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The Influence of Learning Models Cooperative Type *Numbered Heads Together* (NHT) on Learning Outcomes of Mathematics Students SMP Muhammadiyah 01 Medan

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ABSTRACT

This study aims to address the low mathematics learning outcomes of eighth-grade students in flat-sided shapes lessons by applying the NHT learning model. The method used is quantitative with a quasi-experimental approach. Sampling was conducted using cluster random sampling from SMP Muhammadiyah 01 Medan. The research design used was a control group. The research instruments were pretest and posttest essay questions. The results showed that the experimental class obtained a higher average N-Gain score of 0.790 (high category) compared to the control class, which obtained a lower average N-Gain score of 0.445 (medium category). The hypothesis test results from the N-Gain data yielded a t-count of 6.025, which is greater than the t-table value of 1.668 at a significance level of 0.05. Therefore, it can be stated that Ha is accepted. These findings suggest that the application of the NHT model significantly enhances students' mathematics learning outcomes. This suggests that cooperative learning, supported by the NHT model, can be an effective alternative for encouraging more active, collaborative, and meaningful mathematics learning in junior high schools.

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1. INTRODUCTION

Mathematics teaching in junior high schools still faces challenges in developing students' mathematical abilities, which has an impact on their learning outcomes [1]. Despite ongoing improvements in curriculum and resources, these challenges persist across schools and cohorts, indicating a need to refine classroom-level pedagogy. Accordingly, the present study is grounded in the practical question of how to organise instruction so that a greater proportion of students make conceptual progress during each lesson. Education plays an important role in the process of human resource development [2]. Through the educational process, individuals not only acquire knowledge, but also internalise moral, social, and cultural values in community life [3]. One important aspect of education is mathematics learning [4]. Accordingly, strengthening mathematics teaching at the junior high level is strategic for building foundational competencies that support lifelong learning. In particular, we focus on everyday classroom routines that can simultaneously cultivate knowledge, values, and productive learning habits.

Mathematics is one of the most important subjects in the education curriculum because it plays a role in developing students' logical, critical, and systematic thinking skills [5]. In the Indonesian education curriculum, one of the subjects taught in schools is mathematics [6]. However, many students still struggle to understand abstract mathematics, resulting in low mathematics learning outcomes [7]. One of the reasons for this is the use of teaching methods that are not interactive and do not encourage student participation in the learning process [8]. This suggests a mismatch between the abstract nature of the content and the predominantly teacher-centred delivery, which limits students' opportunities to reason, explain, and collaborate. These conditions motivate the search for pedagogies that render abstract ideas accessible through interaction, explanation, and guided practice.

From the observation results, it was found that 1) students had difficulty completing descriptive mathematics questions because their understanding of the concepts was still weak, 2) students were unable to systematically explain their answers even though they obtained the correct final results, 3) Teachers only relied on books or videos and giving assignments, which resulted in minimal classroom interaction and ineffective, inactive teaching and learning processes, and passive learning, 4) The average score of students' mathematics tests was still low. Taken together, these findings suggest that both conceptual understanding and mathematical communication are fragile, while limited class interaction constrains formative feedback and peer learning. Therefore, a learning approach that explicitly structures discussion, accountability, and collective problem-solving is warranted. These baseline observations provide the empirical rationale for testing an interactive, discussion-oriented learning model.

Learning outcomes are important indicators that reflect the extent to which learning objectives have been achieved [9]. According to Sudjana [10], learning outcomes can also be seen as observable and measurable changes in behaviour resulting from the learning process. From these learning outcomes, educators can evaluate the extent of student development [11]. Clear evidence on learning outcomes is thus essential not only for judging effectiveness but also for guiding targeted instructional improvement. Consequently, proposed pedagogical changes should be evaluated with valid measures that capture meaningful gains in student learning.

However, student learning outcomes are still low in terms of exam scores and assignments, which are not yet optimal due to difficulties in understanding mathematics, caused by various factors [12]. The factors that influence student learning outcomes can be categorized into two main groups: internal and external factors [13]. Internal factors include student interest, motivation, and cognitive capacity [14]. Meanwhile, external factors that can influence student learning outcomes include teachers and the learning models they use when teaching [15]. Among external levers, the choice of learning model is especially salient because it shapes opportunities for engagement, explanation, and feedback during lessons.

