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Journal of Educational Management and Learning

Vol. 1, No. 2, 2023

Boosting Students' Representation Ability in Mathematics Using Numbered Heads Together

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Article History

Received 27 September 2023
Revised 29 October 2023
Accepted 4 November 2023
Available Online 11 November 2023

Keywords:
Mathematical representation
Numbered Heads Together
Mathematics learning

Abstract

This study aims to examine the efficacy of the Numbered Heads Together learning model in enhancing students' proficiency in whole number calculations. Utilizing a classroom action research methodology, the research was structured into two main cycles, preceded by an initial pre-cycle phase. Each cycle comprises four phases: planning, acting, observing, and reflecting. Data were primarily collected through tests, complemented by student interviews to enrich the test findings. The gathered data were processed and analyzed using qualitative descriptive methods. The participants were nine fifth-grade students from SDN Panglegur 1 Pamekasan, Madura, Indonesia who had previously engaged with integer arithmetic operations. The findings reveal that the Numbered Heads Together model not only significantly improved students' academic performance but also positively influenced their engagement, responsibility, discipline, and confidence in interactive learning scenarios. This improvement was evident from the pre-cycle phase through to the second cycle, with student performance increasing from 33% in the pre-cycle to 56% in the first cycle, and further to 78% in the second cycle.

1. Introduction

Mathematics is a mandatory subject in educational institutions, and it plays a vital role in everyday life. It not only assists in the development of science and technology but also provides essential skills for various real-world applications [1, 2]. The very important role of mathematics is inversely proportional to the impression of students who still consider mathematics to be a difficult subject. Many students, from elementary school through high school, continue to perceive mathematics as a challenging subject [3]. This is proven by the fact that students' mathematics test scores every year sometimes always have the lowest scores among other subjects. Students consider mathematics difficult to learn and sometimes give a negative impression [4]. Therefore, one way that can be used to communicate mathematical material is through mathematical representation.

Mathematical representation can be one of the methods used by teachers to study mathematics which is still considered difficult by students. Many representational media can be used as learning media in presenting mathematical material. Representation is a method used by someone to express the answer or mathematical idea in question [5]. Several types of representation are often used in communicating mathematics, including tables, pictures, graphs, mathematical expressions, or notation, as well as writing in your language, both formal and informal. Representation is a model or substitute form of

a problem situation that is used to find a solution to the problem [6]. Representation skills are essential for interpreting and applying various concepts effectively when solving problems [7]. In mathematics education, representation is a key psychological concept that helps explain significant phenomena related to how students approach problem-solving. This ability encompasses using one's thought processes as tools for tackling mathematical challenges and effectively communicating the solutions to these problems [8, 9]. If students have conceptual understanding, it will enable them to understand the rules and procedures in mathematical activities and have a strong basis for effective problem-solving. Superior representational knowledge may be associated with higher performance on complex tasks that require an understanding of mathematical concepts.

Mathematical representation ability is one of the general goals of mathematics learning in schools. This ability is very important for students and is closely related to communication and problem-solving abilities [10, 11]. Mathematical representation can be said to be important and needed by students because representation skills can support students in understanding the concepts and ideas communicated or their ideas in learning mathematics [12]. To be able to communicate something, someone needs representation in the form of pictures, graphs, diagrams, or other forms of representation. With representation, problems that initially look complicated can be seen more easily and simply, so that the problems presented can be solved more easily.

The learning process in educational units, whether in primary, secondary, or higher education, generally still applies the old paradigm, namely teacher-centered learning, and is dominated by the role of the teacher, the teacher being more active in the learning process than the students [13]. Students only listen to explanations from the teacher and tend not to be invited to understand the concepts of the material so students are slow in mastering and understanding the learning material. In teaching and learning activities, interaction between teachers and students is very necessary. Student-centered learning can improve abilities or understanding of the concepts of the material being taught. In this interaction, the teacher's role is to make the interaction fun and not boring so that students feel comfortable. In learning interactions, the use of mathematical representations can be applied.

