International Journal of Technology and Education Research

https://e-journal.citakonsultindo.or.id/index.php/IJETER

E-ISSN: 2986-0733

The Effect of the Numbered Heads Together Cooperative Learning Model on Students' Mathematical Problem-Solving Ability

Syamsinar[1]

[1] Lecturer of Mathematics Education, Makassar State University, Indonesia

Corresponding Author:syamsinar@unm.ac.id

Abstract

This research was motivated by students' low mathematical problem-solving abilities. This quantitative study used a pre-experimental approach and was conducted at SMAN 1 Wondama. The purpose of this study was to determine the effect of the Numbered Heads Together cooperative learning model on the mathematical problem-solving abilities of tenth-grade students at SMAN 1 Wondama.The subjects were 30 tenth-grade students. Data collection techniques used included observation, tests (pretest and posttest), and documentation. Based on the results, the average pretest score was 67.30, while the average posttest score after implementing the Numbered Heads Together cooperative learning model increased to 82.50, with a maximum score of 95 and a minimum score of 60. The results of the hypothesis test using the t-test showed a significance value of 0.000 <0.05, thus concluding that the implementation of the Numbered Heads Together cooperative learning model has a significant effect on the mathematical problem-solving abilities of tenth-grade students at SMAN 1 Wondama.Thus, the Numbered Heads Together cooperative learning model is effective in improving students' mathematical problem-solving skills.

Keyword: Numbered Heads Together, cooperative learning, mathematical problem-solving

INTRODUCTION

Education plays a crucial role in improving the quality of human resources, particularly in responding to the demands of the 21st century, which emphasize critical thinking, creativity, collaboration, and communication skills. In mathematics learning, problem-solving ability is considered a fundamental competence, as it is closely related to higher-order thinking skills and

Copyright to the author of some rights reserved This work is licensed under aCreative Commons Attribution-ShareAlike 4.0 International License.

the application of concepts in real-life situations. However, numerous studies indicate that students' mathematical problem-solving ability remains relatively low, primarily due to teacher-centered learning approaches and limited student engagement in the learning process.

Mathematical problem-solving ability requires students to engage in complex cognitive processes, including understanding problems, planning strategies, executing solutions, and evaluating results. Previous studies have shown that this ability is strongly influenced by the instructional approaches used by teachers (Putri, Roza, & Maimunah, 2020). Nevertheless, conventional teaching practices that emphasize procedural knowledge and memorization hinder students from developing independent and systematic problem-solving strategies.

Based on preliminary observations conducted at SMAN 1 Wondama, several issues were identified in mathematics learning. Students tend to experience difficulties in understanding problem-based questions, particularly in identifying known and unknown information. In addition, students often struggle to develop appropriate solution strategies and frequently make errors in interpreting their results. The teaching process is still dominated by lecture-based methods, resulting in limited student participation in discussions and conceptual exploration. These conditions contribute to the low level of students' mathematical problem-solving ability.

Recent studies in reputable journals highlight the importance of student-centered learning approaches, such as Problem-Based Learning (PBL), in addressing these issues. PBL has been shown to significantly improve students' problem-solving ability, critical thinking, and metacognitive skills (Hmelo-Silver, 2020; Marchy et al., 2022). Furthermore, PBL enhances student engagement by providing contextual learning experiences that encourage exploration and investigation (Akram, Farooq, & Alam, 2023).

However, several studies also reveal limitations in the implementation of PBL. Its effectiveness largely depends on students' readiness and teachers' ability to manage the learning process effectively (Peranginangin, 2025). Moreover, some students still encounter difficulties in formulating strategies and making decisions during problem-solving activities, even when PBL is applied (Noor, Purwosetiyono, & Wardani, 2024). This indicates that PBL alone may not be sufficient without a well-structured interaction framework within the learning process.

On the other hand, recent research suggests that collaborative learning can complement the limitations of PBL. Collaborative learning enhances social interaction, motivation, and conceptual understanding through group discussions and teamwork (Slavin, 2020). Nevertheless, most studies focus on general collaborative approaches and do not specifically examine structured interaction models that ensure equal participation and individual

Copyright to the author of some rights reserved This work is licensed under aCreative Commons Attribution-ShareAlike 4.0 International License.

accountability within groups.

The research gap lies in the limited studies that integrate collaborative learning with structured individual accountability in group settings. In cooperative learning, group success depends heavily on each member's contribution. Therefore, there is a need for a learning model that not only promotes collaboration but also ensures active participation from every student.

The cooperative learning model Numbered Head Together (NHT) offers such characteristics. This model emphasizes both group collaboration and individual accountability through a numbering system that ensures each student actively participates in the learning process (Trianto, 2013). In addition, previous research indicates that learning models integrated with 21st-century skills (4C) significantly enhance students' mathematical problem-solving ability (Syamsinar, Rahman, & Dassa, 2023).

