scoring below the Minimum Competency Criteria (*Kriteria Ketuntasan Minimal/ KKM).*

According to Polya's problem-solving indicators, as cited in Sagita et al., (2023), these include: (1) understanding the problem, (2) planning the solution strategy, (3) solving the problem, and (4) reviewing the solution. Students are considered to possess high mathematical problem-solving abilities if they meet all these indicators. Given these issues, it can be inferred that students at SDN CBT require improvement in their mathematical problem-solving abilities, underscoring the importance of implementing strategies to support their competences.

The researchers observed the teaching model implemented by the teacher in the fifth-grade classroom at SDN CBT, which utilized a conventional lecture-based method. In this teaching approach, students primarily listened, paid attention, completed assignments, and only a few were willing to solve problems on the blackboard. Students rarely asked questions directly to the teacher or expressed their opinions about the material being discussed. In response to this situation, the researchers sought to address the existing issues by reforming the learning process. The previously teacher-centered approach was transformed into a student-centered approach. This shift was realized through the implementation of the Cooperative Learning approach using the Numbered Heads Together (NHT) model.

The Numbered Heads Together (NHT) model represents a cooperative learning approach designed to foster student collaboration through structured group interaction. In this approach, each student is assigned an identification number and is given an equal opportunity to respond to problems posed by the teacher, and they are selected randomly based on their numbers, ensuring active participation from all group members (Ernawati & Wiwik, 2021). Similarly, Astutik & Wulandari (2020) described the NHT as a student-centered model that fosters free thinking and open inquiry, enabling students to learn independently while solving problems.

The selection of this learning model is based on the criteria proposed by Febyani & Setiawan (2022), which include consideration of the intended learning objectives, the characteristics of the instructional material, as well as the needs and preferences of the students. The primary objective is to support mathematical problem-solving abilities, with this model facilitating effective discussion activities to assist students in selecting and resolving problems. The instructional material focuses on mathematical concepts, while from the students' perspective, the majority express a preference for discussion-based learning approaches (Larasati, 2023).

The research aims to understand how the NHT learning model affects students' problem-solving abilities. Previous studies conducted by Nourhasanah & Aslam (2022), Asmoro et al. (2023), and Wati & Suarni (2020) have employed the NHT learning model to optimize mathematics achievement results. The results of these studies demonstrated that the NHT model is effective in enhancing mathematics learning outcomes. What distinguishes this current research from previous studies is that this research intends to optimize the ability of fifth-grade elementary school students to solve mathematical problems through the implementation of the NHT learning model in the topic of geometry. This includes differences in the research location, instruments used, sampling procedures, variable and a population.

Based on these issues, the researchers intend to conduct the study titled "The Effect of Numbered Heads Together (NHT) on Elementary School Students' Mathematical Problem-Solving Ability in Geometry." This research aims to examine the effect of the cooperative learning approach, particularly the Numbered Heads Together (NHT) model, on mathematical problem-solving ability of fifth-grade elementary students in the topic of geometry.

METHODS

This research employed an experimental approach with a quasi-experimental design. A quasi-experimental design was chosen because of the challenges in controlling all external factors that could affect the implementation of the experiment. The research design involves two groups: an experimental group and a control group. This study employs the non-equivalent control group design, where the treatment is applied solely to the experimental group, leaving the control group without intervention.

$$\begin{array}{ccc} O_1 & X & O_2 \\ O_3 & & O_4 \end{array}$$

Figure 1. **Pattern of Nonquaivalent Control Group Design**

Description :

O_1 : Pre-test scores of the experimental group

O_3 : Pre-test scores of the control group

X : Treatment using the Numbered Heads Together (NHT) cooperative learning model

O_2 : Post-test scores of the experimental group that received the Numbered Heads Together (NHT) model treatment

O_4 : Post-test scores of the control group that did not receive the Numbered Heads Together (NHT) model treatment.

In this observation, the entire population was used as the sample, consisting of 24 students from Class V-A, who participated in the cooperative learning approach using the

Numbered Heads Together (NHT) model, and 20 students from Class V-B, who did not receive the Numbered Heads Together (NHT) model treatment. At SDN CBT, the total sample from these two classes comprised 44 students. The saturated sampling method was used by including the entire population. The researchers chose this method because the population size is relatively small, with fewer than 50 individuals. The instrument utilized in this research is a test designed to assess students' mathematical problem-solving abilities, consisting of 10 essay questions on the topic of geometry. These questions were developed based on Polya's indicators of mathematical problem-solving abilities, which served as guidelines in creating the instrument.

Trihudiyatmanto et al. (2022) stated that the quality of research instruments significantly influences research outcomes. Therefore, to obtain optimal results, it is essential to use high-quality research instruments. This quality is determined based on criteria such as validity, reliability, and difficulty level. Before being administered to the experimental and control classes, the test instruments were validated and reviewed by experts in mathematics and education.

