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Enhancing Student Learning in Mathematics through Numbered Head Together: An Experimental Study

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Abstract

Student problem-solving is fundamental in Mathematics because in problem-solving, students can explore the subject by applying the concepts to real-world problems. Numbered Head Together (NHT) is one of the learning models where students can work together to solve problems and can be as an effective method to encourage students to become more involved and to think critically. This research aims to determine the effect of the Numbered Head Together learning model on problem-solving for 101 students in class X SMA Negeri Punung in 2022/2023. The research method used was pseudo-experimental research because researchers want to identify the effect of the NHT model on student's problem-solving. Data analysis using Anova shows the significance value is <0.05. The Anova results show an effect of the learning model on students' problem-solving ability. After further testing, there is a difference in the average value of students subjected to NHT treatment is higher than students subjected to TPS and conventional treatment. Based on the study results, the NHT model is more effective in improving students' problem-solving ability in class X SMA Negeri Punung in 2022/2023.

Keywords: Numbered Head Together, Experimental Study, Cognitive Learning Style, Mathematics Education

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INTRODUCTION

Many students often say that Mathematics is a complicated and challenging subject (Capuno et al., 2019; Febriana, Leonard, & Astriani, 2020; Leonard et al., 2022). This negative perspective on Mathematics impacts the low learning outcomes of students in Mathematics. This is found in the 2015 Program for International Student Assessment (PISA) survey results which ranked Indonesia 62 out of 72 countries with a Mathematics proficiency score of 386, as well as the 2015 TIMSS survey results which ranked Indonesia 44 out of 49 countries (OECD, 2019). Assessment of Mathematics learning outcomes at the national level uses the National Examination (UN), and data from the Ministry of Education and Culture shows that the average junior high school Mathematics UN scores from year to year tend to be in the 40s and 50s, which is far from the expected value (Kemendikbud, 2019).

Low Mathematics learning outcomes do not occur without cause (Jiang et al., 2023). The learning process in the classroom dramatically affects student's learning outcomes. However, in reality, many teachers in Indonesia have not been able to apply learning models that follow students' material and characteristics and even tend to use monotonous learning models from meeting to meeting. This is supported by research Mosvold et al. (2023), which states that the learning model used by teachers is still

monotonous, so students are less motivated to participate in learning. The research of Wilson and Fowler (2005) also shows that conventional learning models with lectures are ineffective and do not result in improved learning outcomes. From these conditions, it is necessary to have a learning strategy that can affect student's learning outcomes, one of which is by involving students in learning.

The most effective way to encourage learners to be actively involved in learning is to put them in groups (Mouw et al., 2023). Baskoro (2020) mentions that Numbered Head Together (NHT) is one of the learning models where students can work together to solve problems and can be as an effective method to encourage students to be more involved and to think critically. Many studies have shown the effectiveness of NHT in learning, Muhaimin et al. (2022) the NHT learning model can spur students' active involvement in learning. Razak (2016) adds in his findings that the NHT learning model could increase learning motivation and student's activeness. Find one more similar research Baskoro (2020) mentions that NHT students can work together to solve problems. Based on the results of the research above, it can be concluded that the NHT learning model is a learning model that can increase student's active involvement and learning motivation, especially in helping solve problems, this will help improve student's learning outcomes.

Considering that student's learning outcomes in Indonesia are still relatively low, there needs to be a solution to be able to improve it, one of which is by implementing this NHT learning model. However, many researchers have conducted experiments on this matter (Kusuma & Maskuroh, 2018; Muhaimin et al., 2022; Pratiwi, 2019; Rahayu & Suningsih, 2018). There needs to be novelty in this study, we conducted experiments involving students' cognitive learning style variables. In learning, cognitive learning style is an internal factor that affects student's learning outcomes (Knoll et al., 2016). The cognitive learning style is a simple way for people to absorb, to process, and to apply the information given to them. The right way to learn is "the key to student success in learning" (Bire et al., 2014). This research is essential to provide information to the general public, especially in the scope of education, regarding the effectiveness of the NHT learning model in learning, thus providing references to other learning models for teachers. Therefore, this research aims to obtain empirical data on the effect of the NHT learning model and cognitive learning style on student's learning outcomes.

