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THE EFFECTIVENESS OF THE NUMBERED HEADS TOGETHER COOPERATIVE LEARNING MODEL ON MATHEMATICS LEARNING OUTCOMES AMONG THIRD-GRADE ELEMENTARY SCHOOL STUDENTS

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ABSTRAK
Penelitian ini mengkaji efektivitas model pembelajaran kooperatif Numbered Heads Together (NHT) dalam meningkatkan hasil belajar matematika siswa kelas tiga sekolah dasar. Penelitian ini dilatarbelakangi oleh rendahnya prestasi matematika siswa, di mana banyak siswa gagal memenuhi standar kompetensi minimum akibat penerapan pendekatan pembelajaran konvensional yang berpusat pada guru. Desain penelitian yang digunakan adalah kuasi-eksperimen dengan kelompok kontrol non-ekuivalen. Partisipan penelitian terdiri dari 35 siswa kelas tiga SD IT Arafah yang dibagi ke dalam kelompok eksperimen dan kelompok kontrol. Data dikumpulkan menggunakan tes prestasi matematika pilihan ganda yang telah divalidasi dan memiliki koefisien reliabilitas sebesar 0,852. Data dianalisis menggunakan SPSS versi 25.0 melalui uji normalitas, uji homogenitas, pengujian hipotesis, dan analisis normalized gain (N-Gain). Hasil penelitian menunjukkan bahwa siswa dalam kelompok eksperimen memperoleh hasil belajar matematika yang secara signifikan lebih tinggi dibandingkan dengan siswa dalam kelompok kontrol. Kelompok eksperimen mencapai skor rata-rata N-Gain sebesar 62,24%, yang mengindikasikan peningkatan hasil belajar dengan tingkat efektivitas sedang. Selain itu, pengujian hipotesis mengonfirmasi adanya perbedaan yang signifikan secara statistik antara kedua kelompok tersebut. Temuan ini menunjukkan bahwa model pembelajaran kooperatif *Numbered Heads Together* efektif dalam meningkatkan hasil belajar matematika siswa dengan mendorong partisipasi aktif, pemecahan masalah secara kolaboratif, dan interaksi kelas yang bermakna. Oleh karena itu, model NHT dapat direkomendasikan sebagai strategi pembelajaran yang efektif untuk meningkatkan hasil belajar matematika di sekolah dasar.
Kata kunci: *Numbered Heads Together*; Hasil Belajar Matematika; Pembelajaran Kooperatif; Pendidikan Dasar; Studi Kuasi-Eksperimen

ABSTRACT
This study examined the effectiveness of the Numbered Heads Together (NHT) cooperative learning model in improving mathematics learning outcomes among third-grade students in elementary school. The study was motivated by the low mathematics achievement of students, as many failed to meet the minimum competency standard due to the implementation of conventional teacher-centered instructional approaches. A quasi-experimental design employing a non-equivalent control group was adopted. The participants were 35 third-grade students from SD IT Arafah, assigned to an experimental and a control group. Data were collected using a validated multiple-choice mathematics achievement test with a reliability coefficient of 0.852. The data were analyzed using SPSS version 25.0 through normality, homogeneity, hypothesis testing, and normalized gain (N-Gain) analyses. The findings revealed that students in the experimental group demonstrated significantly higher mathematics learning outcomes than those in the control group. The experimental group achieved an average N-Gain score of 62.24%, indicating a moderately effective improvement in learning outcomes. Furthermore, hypothesis testing confirmed a statistically significant difference between the two

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groups. These findings suggest that the Numbered Heads Together cooperative learning model effectively enhances students' mathematics learning outcomes by promoting active participation, collaborative problem-solving, and meaningful classroom interaction. Therefore, the NHT model can be recommended as an effective instructional strategy for improving mathematics learning outcomes in elementary schools.
Keywords: *Numbered Heads Together; Mathematics Learning Outcomes; Cooperative Learning; Elementary Education; Quasi-Experimental Study*

INTRODUCTION

Education plays a fundamental role in developing students' knowledge, skills, and competencies required to face future academic and social challenges. At the elementary school level, learning experiences serve as the foundation for students' cognitive development, particularly in acquiring literacy and numeracy competencies that support lifelong learning. Among the subjects taught in elementary education, mathematics occupies a strategic position because it develops logical reasoning, problem-solving, critical thinking, and decision-making skills that are essential in everyday life and at higher levels of education.