The hypothesis of this study is as follows: H0 states that "there is no effect of implementing Numbered Heads Together (NHT) on students' mathematical problem-solving ability in geometry in fifth-grade students at SDN CBT." Meanwhile, H1 states that "there is an effect of implementing Numbered Heads Together (NHT) on students' mathematical problem-solving ability in geometry in fifth-grade students at SDN CBT." The data analyzed in this study were quantitative data obtained from pre-test and post-test, comprising 10 essay questions designed according to the indicators of students' mathematical problem-solving abilities.

Before performing the tests for drawing conclusions, prerequisite tests, including normality and homogeneity tests, were carried out. This study employed the Shapiro-Wilk test to assess data normality and Levene's test to examine homogeneity of variance, both with the support of SPSS software. The results confirmed that the data were normally distributed and homogeneous, allowing for further analysis using the Paired Samples t-test to evaluate the effectiveness of the NHT learning model on students. Furthermore, the N-gain test was utilized to measure the extent to which the learning intervention influenced student outcomes.

RESULT AND DISCUSSION

The results obtained align with problem-solving abilities based on Polya's steps, which include understanding the problem, planning a solution, solving the problem, and reviewing the results. The data collection involved a test of problem-solving ability consisting of 10 essay questions, administered to 24 students in class V-A (experimental group) and 20 students in class V-B (control group). An analysis was carried out to examine whether there was a difference in students' mathematical problem-solving skills between the two groups, based on pre-test data reflecting their initial abilities prior to the intervention and post-test data measuring their performance following the intervention. Additionally, the data were analyzed to identify which instructional model yielded better results. The analysis results are presented as follows:

Table 1. Normality Test

Tests of Normality

	Shapiro-Wilk		
	Statistic	df	Sig.
Pretest A (Control)	.958	24	.397
Postest A (Control)	.962	24	.473
Pretest B (Experimental)	.934	20	.186
Postest B (Experimental)	.917	20	.088

a. Lilliefors Significance Correction

According to the table 1, the criteria for normality testing are defined as follows: a significance (Sig.) value greater than 0.05 suggests that the data are normally distributed, while a value less than 0.05 indicates non-normal distribution. The significance values obtained are: 0.397 for the control class pre-test, 0.473 for the control class post-test, 0.186 for the experimental class pre-test, and 0.088 for the experimental class post-test. Based on these values, it can be concluded that the pre-test and post-test scores for both the control and experimental groups follow a normal distribution distributed.

Table 2. Homogeneity

Test of Homogeneity of Variance

		Levene Statistic	df1	df2	Sig.
Problem-Solving Ability Results	Based on Mean	2.009	1	42	.164
	Based on Median	2.129	1	42	.152
	Based on Median and with adjusted df	2.129	1	37.403	.153
	Based on trimmed mean	2.037	1	42	.161

Referring to the table 2, a significance (Sig.) value greater than 0.05 indicates that the data are homogeneous, whereas a value less than 0.05 indicates that the data are not homogeneous. The post-test data produced a Sig. value of 0.164. Thus, the results demonstrate that the post-test results in this study are homogeneous.

Table 3. Hypothesis Test (T-Test)

Paired Samples Test								
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
				Lower	Upper			
Pair 1 Pretest - Postest	-28.350	.489	.109	-28.579	-28.121	-259.083	19	.000

Based on the table 3, a Sig. (2-tailed) value > 0.05 indicates no significant difference in the mean scores, while a Sig. (2-tailed) value < 0.05 indicates a statistically significant difference in the mean scores. The results show a Sig. (2-tailed) value of 0.000. These findings reveal a statistically significant difference between the pre-test and post-test scores in the experimental group, indicating that the treatment given to students in the experimental class had an effect. As a result, the null hypothesis (H_0) is rejected, and the alternative hypothesis (H_1) is accepted.

Table 4. Control class N-Gain Test

	Experimental class		N1	N2	N1/N2	%
	Pretest	**Post test**	**Posttest-Pretest**	**Skor Maks-Pretest**	**N-Gain Score**	**N-Gain Persen**
Mean	56.41	68.79	15.64	37.59	.2852	**28.51**
Min	50	63	12	38	.25	**25**
Max	62	74	13	50	.32	**31.58**

Table 5. Experimental class N-Gain Test

	Kelas Kontrol		N1	N2	N1/N2	%
	Pretest	**Post test**	**Posttest-Pretest**	**Skor Maks-Pretest**	**N-Gain Score**	**N-Gain Persen**
Mean	54.85	83.2	28.35	45.15	.6294	**62.94**
Min	52	80	28	42	.58	**58.33**
Max	58	87	29	48	.69	**69.05**

The results of the N-gain analysis reveal that the experimental class attained an N-gain of 62.94%, which falls into the category of moderate effectiveness. Meanwhile, the control class recorded an N-gain of 28.51%, indicating a lower level of effectiveness. Several factors could have influenced the experimental class's placement in the moderately effective category. These include the relatively short duration of the intervention, which may not have been adequate to significantly improve students' abilities, and technical constraints such as ineffective use of technology.