Accordingly, this study concentrates on the instructional lever that is most amenable to immediate change at the classroom level, the learning model employed by teachers.

One type of learning model that can be used in mathematics education is the Numbered Heads Together approach. This model emphasizes group work, joint discussion, and knowledge exchange among students [16]. In implementing this method, students are divided into small groups, and each member is assigned a number to facilitate coordination during discussions and collaboration. After the teacher delivers the material to the whole class, each group discusses the topic that has just been learned. Then, the teacher gives numbered questions or assignments to all students. Group members discuss the questions together, exchange opinions and understanding, and then determine the most appropriate answer. Next, one person from each group is randomly selected to present the results of the discussion to the class. The teacher then provides feedback or assessment of the answers, allowing students to deepen their understanding of the material [17]. NHT operationalises two core principles of cooperative learning—positive interdependence and individual accountability —thereby encouraging every student to prepare, participate, and articulate their reasoning. By design, NHT requires all learners to be ready to explain, aligning with the observed need for accountable participation and clear mathematical communication.

Several previous studies have also shown that the Numbered Head Together (NHT) learning model is effective in improving students' mathematics learning outcomes at the junior high school level. In their study, Milga et al. [18] found that the application of NHT assisted by Powtoon media can improve mathematics learning outcomes in SPLTV material. Furthermore, Annisa et al. [19] stated that NHT had a positive effect on students' mathematics learning achievement in the context of the Pythagorean theorem material. Atin et al. [20] also stated that the NHT model, combined with the PAIKEM approach, positively affected mathematics learning outcomes in the number pattern material. Meanwhile, according to Eka et al. [21], the use of NHT can improve students' understanding of mathematical concepts in algebraic operations. In line with these findings, Cinta et al. [22] concluded that the NHT learning model can improve students' mathematics learning outcomes in relations and functions. Taken together, these studies indicate that NHT has promise across multiple topics and contexts at the junior high level.

Nevertheless, most of this evidence focuses on topics other than polyhedron concepts or combines NHT with specific media, leaving limited documentation of NHT's standalone impact on flat-sided solids (polyhedra) at the junior high level. Addressing this gap is important because three-dimensional, flat-sided shapes are conceptually demanding and often require sustained discussion to connect representations, properties, and problem-solving strategies. In this study, we isolate the core NHT model, without additional media, to examine its effects on learning outcomes in polyhedron content. However, this study also integrates discussion activities that involve all group members, oriented towards improving students' mathematics learning outcomes. Therefore, this study provides novelty by examining the application of NHT to improve students' mathematics learning outcomes at the junior high school level in abstract flat-sided shapes material. Specifically, we position structured discussion and randomized reporting as mechanisms to promote conceptual clarity and mathematical communication during problem-solving on polyhedron topics. By isolating the NHT model without additional media, the study contributes evidence on the pedagogical model itself. This focus sharpens both the theoretical contribution (mechanisms of cooperative learning) and the practical contribution (classroom feasibility using routine resources).

Based on this, this study aims to explore in depth how the application of the Numbered Head Together model can affect students' mathematics learning outcomes in flat-sided shapes. The findings of this study are expected to serve as an important reference for educators in choosing more effective and interactive learning strategies, as well as input for education policymakers in designing curricula that meet students' needs. Accordingly, the guiding question is: Does NHT lead to higher mathematics learning outcomes on flat-sided solids than conventional instruction in junior high school? The expected contribution is twofold: practical guidance for teachers on implementing NHT phases in polyhedron lessons, and empirical input for policymakers regarding active-learning strategies in the mathematics curriculum. In summary, we present a clear objective, a focused research question, and actionable implications that connect classroom practice with curriculum-level decision-making.

2. METHOD

This research employs a quantitative research method in a quasi-experimental design with a control group. Group to determine the effect of the NHT type cooperative learning model on students' mathematics learning outcomes in the material on flat-sided geometric shapes in class VIII. Sampling was carried out using the *cluster technique*. *Random sampling* was used to select class VIII-T2, consisting of 34 students, as the experimental class, and class VIII-T4, also consisting of 34 students, was selected as the control group. The experimental class received instruction using the NHT phases (present → group discussion → numbered response → randomised reporting), while the control class received conventional, teacher-centred instruction aligned with the existing syllabus. To mitigate selection bias inherent in intact classes, baseline equivalence was examined via pretest scores, and both groups followed the same curricular content and time allocation.