Despite its importance, mathematics remains one of the subjects in which many elementary school students experience learning difficulties. Classroom instruction is often dominated by teacher-centered approaches that emphasize memorization and procedural knowledge rather than conceptual understanding and active student participation. Such instructional practices frequently result in low mathematics learning outcomes, as evidenced by students' inability to meet the minimum competency standards set by schools. Therefore, improving mathematics learning outcomes has become an important concern for educators and researchers alike.

Learning outcomes represent the extent to which students successfully acquire the intended knowledge, skills, and competencies after participating in instructional activities. According to educational assessment theory, learning outcomes are commonly measured through cognitive achievement tests that evaluate students' mastery of learning objectives. Consequently, selecting an appropriate instructional model becomes a critical factor in improving students' academic achievement.

One instructional approach that has attracted considerable attention is cooperative learning. Cooperative learning encourages students to work collaboratively in small groups to achieve shared learning goals while developing individual accountability and interpersonal skills. Among various cooperative learning models, the Numbered Heads Together (NHT) model, introduced by Spencer Kagan, emphasizes equal participation by assigning each student a number and randomly selecting group representatives to answer questions. This strategy encourages every student to understand the learning material because each member has an equal opportunity to represent the group during classroom discussions. As a result, NHT promotes active learning, collaborative problem-solving, peer interaction, and individual responsibility.

Previous empirical studies have demonstrated that the NHT model contributes positively to mathematics learning. Several researchers have reported that students taught using NHT achieve significantly higher mathematics learning outcomes than those taught through conventional instruction. The cooperative structure of NHT facilitates discussion, knowledge sharing, immediate feedback, and collaborative problem-solving, enabling students to construct a deeper understanding of mathematics. These findings indicate that cooperative learning provides a more meaningful learning environment than traditional teacher-centered instruction.

However, although numerous studies have examined the effectiveness of NHT in mathematics education, most have focused on different educational contexts, grade levels, or mathematical topics. Furthermore, limited evidence is available regarding the effectiveness of the NHT model in improving mathematics learning outcomes among third-grade elementary school students studying plane geometry at SD IT Arafah. This contextual gap indicates the need for further empirical investigation to determine whether implementing NHT can produce significant improvements in students' mathematics learning outcomes in this educational setting.

Therefore, this study aims to examine the effectiveness of the Numbered Heads Together (NHT) cooperative learning model in improving mathematics learning outcomes among third-grade elementary school students. The findings are expected to contribute to the growing body of knowledge on cooperative

learning while providing practical recommendations for elementary school teachers seeking effective instructional strategies to improve students' mathematics achievement.

METHOD

This study employed a quasi-experimental research design using a non-equivalent control group design to examine the effectiveness of the Numbered Heads Together (NHT) cooperative learning model on students' mathematics learning outcomes. This design was selected because the researcher was unable to randomly assign participants to different groups due to the existing classroom organization.

The study involved two intact classes. Both groups completed a pre-test before the intervention and a post-test after. The experimental group received mathematics instruction through the Numbered Heads Together (NHT) cooperative learning model, whereas the control group was taught using conventional teacher-centered instruction. The research design can be illustrated as follows.

