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The Influence of Initial Mathematical Ability and Numbered Head Together Type Cooperative Learning Model on Mathematical Communication Ability and Self Efficacy

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Abstrak

Penelitian ini bertujuan untuk mengetahui: Pengaruh kemampuan awal matematika terhadap kemampuan komunikasi matematis siswa; Pengaruh kemampuan awal matematika terhadap self efficacy siswa; Pengaruh model pembelajaran kooperatif tipe numbered heads together dan pembelajaran langsung terhadap kemampuan komunikasi matematis siswa; Pengaruh model pembelajaran kooperatif tipe numbered heads together dan pembelajaran langsung terhadap self efficacy siswa; Interaksi antara kemampuan awal matematika dan model pembelajaran terhadap kemampuan komunikasi matematis; dan Interaksi antara kemampuan awal matematika dan model pembelajaran terhadap self efficacy. Penelitian ini merupakan penelitian kuantitatif dengan eksperimen semu. Sampel penelitian ini adalah siswa MAN 1 Medan kelas X berjumlah 62 orang, dengan anailisis ANAVA dua jalur. Hasil penelitian menunjukan bahwa : Terdapat pengaruh kemampuan awal matematika terhadap kemampuan komunikasi matematis siswa; Terdapat pengaruh kemampuan awal matematika terhadap self efficacy siswa; Terdapat pengaruh model pembelajaran kooperatif tipe numbered heads together dan pembelajaran langsung terhadap kemampuan komunikasi matematis siswa; Terdapat pengaruh model pembelajaran kooperatif tipe numbered heads together dan pembelajaran langsung terhadap self efficacy siswa; Tidak terdapat interaksi antara kemampuan awal matematika dan model pembelajaran terhadap kemampuan komunikasi matematis ; Tidak terdapat interaksi antara kemampuan awal matematika dan model pembelajaran terhadap self efficacy.

Kata Kunci: *Kemampuan Awal Matematika, Model Kooperatif, Komunikasi Matematis.*

Abstract

This study aims to determine: The effect of initial mathematical ability on students' mathematical communication ability; The effect of initial mathematical ability on students' self-efficacy; The effect of cooperative learning model type numbered heads together and direct learning on students' mathematical communication ability; The effect of cooperative learning model type numbered heads together and direct learning on students' self-efficacy; The interaction between initial mathematical ability and learning model on mathematical communication ability; The interaction between initial mathematical ability and learning model on self-efficacy. This study is a quantitative study with a quasi-

experiment. The sample of this study was 62 students of MAN 1 Medan class X, with a two-way ANOVA analysis. The results of the study showed that: There is an influence of initial mathematical abilities on students' mathematical communication abilities; There is an influence of initial mathematical abilities on students' self-efficacy;There is an influence of the cooperative learning model type numbered heads together and direct learning on students' mathematical communication abilities; There is an influence of the cooperative learning model type numbered heads together and direct learning on students' self-efficacy; There is no interaction between initial mathematical abilities and learning models on mathematical communication abilities; There is no interaction between initial mathematical abilities and learning models on self-efficacy.

Keywords: Initial Mathematical Ability, Cooperative Model, Mathematical Communication.

A. Introduction

James' dictionary defines mathematics as the study of logic about the shape, organization, amount, and other associated notions in huge numbers, split into algebra, analysis, and geometry (Hasratuddin., 2015). The US National Research Council says arithmetic is the key to success. Success in studying it will lead to a great career for kids. Success in studying it will lead to a great career for kids. Math is usually unpopular among pupils. Especially those who have always found arithmetic terrifying. This initial approach causes kids struggle to learn arithmetic and find it dull, which affects their success. In 2015, Indonesia ranked 44th out of 49 nations in the TIMSS (Trends worldwide Mathematics and Science Study) with a score of 397, much below the worldwide average of 500 (Pianda, Didi, Jon Darmawan, 2018) state that in 2000, the National Council of Teachers of Mathematics (NCTM) created six mathematical criteria for students: comprehension, problem solving, communication, connection, reasoning, and representation.