METHODS

This research was quantitative research with a quasi-experimental design. According to Creswell (2015), in a quantitative study, one uses theory deductively and places it at the beginning of the proposed study to test or to verify the theory rather than to develop it. The researcher advanced the theory, collected data to test it, and reflected on confirmation with results. The researcher tested or verified the theory by examining the hypotheses or questions derived from it. The researchers placed instruments to be used in measuring or in observing the attitudes or behaviors of participants in a research. Then the researchers collected scores on these instruments to confirm or to disconfirm the theory. This research used a 3×3 factorial design to determine the effect of two independent variables on the dependent variable. The first factor was the learning model, namely the *NHT*, *TPS*, and Direct Learning Model. The second factor was learning style with *visualizer*, *verbalizer*, and *negligible*.

This study used a 3×3 factorial design to determine the effect of two independent variables on the dependent variable. The first factor is the learning model, which is *NHT*, *TPS*, and Direct Learning Model. The second factor is learning style with *visualizer*, *verbalizer*, and *negligible*. This research design can be seen in Table 1.

Table 1. Research factorial design

Learning Model (A)	Cognitive Learning Style (B)		
	Visualizer (b)$_1$	*Verbalizer* (b)$_2$	*Negligible* (b)$_3$
Cooperative Learning Model type *Numbered Heads Together* (NHT) (a)$_1$	a b_{11}	a b_{12}	a b_{13}
Cooperative Learning Model type *Think Pair Share* (TPS) (a)$_2$	a b_{21}	a b_{22}	a b_{23}
Direct Learning Model (a)$_3$	a b_{31}	a b_{32}	a b_{33}

Description:
abi_j : Problem-solving ability on learning model a_i and cognitive learning style b $_j \forall$ i,j = 1,2,3

This research was conducted at SMA Negeri Punung in the 2022/2023 academic year. The research population was all X-grade students at SMA Negeri Punung, with 101 students in total. The research sample consisted of 33 students in the experimental class (a_1)*, Numbered Heads Together,* 33 students in the experimental class (a_2)*, Think Pair Share,* and 35 students in the control class (a_3). The sampling technique was carried out by random cluster sampling. Data sources were obtained from the Math problem-solving ability test results—data collection techniques through problem-solving tests, questionnaires, and observations.

This research used test instruments and non-test instruments. The test instrument included a problem-solving test. The problem-solving test instrument consisted of 4 questions in descriptions that use Polya's steps. The test was implemented at the end of the learning activities after being subjected to treatment. Non-test instruments used to classify students' cognitive learning styles were questionnaire sheets with a Likert scale consisting of 5 scales, namely SS (Strongly Agree), S (Agree), R (Undecided), TS (Disagree), and STS (Strongly Disagree). (Joshi et al., 2015). The NHT learning model was implemented with the following steps: (1) the teacher asked a question or problem that was related to the lesson starting with a lighter question about right triangles, (2) the teacher divided 4 to 5 students into groups and gave numbers to students in each group, (3) students gathered information with their group members, and students combined their opinions with other members on the answer to the question and ensured that each group member knew the team's answer, and (4) the teacher mentioned a number, and the student with that number answered the question for the whole class.

Data analysis used inference statistics, namely two-way variance analysis with unequal cells, to determine the effect of the NHT, TPS, and conventional learning models on student's problem-solving with the criteria if the significance value <0.05, then it is concluded that there is no effect between the learning models on student's problem-solving ability, but if the significance value is <0.05, then it is concluded that there is no effect between the learning models on student's problem-solving ability. $0{,}05$, then it can be concluded that there is no influence between the learning model on students' problem-solving skills, but if the significance value $> 0{,}05$, then it can be concluded that there is an influence between the learning model on problem-solving ability. Before the analysis,

researchers conducted a prerequisite test using the normality and homogeneity tests—data analysis using SPSS.

RESULTS & DISCUSSION

Results

This data processing is done with the help of SPSS software. Then the test results are processed again by the researcher. Based on the research findings, Table 2 provides descriptive statistical information on students' problem-solving ability, including mode, median, mean, standard deviation, and variance of 101 students of SMA Negeri Punung.