The novelty of this study lies in the integration of the Numbered Head Together model as a solution to the real problems identified at SMAN 1 Wondama, particularly the low level of students' mathematical problem-solving ability caused by limited student engagement and unstructured learning interactions. Unlike previous studies that focus solely on the effectiveness of PBL or general cooperative learning, this study specifically examines how the structured interaction and individual accountability embedded in the NHT model can enhance students' problem-solving ability. Therefore, this study contributes not only empirically but also conceptually to the development of more structured, contextual, and effective mathematics learning strategies aligned with 21st-century educational demands.

Based on the above explanation, this study aims to analyze the effect of the Numbered Head Together cooperative learning model on students' mathematical problem-solving ability in Grade VIII at SMAN 1 Wondama.

METHOD

This study employed a quantitative approach with a pre-experimental design. The design employed a one-group pretest-posttest design, involving one group of subjects who were given an initial test (pretest), then given treatment, and then concluded with a final test (posttest). This design was used to determine the effect of the learning model on students' mathematical problem-solving abilities before and after the treatment.

Research Subjects

The subjects in this study were 30 tenth-grade students of SMAN 1 Wondama. The sampling technique used was purposive sampling, which selects the sample based on certain

Copyright to the author of some rights reserved This work is licensed under aCreative Commons Attribution-ShareAlike 4.0 International License.

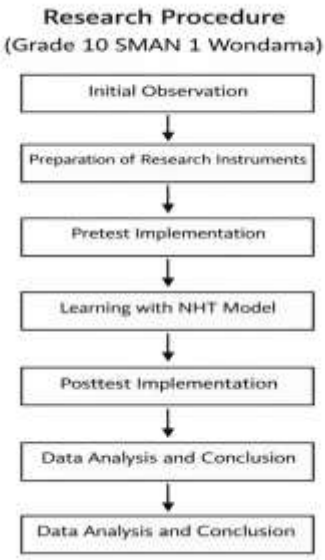
considerations, such as the relatively homogeneous initial ability levels of the students.

Research Variables

The variables in this study consist of: The independent variable is the Numbered Heads Together (NHT) cooperative learning model. The dependent variable is students' mathematical problem-solving abilities.

Research Procedure

The steps taken in this research are shown in Figure 1 belo



The research procedure carried out in this study consists of several systematic stages, as illustrated in the research flowchart. Each stage is designed to ensure that the research is conducted in a structured and scientific manner.

1. The first stage is initial observation, which aims to identify problems related to students' mathematical problem-solving abilities at SMAN 1 Wondama. This stage provides a preliminary understanding of the learning conditions and students' difficulties in solving mathematical problems.
2. The second stage is the preparation of research instruments, which includes designing lesson plans, preparing test instruments (pretest and posttest), and validating the instruments to ensure their reliability and validity.

Copyright to the author of some rights reserved This work is licensed under aCreative Commons Attribution-ShareAlike 4.0 International License.

3. The third stage is the implementation of the pretest, which is conducted to measure students' initial abilities in mathematical problem-solving before the treatment is applied.
4. The fourth stage is the implementation of learning using the Numbered Head Together (NHT) model. In this stage, students are engaged in cooperative learning activities that emphasize group discussion, individual accountability, and active participation.
5. The fifth stage is the implementation of the posttest, which aims to measure students' mathematical problem-solving abilities after the application of the NHT model.
6. The final stage is data analysis and conclusion, where the collected data are analyzed using statistical methods to determine the effect of the NHT model. The results of the analysis are then used to draw conclusions regarding the effectiveness of the learning model in improving students' mathematical problem-solving abilities.

Data Collection Techniques

Data collection techniques in this study included:

- A test, in the form of descriptive questions, used in the pretest and posttest to measure students' mathematical problem-solving abilities.
- Observation, used to observe student activities during the learning process.
- Documentation, used to obtain supporting data such as attendance lists, student grades, and photographs of learning activities.

Research Instruments

The instrument used in this study was a mathematical problem-solving ability test structured based on the following indicators:

- Identifying problems
- Planning solution strategies
- Solving problems
- Interpreting results

Data Analysis Techniques

The data obtained were analyzed using:

- Descriptive Statistical Analysis
- Used to determine the average, minimum, maximum, and standard deviation of the pretest and posttest results.

Copyright to the author of some rights reserved This work is licensed under aCreative Commons Attribution-ShareAlike 4.0 International License.

- Normality Test
- Used using the Kolmogorov-Smirnov test to determine whether the data were normally distributed.