The quotation above illustrates that pupils must have mathematical communication abilities as a fundamental competency. The (Branca, 2017) states that mathematical communication is a fundamental ability in mathematics education. Math growth is tough without proper communication. According to Baroody in (Hendriana, H., & Soemarno, 2017) mathematical communication enriches solving, investigating, and learning mathematics and helps people exchange ideas and convince others.

Accordingly, (Mahmuzah, 2018) state that mathematics communication abilities are crucial for students to learn since they require oral and written communication to graduate. Mathematical communication abilities are used to solve issues, make conclusions, and express thoughts, ideas, and mathematical concepts in mathematical symbols, especially while learning mathematics.

Drawing by reflecting actual things, drawings, and diagrams into mathematical concepts are indicators of students' mathematical communication abilities. Mathematical expression by stating everyday events in mathematical language or symbols, and writing, including providing answers in one's own language, creating models of situations or problems in spoken language, writing, graphs, algebraic expressions, explaining, asking questions about studied mathematics,

listening, discussing, making conjectures, constructing arguments, and (Arina, 2022) found that students' mathematical communication remains low due to factors such as not understanding teacher-provided material, difficulty in writing story problems, mistakes with mathematical symbols, and not answering questions. NCTM indices of mathematics communication abilities (Nani, H., 2018) The ability to express mathematical ideas orally, in writing, and visually; 2) The ability to use mathematical terms, notations, and structures to present ideas and describe relationships and situations; and 3) The ability to understand, interpret, and evaluate mathematical ideas.

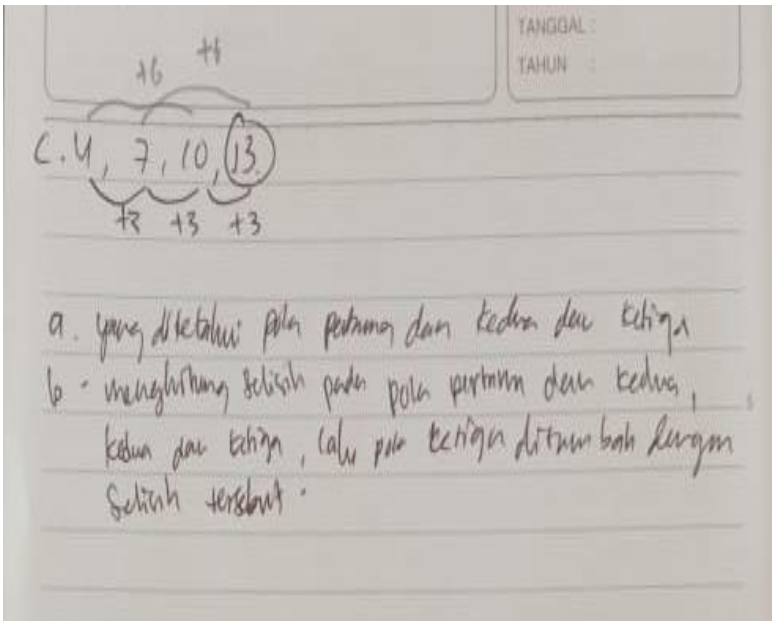

Figure 1. Initial Test Answers for Student Communication Skills

Of 40 students who worked on the issue, 25 replied wrong, the solution procedure was not detailed, and students did not convey the problem appropriately. The kids' mathematical communication ability exam answers show various signs that have not been met. Students cannot write down what is understood and asked from the issue at the level of using words, mathematical notations, and their structures to express thoughts and put mathematical concepts into mathematical models in Figure 1.2. Students should be able to write out each pattern, such as U1 = 4, U2 = 7, and U3 = 10. Question: How many patterns are fourth U4? At the level of understanding, interpreting, and evaluating mathematical concepts, students may write down the solution technique and the two pupils above have accurate answers. Students cannot articulate the pattern when speaking, writing, demonstrating, and visualizing mathematical concepts.

Based on the students' results, we can conclude that the success of mathematics learning to build and develop mathematical communication skills depends on both the teacher's learning model and the students' learning process. Student achievement depends on discipline, learning tactics, coursework, and environmental interactions. As with mathematical communication, self-efficacy is crucial in other emotional areas. Confidence in one's talents enhances learning. This idea encourages optimistic student behaviour to succeed in learning (Saptika, Y. A., Rosdiana, F., & Sariningsih, 2018). According to (Ratna., 2017), student self-efficacy affects task completion and problem-solving. Self-efficacy helps pupils complete assignments and improve their performance by appropriately assessing themselves.