Table 2. Descriptive Statistics

No.	Descriptive Measures	Value
1	Mode	31
2	Median	38
3	Mean	39
4	Standard Deviation	19
5	Variance	369

Before analyzing the hypothesis test, data normality and homogeneity tests are carried out. Data normality test using One-Sample Kolmogorov Smirnov.

Table 3. Normality Test of Learning Model on Problem-Solving Ability

Learning Model	Statistic	Df	Significance
NHT	0,085	33	0,200
TPS	0,125	33	0,200
Conventional	0,115	35	0,200

Table 4. Normality Test of Cognitive Learning Style on Problem-Solving Ability

Cognitive Learning Style	Statistic	df	Significance
Visualizer	0,104	40	0,200
Verbalizer	0,088	42	0,200
Negligible	0,106	19	0,200

Based on Table 3 and Table 4, the results of the data normality test using the One-Sample Kolmogorov Smirnov Test show a significance value of $> 0{,}050$. These results indicate that the data is typically distributed. After the normality test, the data homogeneity test is conducted using the Scheffe method.

Table 5. Homogeneity Test of Learning Model on Problem-Solving Ability

Learning Model	N	1	2	3
NHT	33			52,0303
TPS	33		41,756	
Conventional	35	24,6286		
Significance		1,000	1,000	1,000

Table 6. Homogeneity Test of Cognitive Learning Style on Problem-Solving Ability

Cognitive Learning Style	N	1
Visualizer	40	42,1500
Verbalizer	42	38,5000
Negligible	19	34,4211
Significance		0,150

In Table 5 and Table 6, the significance value is $> 0{,}05$, the results show that the data come from a homogeneous population. The data analysis is carried out using two-way ANOVA with unequal cells. The analysis results are to determine the effect of NHT, TPS, and conventional learning models on students' problem-solving skills in terms of students' cognitive learning styles.

Table 7. Two-way ANOVA with Unequal Cells

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	16316,782	8	2039,598	8,958	0,000
Intercept	128427,854	1	128427,854	564,033	0,000
X1	8744,289	2	4372,145	19,202	0,000
X2	1260,632	2	630,316	2,768	0,068
X1 * X2	2267,082	4	566,771	2,849	0,049
Error	20948,010	92	227,696		
Total	192293,000	101			
Corrected Total	37264,792	100			

Note
X1: Learning Models
X2: Cognitive Learning Style

Table 7 shows that the significance value of the learning model is > 0.05 and the significance value of the cognitive learning style is < 0.05. This represents that the learning model has a significant effect on learning outcomes, but cognitive learning style has no significant effect on learning outcomes. Furthermore, to find out the learning model that has the most influence on learning outcomes, a post hoc follow-up test is carried out after an analysis of variance is carried out with the Scheffe method.

Table 8. Post Anova further test

Learning Model (I)	Learning Model (A)	Mean-Difference (I-J)	Std. Error	Sig.	95% internal confidence Lower Bound	95% internal confidence Upper Bound
NHT	TPS	10,2727	3,71480	0,025	1,0298	19,5157
	Conventional	27,4017	3,66135	0,000	18,2918	36,5117
TPS	NHT	-10,2727	3,71480	0,025	-19,5157	-1,0298
	Conventional	17,1290	3,66135	0,000	8,0190	26,2390
Conventional	NHT	-27,4017	3,66135	0,000	-35,5117	-18,2918
	TPS	-17,1290	3,66135	0,000	-26,2390	-8,0190

Based on data analysis using post Anova further test (Table 8), the mean value of students' problem-solving ability with the NHT learning model with TPS is higher by

10.2727. This shows that students subjected to the NHT learning model have better problem-solving skills than students subjected to the TPS learning model. Students subjected to the NHT learning model can be more responsible in completing tasks with other students whose head numbers are the same. From Table 8, it is also obtained that the average value of students' problem-solving ability with the NHT learning model with conventional is higher by 27.4017. The further test data shows that the NHT learning model can improve the problem-solving ability of grade X students of SMA Negeri Punung in 2022/2023 compared to the TPS and conventional learning models.