Numbered Head Together (NHT) is one that is included or classified as a type of cooperative learning model [14]. However, the procedures and implementation have their specifics which are different from other cooperative learning models. The NHT learning model is a type of learning that is classified as a cooperative model whose aim is to influence student interaction patterns and as an alternative to traditional classroom structures. This approach encourages mutual support, as students collaborate in both giving and accepting input from one another [15]. This NHT helps students to develop their understanding when carrying out social interactions in groups and presentations, one model is NHT which is considered relevant for elementary school students [16].

Numerous researchers have conducted research on NHT in mathematics learning. There is an influence of implementing the NHT type learning model on students' mathematical representation abilities [17, 18]. The influence of NHT on increasing the ability to understand concepts [19] and problem-solving abilities [20]. There is an increase in students' mathematics learning achievement in the NHT type cooperative learning model [21]. This research does not specifically and specifically emphasize the implementation of collaboration in the NHT learning model. Therefore, there needs to be research on the reliance on collaboration in improving students' mathematical representation abilities through NHT learning.

This study aimed to enhance the academic performance of students facing challenges in learning mathematics, particularly in the domain of whole number arithmetic operations. This will be achieved through the implementation of the NHT approach, to elevate students' proficiency in mathematical representation. This initiative is prompted by observed indications of insufficient representation skills among students during integer counting operations in mathematics lessons.

2. Materials and Methods

The type of data in this research is classroom action research. The purpose of this research is to describe the implementation of the NHT learning model as an improvement in students' mathematical abilities in whole number calculation operations.

2.1. Participants

The type of data in this research is classroom action research. The research subjects were elementary school students who had studied material on integer counting operations at SDN Panglegur 1 Pamekasan, Madura, Indonesia. The research spanned one month, specifically in December 2022. The implementation of this research is divided into several stages, namely the pre-cycle stage, cycle I, and cycle II.

Table 1. Pre-cycle student learning outcomes.

No	Mark	The number of students
1	Complete (≥60)	3
2	Complete (<60)	6
Amount		9

Table 2. Cycle I student learning outcomes.

No	Mark	The number of students
1	Complete (≥60)	5
2	Complete (<60)	4
Amount		9

2.2. Research Design and Procedures

This research employs classroom action research and is structured into two cycles, beginning with an initial pre-cycle. Each cycle encompasses four stages: planning, acting, observing, and reflecting. Data collection involved conducting tests, complemented by student interviews to reinforce the test data.

2.3 Data Collection and Data Analysis

The data was processed and analyzed using descriptive data analysis. The techniques for data collection included tests, comprising a pre-test and post-test, and interviews to confirm the test responses. The interviews were conducted using a semi-structured guide. The analysis involved several stages. In the pre-test stage, students' initial abilities were assessed before implementing the NHT learning model, aimed at enhancing their mathematical representation skills in integer counting operations. Interviews were also conducted to explore the reasons behind students' low learning representation abilities. Finally, a post-test was conducted to evaluate student achievements after learning with the NHT model, focusing on improving their mathematical representation skills in integer counting operations.

3. Results and Discussion

3.1. Pre-Cycle

Before acting in cycle I, the researcher first carried out pre-cycle activities using lectures, question and answer methods, and assignments regarding the material on integer operations this activity aims to find out how students' abilities are in mathematics lessons, especially in discussing the material on integer arithmetic operations and to find out student learning outcomes using the NHT learning model.

In the pre-cycle learning process, it can be described that students' understanding of the teacher's explanation regarding integer operations is still low, students' activeness in learning is still lacking, and there is a lack of cooperation and responsibility in carrying out assignments.

Based on the results of activity observations, student learning outcomes in pre-cycle activities are still low, namely with a percentage of 33% in Table 1. This shows that at the pre-cycle stage there are still many who have not achieved completeness, and this means that students still do not understand the material.