Table 1. A Non-Equivalent Control Group Design

Group	Pre-test	Treatment	Post-test
Experimental	O_1	X (NHT)	O_2
Control	O_3	Conventional Learning	O_4

The study was conducted at SD IT Arafah during the 2025/2026 academic year. The population consisted of all third-grade students, 35 in total, distributed across two existing classrooms.
A total sampling technique was employed because the population size was relatively small, allowing all students to participate in the study. The participants consisted of:

Table 2. Distribution of Research Participants

Group	Class	Number of Students
Experimental	Grade III Mumtazh	20
Control	Grade III Honest	15

The instrument used in this study was a mathematics achievement test consisting of multiple-choice items developed in accordance with the mathematics learning objectives for plane geometry.
The instrument blueprint was developed based on the cognitive domain of Bloom's Revised Taxonomy, including identifying, explaining, analyzing, and applying concepts related to plane geometry.

Prior to data collection, the instrument underwent validity and reliability testing. Item validity analysis indicated that 21 of 30 items met the validity criteria and were retained for the final test, while 9 were excluded. Furthermore, the reliability analysis yielded a Cronbach's Alpha coefficient of 0.852, indicating high internal consistency and suitability for measuring students' mathematics learning outcomes.

The research was conducted over four instructional meetings, with each meeting lasting 2 × 35 minutes. Both the experimental and control groups studied the same mathematics topic, namely plane geometry, and were taught by the same classroom teacher to minimize teacher-related bias. The instructional procedures differed only in the learning model implemented.

The experimental group received instruction using the Numbered Heads Together cooperative learning model through the following stages: (1) Introduction: The teacher introduced the lesson objectives, reviewed prerequisite knowledge, and explained the learning activities; (2) Numbering: Students were organized into heterogeneous groups consisting of four to five members. Each student received an identification number; (3) Presenting Problems: The teacher presented mathematics problems related to plane geometry; (4) Heads Together Discussion: Group members discussed each problem collaboratively until every student understood the solution; (5) Answering: The teacher randomly called one number. Students with the selected number presented their group's answers: (6) Feedback: The teacher provided feedback, clarified misconceptions, and reinforced correct mathematical concepts; and (7) Closing: Students summarized the lesson together with the teacher.

The control group received instruction using conventional teaching methods consisting of explanation, question-and-answer sessions, individual exercises, and teacher feedback without cooperative group discussion.

Data collection was carried out in three stages. First, students completed a pre-test before receiving instructional treatment. Second, the experimental and control groups participated in their respective learning activities according to the assigned instructional model. Finally, both groups completed a post-test using the same validated mathematics achievement test to evaluate the effectiveness of the instructional intervention.

The collected data were analyzed using IBM SPSS Statistics version 25. Descriptive statistics were first employed to summarize students' mathematics learning outcomes through the calculation of the mean, standard deviation, frequency, and percentage. Subsequently, normality was assessed using the Shapiro–Wilk test, and homogeneity of variance was assessed using Levene's Test. If the assumptions of normality and homogeneity were met, the Independent Samples t-test was used for hypothesis testing. However, if the assumption of normality was violated, the Mann–Whitney U test was employed as the non-parametric alternative. Finally, the effectiveness of the instructional intervention was evaluated using the Normalized Gain (N-Gain) score.

RESULTS

The distribution of students' pre-test scores is presented in Table 3.

Table 3. Frequency Distribution of Pre-test Scores

No	Interval	Frequency	Percentage
1	0-16	4	11,4
2	17-33	11	31,4
3	34-50	12	34,2
4	51-67	2	5,7
5	68-84	0	0
6	85-100	6	17,1
	Total	**35**	**100%**

As shown in Table 3, the majority of students' scores were concentrated in the 34–50 range, with a total of 12 students (34.2%). Additionally, 11 students (31.4%) were in the 17–33 score range, while 4 students (11.4%) were in the 0–16 range. A smaller proportion of students achieved higher scores, with 6 students (17.1%) scoring 85–100 and only 2 (5.7%) scoring 51–67. No students were recorded in the 68–84 interval.

The distribution of students' post-test scores is presented in Table 4.