Hypothesis Testing (t-Test)

The t-test was used to determine the effect of the Numbered Heads Together learning model on students' mathematical problem-solving abilities. The test criteria are:
If the significance value is <0.05, there is a significant effect.
If the significance value is ≥0.05, there is no significant effect.

RESULTS AND DISCUSSION

The results of this study are presented based on the stages of the research procedure, namely the pretest results, the implementation of the Numbered Head Together (NHT) learning model, and the posttest results, which were then analyzed statistically.

1. Pretest Results (Students' Initial Ability)

The pretest results describe students' initial ability in mathematical problem-solving before the treatment was applied. The analysis showed that the mean pretest score was 67.30.

This result indicates that students' initial ability was still at a moderate level and not yet optimal in solving mathematical problems. Most students experienced difficulties in understanding the problem, planning appropriate solution strategies, and interpreting the results.

2. Implementation of the NHT Learning Model

The learning process was conducted using the Numbered Head Together (NHT) cooperative learning model. During the learning activities, students were divided into several small groups, and each member was assigned a number.

Each group was given problem-solving tasks to be discussed collaboratively. Students showed increased participation in sharing ideas, engaging in discussions, and working together to solve problems. Furthermore, the numbering system in the NHT model encouraged each student to take responsibility for the group's work.

The observation results indicated an improvement in students' activeness and participation during the learning process.

3. Posttest Results (Students' Final Ability)

After the implementation of the NHT model, a posttest was administered to measure students' mathematical problem-solving ability.

Copyright to the author of some rights reserved This work is licensed under aCreative Commons Attribution-ShareAlike 4.0 International License.

International Journal of Technology and Education Research

https://e-journal.citakonsultindo.or.id/index.php/IJETER

E-ISSN: 2986-0733

Table 1. Pretest and Posttest Results of Students' Mathematical Problem-Solving Ability

No	Test Type	Number of Students	Mean Score	Highest Score	Lowest Score
1	Pretest	30	67.30	80	50
2	Posttest	30	82.50	95	60

The analysis showed that the mean posttest score increased to 82.50, with the highest score being 95 and the lowest score being 60.

This improvement indicates that students' ability to understand problems, plan solution strategies, and solve mathematical problems significantly improved after the application of the NHT model.

4. Normality Test and hypothesis Test Result

Table 2. Normality Test and Hypothesis Test Results

No	Test Type	Significance Value	Description
1	Normality Test	0.145	Normally Distributed
2	t-test (Hypothesis)	0.000	Significant Effect

The normality test was conducted to determine whether the data were normally distributed. Based on the Kolmogorov-Smirnov test, the significance value was 0.145 > 0.05, indicating that the data were normally distributed and met the requirements for hypothesis testing.

The results of the t-test showed a significance value of 0.000 < 0.05, indicating that there is a statistically significant effect of the Numbered Head Together cooperative learning model on students' mathematical problem-solving ability.

5. Summary of Findings

Overall, the findings of this study indicate that:

- There was an increase in the mean score from 67.30 (pretest) to 82.50 (posttest).
- The NHT learning model improved students' participation in the learning process.
- The NHT model had a significant effect on students' mathematical problem-solving ability.

Copyright to the author of some rights reserved This work is licensed under aCreative Commons Attribution-ShareAlike 4.0 International License.

International Journal of Technology and Education Research

https://e-journal.citakonsultindo.or.id/index.php/IJETER

E-ISSN: 2986-0733

DISCUSSION

The results of the study showed an increase in students' mathematical problem-solving abilities after implementing the Numbered Heads Together (NHT) cooperative learning model, as evidenced by an increase in the average score from 67.30 to 82.50. This finding indicates that the NHT model is effective in improving the quality of mathematics learning, particularly in the problem-solving aspect.

This improvement can be explained by the NHT model's main characteristics, which emphasize collaboration and individual responsibility. During the learning process, students not only work in groups but are also required to understand the results of the discussion because each member has the possibility of being called on randomly. This encourages the active involvement of all students in the learning process. This finding aligns with constructivist learning theory, which states that knowledge is built through social interaction and active learning experiences.

These results are consistent with previous research showing that cooperative learning can significantly improve mathematical problem-solving abilities (Slavin, 2020). Furthermore, research (Syamsinar, Rahman, & Dassa, 2023) also found that learning emphasizing collaboration and 21st-century skills can improve students' critical thinking and problem-solving abilities. Compared to the Problem-Based Learning (PBL) approach, the NHT model has advantages in terms of interaction structure. PBL tends to provide a high degree of freedom for exploration, but in some cases is less effective if students are not accustomed to independent learning (Hmelo-Silver, 2020). In contrast, NHT provides a clearer structure through the division of individual roles and responsibilities within a group, making it more suitable for students with heterogeneous abilities.