3.2. Cycle I

The results of observations during cycle I activities showed that almost half of the students were enthusiastic about participating in the learning so student activity began to appear in group work activities. However, in terms of asking questions it is still not optimal, there are still many students who are still shy. The detailed student learning outcomes following the cycle I learning process are presented in Table 2. Analysis of this data reveals that in cycle I, 5 students, or 56%, achieved complete learning results, while 4 students, or 44%, had incomplete results. This shows that in cycle I, there were still many who did not understand the material even though the results in cycle I were better than the pre-cycle results [22].

Reflecting on student learning outcomes in cycle I, there were still some students who did not understand the material, so special guidance needed to be provided so that the level of student learning success was even better. In implementing cycle I, several weaknesses surfaced that merit consideration. Firstly, researchers encountered ongoing challenges, with some students displaying a lack of discipline and engaging in disruptive behavior. Additionally, shyness among students hindered their willingness to ask questions, and some failed to effectively utilize the time provided by the researchers. These issues persisted in cycle I, where students continued to experience embarrassment and a lack of discipline [23, 24]. Based on the reflection results, the research progressed to cycle II to improve the overall success rate of students.

3.3. Cycle II

The results of observations during the second cycle activities carried out showed that the students' learning outcomes were very enthusiastic in participating in the learning so that students' activeness became more visible and increased in group work, students asked more questions and no longer felt embarrassed. From the results of these observations, in detail the student learning outcomes after the second cycle learning process can be seen in Table 3.

Table 3. Cycle II student learning outcomes.

No	Mark	The number of students
1	Complete (≥60)	7
2	Complete (<60)	2
Amount		9

Based on the data analysis, the learning process in cycle II at the level of student learning outcomes shows that the number of students whose learning results were complete was 7 people or 78%, while the students whose learning results were incomplete were 2 people or 22%. This shows that reflection in cycle II can be concluded that there was an increase in student learning outcomes from cycle I to cycle II.

The research findings up to cycle II indicate the success of employing NHT, as the outcomes align with the predetermined plans. The percentage increase in student learning outcomes proves that learning actions from pre-cycle to cycle II are increasing. So that the learning action is completed in cycle II and is not continued in the next cycle. There was an increase in the percentage level of student learning outcomes, proving that learning actions started from pre-cycle to cycle II [25]. Besides that, the use of group collaboration shown in the implementation of NHT learning is very dominant in the class. A constructivist alternative to representational and group views in mathematics education [26, 27].

The research conducted over two cycles has progressed smoothly. Theoretically, this study serves as a valuable reference for future research on the NHT methodology. Practically, mathematics education, offers an alternative approach for teachers. The NHT model can enhance the quality of instruction in mathematics [28, 29]. A key observation is the dominant role of group collaboration in NHT implementation within classrooms. This group-based approach in NHT not only fosters cooperative learning but also significantly improves students' problem-solving skills.

4. Conclusions

The implementation of the NHT learning model has the potential to enhance student learning outcomes. Additionally, this learning model can foster increased student activeness, a sense of responsibility, discipline, and courage in asking questions or challenging presentations from other groups. However, several obstacles were identified during the implementation, including a lack of subjects studied, insufficient facilities and infrastructure in schools, initial confusion and passivity among students during group discussions due to the novelty of the learning model, conceptual errors in multiplication and subtraction calculations (some students still perform subtraction before multiplication), errors in executing calculation operations from the left, standardizing calculation operations, and mistakes in performing subtraction and addition arithmetic operations involving negative numbers.

Author Contributions: Conceptualization, F.N., L.Q. and M.Z.; methodology, M.Z.; software, F.N. and D.A.; validation, M.Z.; formal analysis, F.N., D.A. and I.M.M.; investigation, L.Q. and I.M.M.; resources, D.A. and M.Z.; data curation, L.Q. and M.Z.; writing—original draft preparation, F.N., L.Q., D.A. and I.M.M.; writing—review and editing, D.A.; supervision, M.Z.; project administration, M.Z. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the University of Madura.

Data Availability Statement: The data is available upon request to the corresponding author.

Acknowledgments: Thanks are addressed to the University of Madura as the funder in carrying out this research and SDN Panglegur 1 Pamekasan who has been willing to be a partner in this activity.

Conflicts of Interest: All the authors declare no conflicts of interest.

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