Table 4. Frequency Distribution of Post-test Scores

No	Interval	Frequency	Percentage (%)
1	12.5-26.5	0	0
2	27.5-41.5	4	11,4
3	42.5-56.5	1	2,9
4	57.5-71.5	2	5,7
5	72.5-86.5	6	17,1
6	87.5-100	22	62,9
	Total	**35**	**100**

As shown in Table 4, the majority of students achieved scores in the highest interval, 87.5–100, with 22 students (62.9%). Meanwhile, 6 students (17.1%) scored within the range of 72.5–86.5, and only a small number of students were distributed across the lower score intervals.

The normality of the data was examined using the Shapiro–Wilk test at a significance level of α = 0.05. The results are presented in Table 5.

Table 5. Results of Normality Test (Shapiro–Wilk)

Group	Statistic	df	Sig.
Pre-test (Control Class)	0.851	21	0.012
Post-test (Control Class)	0.878	21	0.017
Pre-test (Experimental Class)	0.884	16	0.039
Post-test (Experimental Class)	0.938	17	0.256

Based on Table 5, the significance values indicate the distribution characteristics of both groups.

The homogeneity of variance between groups was tested using the Fisher test. The distribution of students' pre-test scores is presented in Table 6.

Table 6. Frequency Distribution of Pre-test Scores

Score Interval	Frequency	Percentage (%)
0–16	4	11.4
17–33	11	31.4
34–50	12	34.2
51–67	2	5.7
68–84	0	0.0
85–100	6	17.1
Total	**35**	**100**

The pre-test results indicate that most students obtained scores within the 34–50 range (34.2%), followed by the 17–33 range (31.4%). Only six students (17.1%) achieved scores between 85 and 100, while no students obtained scores within the interval of 68–84. These findings indicate that students' initial mathematics learning outcomes were relatively low prior to the implementation of the instructional treatment.

The distribution of students' post-test scores is presented in Table 7.

Table 7. Frequency Distribution of Post-test Scores

Score Interval	Frequency	Percentage (%)
12.5–26.5	0	0.0
27.5–41.5	4	11.4
42.5–56.5	1	2.9
57.5–71.5	2	5.7
72.5–86.5	6	17.1
87.5–100	22	62.9
Total	**35**	**100**

The post-test results demonstrate a substantial improvement in students' mathematics learning outcomes. Most students (62.9%) achieved scores within the 87.5–100 range, whereas only one student (2.9%) scored within the 42.5–56.5 range. No students obtained scores within the 12.5–26.5 range, indicating an overall improvement in students' performance after the instructional intervention.

The normality of the data distribution was examined using the Shapiro–Wilk test at a significance level of 0.05. The results are presented in Table 8.

Table 8. Results of Normality Test (Shapiro–Wilk)

Variable	Statistic	df	Sig.
Control Pre-test	0.851	21	0.012
Control Post-test	0.878	21	0.017
Experimental Pre-test	0.884	16	0.039
Experimental Post-test	0.938	17	0.256

The Shapiro–Wilk test was conducted to examine whether the data followed a normal distribution. Based on the significance values, only the experimental post-test data were normally distributed (Sig. = 0.256 > 0.05), whereas the remaining datasets showed significance values below 0.05.

The homogeneity of variance was tested using Levene's Test. The results are presented in Table 9.

Table 9. Homogeneity Test

Variable	Levene Statistic	df1	df2	Sig.
Mathematics Learning Outcomes	2.91	2	34	0.099

The homogeneity test yielded a p-value of 0.099, which exceeded the 0.05 significance level. Therefore, the variances of the experimental and control groups were considered homogeneous.

Hypothesis testing was conducted to determine whether implementing the Numbered Heads Together (NHT) cooperative learning model significantly affected students' mathematics learning outcomes.