The data collection technique in this study consisted of a test assessing students' mathematics learning outcomes, which included 10 essay questions: 5 pretest questions and five *post-test questions*. The process of administering the test was carried out before and after learning. Before being used in the study, the research instrument was first tested on a group of students who were not research subjects. The test questions tested included validity, reliability, difficulty level, and discrimination. After the test questions were tested, the data were analysed using prerequisite tests, namely, the N-Gain test, normality test, homogeneity test, and hypothesis test. Student responses were scored using consistent analytic criteria for each item to yield total pretest and posttest scores for each participant. Learning gains were quantified using normalised gain (N-Gain) computed from the pretest and posttest totals. Assumption checks included tests of normality and homogeneity prior to hypothesis testing. Between-group differences in N-Gain were analysed at $\alpha = 0.05$ using the appropriate parametric test when assumptions were met (and a non-parametric alternative otherwise).

3. RESULTS AND DISCUSSION

3.1 . Results

This research was conducted at SMP Muhammadiyah 01 Medan, with data collected from the experimental and control classes through a descriptive test consisting of 10 *pretest and posttest questions*. Prior to administering the test, a trial of the questions was conducted on a group of students. The trial of the questions was conducted to determine validity, reliability, difficulty level, and discriminating power.

The results of the validity test on the students' mathematics learning outcomes test yielded a calculated r value ranging from 0.721 to 0.858, while the table r according to the provisions was 0.339. Since the calculated r value exceeded the table r, 10 learning outcome questions were included in the valid category.

The results of the reliability test for the trial test questions yielded a value of 0.896, which is classified as very high reliability, as indicated by the criteria of the quality instruments used. Based on the theory put forward by Basuki, characteristic questions have a minimum quality worth in valid and reliable categories [23].

This value falls within the moderate category and is evident in the uneven distribution of question difficulty. Based on the theory put forward, Sudjana's calculation level difficulties question uses a comparison of 30% of questions as easy, 50% of the questions as medium, and 20% of questions as difficult [24].

The power of the trial test questions obtained a value of 0.411-0.517, with 10 questions included in the good category. As stated, Arikunto raises questions that can differentiate students with high and low entry into the categories of good and very good [25].

Based on the results of the trials conducted, including validity tests, reliability tests, difficulty level tests, and discriminatory power tests, 10 questions meet the criteria for good questions. They can be used as *pretest* and *post-test questions* to measure students' mathematics learning outcomes.

Descriptive Data Test Results

The learning outcomes of the experimental and control classes were assessed by administering descriptive tests to students at the beginning and end of the study to determine their progress in mathematics learning. The summary of *the pretest* and *post-test learning outcomes* for the experimental class is shown in Table 1 below:

Table 1. Recapitulation of Experimental Class Mathematical Learning Outcomes Test

Test	N	Total value	Average	Variance	Standard deviation	Min	Max
Pretest	34	837	24,618	100	10	8	52
Posttest	34	2872	84,471	77,348	8,794	68	100

Referring to Table 1, the *pretest results* in the experimental class involving 34 students showed a total score of 837 with an average of 24.618, a variance of 100, a standard deviation of 10, a maximum score of 52, and a minimum score of 8. Meanwhile, the *post-test results* involving 34 students produced a total score of 2872, an average of 84.471, a variance of 77.348, a standard deviation of 8.794, a maximum score of 100, and a minimum score of 68.

Table 2. Recapitulation of the Mathematics Learning Outcomes Test for the Control Class

T es	N	Total value	Average	Variance	Standard deviation	Min	Max
Pretest	34	1202	35,352	132,175	11,496	10	57
Posttest	34	2204	64,823	73,301	8,561	57	80

Referring to Table 2, the *pretest results* in the experimental class involving 34 students showed a total score of 1202 with an average of 35.352, a variance of 132.175, a standard deviation of 11.496, a maximum score of 57, and a minimum score of 10. Meanwhile, the *post-test results* involving 34 students produced a total score of 2204, an average of 64.823, a variance of 73.301, a standard deviation of 8.561, a maximum score of 80, and a minimum score of 57.