Discussion

Based on the results of statistical calculations, it is found that the NHT learning model has an effect on improving student's learning outcomes, but positive learning styles has no effect on improving student's learning outcomes. This condition is in line with the results of Huang et al. (2020) that positive learning styles have no effect on improving student's learning outcomes, this is due to the failure of student's learning styles in improving learning outcomes, namely the use of various methods such as strategies and learning media which are lacking so that the approach to the three learning styles has not been maximized. Internal factors also influence, such as low interest and motivation of students. As a result, they are not motivated to learn and their learning style is not effective. (Saleh et al., 2022). Internal student's factors comprising of health, physical disabilities, intelligence, attention, interests, talents, motives, maturity, readiness, and fatigue as well as student's external factors including external factors (Septiana, 2015).

The first hypothesis shows that the NHT learning model produces better problem-solving than TPS. The fact that the NHT learning model can improve the ability of Mathematics learning outcomes is supported by the research of Baskoro (2020), which states that the NHT learning model is better than the TPS learning model. Research results Muhaimin et al. (2022) align with these findings, which show that the NHT learning model produces a higher level of learning achievement than the TPS learning model. This is due to differences in the structure and the characteristics of the two learning models. The TPS learning model allows students to work independently or to cooperate with classmates. In contrast, the NHT learning model encourages students to think together in groups with a random number-calling system that gives equal opportunities to all students to answer questions posed by the teacher (Muliandari, 2019).

The second hypothesis shows that the TPS learning model produces better problem-solving than the direct learning model (Alsmadi et al., 2023). In its application, TPS is a learning model designed for active students, giving students free time to think deeply about what the teacher explains to think and to answer simultaneously (Khotimah et al., 2023). This makes the TPS model tends to be time-consuming in its implementation (Baskoro, 2020). In applying the TPS model, students are challenged to organize to form heterogeneous groups when dividing groups (Dyson & Grineski, 2001). Intelligent students will feel dominant in completing tasks, so communication with other students is rare (Lutfi & Dasari, 2023). When students discuss, not all students are active in group discussions, and the lack of communication between weak students and intelligent students in solving problems, so group discussions in completing teaching modules are less than optimal (Ahmad, 2021). At the same time, the NHT learning model tends to be more effective because students can communicate with other group members with the same task (Riansyah et al., 2023).

The NHT learning model encourages collaboration and interaction between students in groups (Kinasih et al., 2023). Each student has a role and responsibility in discussion and problem solving, which encourages the active participation of each group member (Sari

et al., 2023). This is different from the TPS model which only involves cooperation between two students (Lange et al., 2016). In the NHT model, students discuss, explain to each other, and support each other in achieving a better understanding (Lago & Nawang, 2007). This collaboration allows them to complement each other's strengths and improve on weaknesses, thus leading to improved learning outcomes (Hendrayati et al., 2019).

The NHT learning model encourages students to engage in problem solving and critical analysis (Widyastuti, 2021). In group discussions, students are given the opportunity to apply their knowledge in real contexts, seek appropriate solutions, and make decisions that are supported by rational thinking. This learning model stimulates high-level thinking and active involvement of students in the learning process, which contributes to improving their learning outcomes (Tuaputty et al., 2021).

In improving social and communication skills, this NHT Model helps improve students' social and communication skills (Asfar et al., 2021). In group discussions, students learn to listen to the opinions of others, respect differences, and articulate their thoughts in a clear and structured manner (Biesta et al., 2015). These skills are important in team collaboration, sharing knowledge, and working together in real life (Serin, 2023). By developing these social and communication skills, students can interact well in various contexts and build positive relationships, which also have a positive impact on student's learning outcomes (Inganah et al., 2023).

CONCLUSION

Based on the data analysis and discussion that have been carried out, it can be concluded that the research results are as follows. 1) NHT learning model produces better problem-solving than the TPS learning model; 2) The TPS learning model produces better problem-solving than the conventional learning model; 3) The NHT learning model produces better problem-solving than the conventional learning model; and 4) The NHT learning model produces better problem-solving ability than TPS and direct learning models. The researcher provides suggestions based on the conclusion of the research results above. Namely, teachers are better off using the NHT learning model to improve problem-solving. In addition, teachers are better off knowing the cognitive learning style of each student before learning so that teachers can optimize problem-solving from students' cognitive learning styles. Teachers can provide routine assignments to students to hone students problem-solving in solving problems or solving mathematical problems.

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