However, the results of this study also indicate that not all students achieve optimal results. This suggests that the effectiveness of the NHT model is still influenced by other factors, such as student readiness, teacher ability to manage the classroom, and available learning time. This finding aligns with research (Noor, Purwosetiyono, & Wardani, 2024) which states that the success of cooperative learning is highly dependent on effective learning management.

Conceptually, this study makes an important contribution in strengthening the role of interaction structure in cooperative learning. Unlike previous research that solely emphasizes group work, this study demonstrates that the combination of collaboration and individual accountability is a key factor in improving students' mathematical problem-solving abilities. Thus, the NHT model is not only empirically effective, but also theoretically relevant in supporting 21st-century skills-based mathematics learning.

Copyright to the author of some rights reserved This work is licensed under aCreative Commons Attribution-ShareAlike 4.0 International License.

CONCLUSION

Based on the results of the study and data analysis, it can be concluded that the implementation of the Numbered Head Together (NHT) cooperative learning model has a significant effect on students' mathematical problem-solving ability in Grade X at SMAN 1 Wondama. This is indicated by the increase in the mean score from 67.30 in the pretest to 82.50 in the posttest.

The results of the hypothesis testing using the t-test show a significance value of 0.000 < 0.05, indicating that the NHT model has a statistically significant effect on improving students' mathematical problem-solving ability. In addition, the implementation of the NHT model also enhances students' participation and engagement in the learning process through group collaboration and individual accountability.

Therefore, the Numbered Head Together cooperative learning model can be considered an effective alternative instructional strategy for improving students' mathematical problem-solving ability, particularly in the context of 21st-century mathematics learning.

REFERENCE

Akram, M., Farooq, M., & Alam, S. (2023). The impact of problem-based learning on students' critical thinking and creativity. Journal of Educational Research, 116(2), 145–158. https://doi.org/10.1080/00220671.2022.2031234

Arends, R. I. (2019). Learning to teach (11th ed.). McGraw-Hill.

Creswell, J. W., & Creswell, J. D. (2018). Research design: Qualitative, quantitative, and mixed methods approaches (5th ed.). SAGE Publications.

Darling-Hammond, L., Flook, L., Cook-Harvey, C., Barron, B., & Osher, D. (2020). Implications for educational practice of the science of learning and development. Applied Developmental Science, 24(2), 97–140. https://doi.org/10.1080/10888691.2018.1537791

Gufron, A., et al. (2025). The effectiveness of problem-based learning in enhancing mathematical literacy: A systematic meta-analysis. Journal of Education and Learning, 11(2), 210–225. https://doi.org/10.29408/jel.v11i2.30002

Hattie, J. (2017). Visible learning for mathematics. Corwin. https://doi.org/10.4135/9781506373363

Hmelo-Silver, C. E. (2020). Problem-based learning: What and how do students learn? Educational Psychology Review, 32(3), 645–660. https://doi.org/10.1007/s10648-020-09502-3

Johnson, D. W., & Johnson, R. T. (2017). Cooperative learning: The foundation for active learning.

Copyright to the author of some rights reserved This work is licensed under aCreative Commons Attribution-ShareAlike 4.0 International License.

https://doi.org/10.5772/intechopen.81086

Marchy, A., et al. (2022). The effect of problem-based learning on students' mathematical problem-solving ability. AlphaMath Journal, 8(2), 85–92. https://doi.org/10.30595/alphamath.v8i2.15047

Noor, N., Purwosetiyono, F. D., & Wardani, S. (2024). The effectiveness of problem-based learning in improving students' mathematical understanding. Journal of Mathematics Education, 15(1), 45–56. https://doi.org/10.22342/jme.v15i1.19045

OECD. (2019). PISA 2018 results (Volume I). OECD Publishing. https://doi.org/10.1787/5f07c754-en

Polya, G. (2014). How to solve it. Princeton University Press.

Putri, A., Roza, Y., & Maimunah. (2020). Development of learning tools with discovery learning model. Journal of Educational Sciences, 4(1), 83–92. https://doi.org/10.31258/jes.4.1.p.83-92

Slavin, R. E. (2020). Cooperative learning and academic achievement. Educational Psychology Review, 32(2), 381–394. https://doi.org/10.1007/s10648-019-09489-8

Syamsinar, S., Rahman, A., & Dassa, A. (2023). Development of a problem-based learning model integrated with 21st century skills. Asian Journal of Education and Social Studies, 48(1), 61–69. https://doi.org/10.9734/AJESS/2023/v48i11039

Trianto. (2013). Mendesain model pembelajaran inovatif-progresif. Kencana.

Copyright to the author of some rights reserved This work is licensed under aCreative Commons Attribution-ShareAlike 4.0 International License.