Prerequisite Test Results

As for the data analysis technique, we used prerequisite tests, including the N-Gain test, normality test, homogeneity test, and hypothesis test.

N-Gain Test Results

The difference between the *pretest* and *post-test findings* was used to examine the N-gain score. The results of the N-gain score calculations for the experimental and control classes can be seen in Table 3 below:

Table 3. Results of the N-Gain Test Calculation for the Experimental and Control Classes

	Experiment	Control
N-Gain	0.789	0.445
Conclusion	Tall	Currently

Based on Table 3, the N-Gain score of the experimental class is 0.789, which is classified as high in the gain criteria, and the control class is 0.445, which is classified as medium in the gain criteria.

Normality Test Results

To determine whether the research data is normally distributed, if the conditions are met $x^2{}_{count} < x^2{}_{table}$. Then the sample is normally distributed. The results of the normality test using the Chi-Square statistical test on the N-Gain score data from the experimental and control classes are presented in Table 4 :

Table 4. Summary of Normality Test of Students' Mathematics Learning Outcomes

No.	N	Class	$X^2{}_{count}$	$X^2{}_{table}$	Information
1	34	Experiment	2,098	7,815	Normal
2		Control	1,829		Normal

Based on Table 4, the normality test data for the mathematics learning outcomes scores of the experimental class students yielded a calculated X2 value of 2.098, which is less than the table X2 value of 7.815. Similarly, the control class had a calculated X2 value of 1.829. Because calculated $x^2{}_{count} < x^2{}_{table}$ Table, it can be concluded that Ho is accepted.

Homogeneity Test Results

After the data is normally distributed, the next step is to test for homogeneity. This test aims to determine whether the sample in the study comes from a homogeneous population. This allows the selected sample to be considered representative of the entire population in the research process. This homogeneity test, using the F-test, is performed on the N-Gain scores in the experimental and control classes, as shown in Table 5:

Table 5. Summary of the Homogeneity Test of Students' Mathematics Learning Outcomes

Class	Variance	F_{count}	F_{table}	Information
Experiment	0,015	1,433	1,788	Homogeneous
Control	0,022			

Based on Table 5, the homogeneity test was performed by comparing the highest variance and the lowest variance, yielding a calculated F value of 1.433. The F table value was 1.788, indicating that 1.433 < 1.788 at the ∝ α = 0.05 level. Based on the calculation results, it can be concluded that the data from the experimental class and the control class are declared homogeneous.

Hypothesis Test Results

After it was discovered that the mathematics learning outcomes of the students in the experimental and control classes were normally distributed and homogeneous, a hypothesis test was conducted. A t-test was used on the N-Gain score data. The results of the hypothesis test can be seen in Table 6 below:

Table 6. Summary of Hypothesis Test Results on Students' Mathematics Learning Outcomes

Statistics	Class		t_{hitung}	t_{tabel}	Conclusion
	Experiment	Control			
Average	0.789	0.445	6,025	1,668	H_a accepted
Standard Deviation	0.126	0.150			
Variance	0.015	0.022			
Number of Samples	34	34			

Based on Table 6, the results of the hypothesis analysis obtained a value t_{count} of 6.025, which is greater than t_{table} 1.668 at a significance level α of 0.05 and dk = n1 + n2 – 2 = 34 + 34 – 2 = 66. This means that the alternative hypothesis (H_a) is accepted, and the null hypothesis (H_0) is rejected. In other words, there is a significant influence on students' mathematics learning outcomes from the application of the Numbered-type cooperative learning model, Head Together.

3.2. Discussion

The study's results showed a significant difference in learning outcomes between students taught using the *Numbered Model. Head Together* (NHT) with those taught using conventional methods. Practically, students in the experimental class using NHT obtained an average score of 0.789, higher than the control class's score of 0.445. This difference illustrates that the application of NHT can improve students' learning outcomes and mathematical understanding, especially in the abstract material of flat-sided solid shapes. This gap corresponds to a “high” versus “medium” gain category, indicating not only statistical significance but also educationally meaningful improvement. Because both classes covered the same content with comparable duration and common assessments, the observed advantage is plausibly attributable to the pedagogical model rather than curricular exposure.