This research aimed to investigate the effect of the Numbered Heads Together (NHT) model on students' mathematical problem-solving abilities of fifth-grade elementary students in the topic of geometry. The results of the data analysis revealed that the significance value of the t-test ($p < 0.005$) indicating a significant difference between pre-test and post-test scores. This outcome supports the acceptance of the alternative hypothesis (H_1), which asserts that the NHT model positively influences students' mathematical problem-solving abilities.

Conversely, in the control class, no significant difference was found between pre-test and post-test scores. As a consequence, the null hypothesis (H_0) is rejected, indicating that learning methods used in the control class did not produce a significant improvement in students' ability. These findings are consistent with the study conducted by Prasetia et al. (2018), which demonstrated that students become more effective when engaged in cooperative learning environments, as they participate more actively in the learning process.

Furthermore, the normalized gain (N-gain) analysis was employed to assess the effectiveness of the observed improvement. The results showed that the N-gain in the experimental class fell within the "moderately effective" category. This level of effectiveness can be attributed to the characteristics of the NHT model, which promote active student engagement through group discussions, individual accountability, and collaborative problem-solving in mathematics. This process enables students to exchange ideas, clarify their understanding, and enhance critical thinking skills in addressing mathematical problems.

In contrast, the control class recorded an N-gain categorized as "ineffective." This outcome is largely due to the conventional teacher-centered learning approach, which offers limited opportunities for active student participation and minimal peer interaction in constructing understanding. As a result, the improvement in students' mathematical problem-solving abilities was suboptimal, despite instruction being delivered over a set period.

The significant difference between the pre-test and post-test scores highlights this gap. Unlike the control group, the experimental group demonstrated significant progress in their post-test results. Through the NHT learning model, where the teacher serves as a facilitator, students are encouraged to engage more actively in the learning process. This increased participation plays a role in strengthening their problem-solving abilities and improves the overall quality of learning in the topic of geometry.

Through the implementation of the Numbered Heads Together (NHT) learning model, students in the experimental group are able to participate actively in peer discussions and are motivated to think independently and critically when tackling mathematical problems involving geometric concepts. This instructional approach fosters open and independent thinking while enhancing students' problem-solving abilities in geometry. The active discussions among students allow them to exchange ideas and collaboratively arrive at the correct solutions for the given problems. This interaction not only strengthens their understanding but also promotes deeper cognitive engagement with the subject matter.

In contrast, in the control class, students merely receive results or information provided by the teacher and they follow the teacher's directions or guidance, which hinders the development of independent critical thinking and limits the optimization of students' problem-solving competencies.

The active role of the teacher in consistently providing information and delivering explanations in the control class may contribute to the development of a fixed mindset among students when responding to questions posed by the teacher. Due to the teacher’s dominant role, students are not adequately provided with opportunities to develop independent thinking when solving mathematical problems related to geometry. When the teacher explains the solution to a given problem, students may only be able to solve similar problems using the same approach. However, when faced with new problems involving different or slightly more complex geometric shapes—though still within the same conceptual framework—students tend to struggle. This difficulty often leads them to rely again on the teacher for guidance in solving the problem. Therefore, the findings of this study indicate that the NHT learning model not only has a statistically significant impact but also demonstrates practical effectiveness in improving students’ mathematical problem-solving abilities.

This is in line with the study carried out by Aminah et al. (2023), which employed a pre-test-post-test experiment with third-grade elementary school students. The data demonstrated that the NHT learning model enhances students' problem-solving competence, as evidenced by improved average scores on the post-test compared to the pre-test. Additionally, research by Saila et al. (2023) compared the Numbered Heads Together (NHT) with conventional learning approaches. The findings indicated that NHT effectively develops students' abilities to tackle mathematical problems.

Addressing problems is a crucial component of mathematics education and offers substantial benefits in everyday life (Jaswandi & Kartiani, 2022). To solve a mathematical problem, students are encouraged to understand the problem's context. Subsequently, students review whether the problem can be resolved correctly and effectively. The NHT learning model, which focuses on active student participation in group settings, plays a role in shaping students' comprehension of the learning process. The creation of discussions among students fosters open and free thinking, and trains students to think critically and make decisions in their problem-solving efforts. This ability will continue to develop, making students proficient in problem-solving with the support of the Numbered Heads Together (NHT) model.

CONCLUSION

The findings of the study indicate that the t-test produced a significance value of less than 0.005, indicating that the analysis meets the requirements for hypothesis testing, where H_1 is accepted and H_0 is rejected. This suggests that the implementation of the NHT learning model has a significant influence on students' mathematical problem-solving abilities in geometry. The NHT teaching method demonstrates its effectiveness in developing students' competencies to solve problems in fifth-grade elementary school classrooms. Therefore, it is recommended that teachers incorporate the responsive learning style of the NHT model into their teaching strategies to enhance students' problem-solving competencies. Moreover, fostering an enjoyable and supportive learning atmosphere is essential to keep students motivated and actively involved in the learning process.

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