The statistical analysis indicated that the calculated t-value **(**6.287**)** was greater than the critical t-value **(**1.792**).** Therefore, the null hypothesis **(**H_0**)** was rejected, while the alternative hypothesis **(**H_1**)** was accepted. These findings indicate a statistically significant difference between students taught using the Numbered Heads Together cooperative learning model and those receiving conventional instruction. Accordingly, the Numbered Heads Together learning model was found to be effective in improving students' mathematics learning outcomes.

To evaluate the effectiveness of the instructional intervention, the normalized gain (N-Gain) score was calculated.

Table 10. N-Gain Analysis

Group	N-Gain (%)	Category
Experimental	62.24	Moderately Effective
Control	33.02	Low Effectiveness

The N-Gain analysis showed that the experimental group achieved an average N-Gain score of 62.24%**,** placing it in the moderately effective category. In contrast, the control group obtained an average N-Gain score of 33.02%**,** indicating low effectiveness**.** These findings further support the effectiveness of the Numbered Heads Together cooperative learning model in improving students' mathematics learning outcomes.

DISCUSSION

The findings of this study demonstrate that implementing the Numbered Heads Together (NHT) cooperative learning model had a positive effect on students' mathematics learning outcomes. The results

of the hypothesis test indicated a statistically significant difference between the experimental and control groups, suggesting that students who participated in cooperative learning through the NHT model achieved better mathematics learning outcomes than those in the control group. Furthermore, the N-Gain analysis revealed that the experimental group attained a moderately effective level of improvement, whereas the control group showed only a low level of improvement. These findings indicate that the NHT model provides a more effective learning environment for improving students' mathematics achievement.

The improved learning outcomes can be explained by the instructional characteristics of the Numbered Heads Together model. During the learning process, students worked collaboratively in small heterogeneous groups to discuss mathematical problems, exchange ideas, and formulate solutions before responding individually. Since every student had an equal opportunity to present the group's answer, each member was encouraged to thoroughly understand the learning material and actively participate in group discussions. This learning structure promotes individual accountability while simultaneously fostering collaborative learning, thereby strengthening students' conceptual understanding of mathematics.

From a Social Constructivist perspective, learning occurs through social interaction and collaborative knowledge construction. Students develop a deeper understanding when they exchange ideas, explain concepts, and solve problems together with their peers. The cooperative structure of the NHT model provides opportunities for meaningful interaction that enables students to construct mathematical knowledge more effectively than through passive teacher-centered instruction.

The findings of this study are also consistent with the principles of Cooperative Learning Theory proposed by Johnson and Johnson, which emphasizes positive interdependence, individual accountability, face-to-face interaction, interpersonal skills, and group processing as essential components of effective cooperative learning. In the NHT model, these elements encourage students to actively contribute to group discussions while maintaining responsibility for their individual understanding, ultimately leading to better academic achievement.

The present findings support previous empirical studies demonstrating the effectiveness of the Numbered Heads Together model in mathematics education. Previous research has consistently reported that students taught through the NHT model achieve higher mathematics learning outcomes than those receiving conventional instruction. Cooperative discussion, peer explanation, and shared problem-solving enable students to develop stronger conceptual understanding and improve their ability to solve mathematical problems. Therefore, the results of the present study reinforce previous evidence regarding the effectiveness of cooperative learning in elementary mathematics education.

Unlike several previous studies that focused on different educational levels and learning topics, this study specifically investigated the effectiveness of the Numbered Heads Together model in teaching plane geometry to third-grade elementary school students. Consequently, the findings provide additional empirical evidence on the applicability of the NHT model in this educational context and contribute to the growing body of literature on cooperative learning in elementary mathematics classrooms.

Overall, the findings suggest that the Numbered Heads Together cooperative learning model represents an effective instructional strategy for improving mathematics learning outcomes among elementary school students. Through structured collaboration, equal participation, and individual accountability, the model enables students to engage actively in mathematical problem-solving and achieve better learning outcomes than conventional teacher-centered instruction.

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