In practice, the use of NHT provides a more lively learning atmosphere than the lecture method. Rokhmat Widodo's research [26] also confirms that NHT is more effective in increasing activity and learning outcomes than lectures. In their application, students are required to participate actively in group discussions, put forward their ideas, and work together to solve problems. This aligns with Dhea's opinion [27], which demonstrates that NHT effectively encourages active student participation in group discussions and fosters their collaboration in problem-solving. This condition has been proven to overcome the initial problems found during observations, namely, low student involvement and weak understanding of mathematical concepts. Through group work, students feel more confident, are more focused on understanding the material, and find solutions to the given mathematical problems more easily. The randomised reporting feature of NHT enforces individual accountability and reduces social loafing, ensuring every member prepares to explain. As a result, students practice articulating reasoning, a critical process for polyhedron topics that demand linking 2D nets, properties, and spatial visualisation.

When viewed from a theoretical perspective, these results align with Vygotsky's constructivist framework. Tamrin et al. [28], which emphasises that knowledge is built through social interaction. In NHT learning, each student has a responsibility to understand the material, as they may be appointed to represent their group at any time. This mechanism makes students more focused, active, and strive to understand the material well. Thus, NHT not only improves learning outcomes but also fosters social skills, communication, and a sense of responsibility among group members. Within the zone of proximal development, peer explanations promote cognitive elaboration and co-regulation, which deepen conceptual understanding and support durable learning.

Several previous studies also support this finding. Baiq Putri's research [29] suggests that the implementation of NHT requires students to remain actively engaged in mathematics learning. This aligns with Nurjannah's [30] assertion that through group work in NHT, students can share knowledge, assist one another in solving problems, and foster a more interactive learning environment. Kusnaeni's research et al. [17] also confirmed that NHT is effective in improving the learning outcomes of elementary school students, and this study demonstrates that this effectiveness also applies to the junior high school level, particularly with more abstract material. Our results extend this literature by demonstrating NHT’s effectiveness on flat-sided solids without auxiliary media, underscoring the model’s standalone pedagogical value for conceptually demanding geometry.

Thus, the results of this study strengthen the empirical evidence that NHT is a relevant and effective cooperative learning model for improving students' mathematics learning outcomes. Furthermore, the implementation of NHT also has the potential to improve students' motivation, communication skills, and critical thinking abilities. However, this study still has limitations, such as suboptimal classroom management during group discussions. This serves as a reminder for teachers to optimize time allocation and group management further to achieve more optimal results in the future. Key limitations include the use of intact classes (non-random assignment), a single-school context, and short-term posttests, which may constrain generalizability and inferences about retention. Future work should involve multi-site samples, delayed posttests to examine retention/transfer, and classroom process measures (e.g., discourse quality, time-on-task) to unpack the mechanisms by which NHT yields gains. For practice, teachers can strengthen implementation by assigning rotating roles, time-boxing discussion phases, and establishing clear norms for explanation and evidence.

4. CONCLUSION

The application of the Numbered Heads Together (NHT) cooperative learning model has been shown to improve students' mathematics learning outcomes in flat-sided shapes in Grade VIII. Compared with conventional instruction, NHT yielded statistically significant and educationally meaningful gains, indicating that its cooperative structure effectively supports conceptual understanding and problem-solving in polyhedron topics. This approach has been proven to be more effective in creating an active, conducive, and cooperative learning atmosphere and fostering a sense of responsibility in students, making it a viable alternative learning strategy. Within the limits of a quasi-experimental, non-equivalent control group design, these findings suggest that NHT is both practicable and scalable for routine classroom use. For further research, it is recommended that the NHT model be applied at various levels of education, extended to other subjects, or combined with digital media to make it more relevant to current times. Future studies should utilize multi-site samples and delayed post-tests to examine retention and transfer, and include process measures (e.g., discourse quality) to clarify the mechanisms of impact. The findings of this study make a significant contribution as an alternative, interactive, and effective learning strategy, which not only improves student engagement and learning outcomes but also fosters the values of cooperation and positive communication in the educational environment. Accordingly, teachers and policymakers can consider NHT as a baseline cooperative routine for mathematics lessons, especially geometry, that require explanation, accountability, and collaborative reasoning.

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