(Winarji, 2019) said that (1) pupils who feel inadequate in mathematics think that success in examinations is a coincidence or good luck, whereas failure (low scores) is incapacity. Strong math students believe that success in math tests is the result of their own abilities, not memorization, and that success in math tests does not depend on memorization. Students must have self-efficacy to achieve the 2013 curriculum's mathematics learning objectives, which include appreciating mathematics' usefulness in everyday life, curiosity, attention and interest in learning mathematics, perseverance and confidence in solving problems.

The investigators found mathematics learning at MAN 1 Medan inefficient. Students are only instructed to work on book questions alone or in groups. Students remain passive and learning is still teacher-centered. The researcher also interviewed a mathematics teacher at MAN 1 Medan on July 17, 2023, who said that students still struggle with confidence in math class, especially in their own abilities. When the instructor presents the subject, students listen more, sit quiet, and are less daring in expressing their thoughts, particularly if given an assignment to declare they are terrified of being incorrect.

This is consistent with (Dewi, M. W. K., 2022) 's study on junior high students' mathematics communication self-efficacy. No kid demonstrated great self-efficacy, according to their research. To address this, a new learning organization approach should be created based on suitable delivery methods, media, and learning materials. Students' inadequate mathematical communication and self-efficacy are linked to the learning model. Teachers still lecture throughout the learning process. Teachers should choose a methodology that engages students in learning and improves their mathematical communication and self-efficacy. Cooperative learning requires student participation.

Because the cooperative learning model involves students studying materials and ideas in small groups to attain shared objectives (Haidir & Salim, 2022). Students may develop competency via Pair Check, Jigsaw, STAD, Role Playing, Numbered Heads Together (NHT), Group Investigation, Example Nonexample, and Make a Match. After reviewing the models above, researchers believe the Numbered Heads Together model is best because Lagur, et al.

(2018) found that the cooperative learning model type improves mathematical communication skills.

The NHT type cooperative learning approach improved mathematical communication abilities more than the direct learning model, according to their research. Wahyuni and Yolanda (2018) used Numbered Heads Together (NHT) cooperative learning to enhance math communication skills and self-efficacy in class VII students at MTS YKWI Pekan Baru. Their research found that the Numbered Heads Together (NHT) learning approach improves communication and self-efficacy.

Numbered Heads Together (NHT) cooperative learning approach encourages student creativity in obtaining, analyzing, and reporting knowledge from multiple sources to give to the class, according to (Fathurrohman, 2021). (Ngalimun., 2017) defines NHT as directive cooperative learning with heterogeneous groups of students with certain numbers, teaching material problems (for each group the same but for each student it is not the same according to student number, each student with the same number gets the same task), and group work. In addition to the learning model used by the teacher, another factor that determines the success of students in receiving lessons is their initial abilities. Students' initial mathematics abilities are abilities that students already have before they take part in the learning that will be given (Sumantri, 2016). Initial abilities will affect the success or failure of a student in the learning process. There must be a continuous and comprehensive relationship so that students can understand a learning concept sequentially. If students do not understand the basic concepts beforehand, students will definitely have difficulty in accepting the next new concept (Pratiwi & Handhika, 2021).

Therefore, it is known that initial abilities in mathematics learning are important for teachers before starting learning. In the initial teaching and learning process, teachers should first see the students' initial abilities. This is useful for knowing whether students have the prerequisite knowledge to take part in learning and to what extent students have understood the material that will be presented so that teachers can design learning better.

Based on the explanation above, cooperative learning of the numbered head Together type assisted by interactive LKPD is considered to be able to spur the enthusiasm of each student to actively participate in their learning experience. With group learning, it is expected that students can communicate their ideas and use their reasoning skills in solving the problems given. Therefore, the author feels the need to conduct research to see "The Effect of Initial Mathematical Ability and the Numbered Head Together Type Cooperative Learning Model on Mathematical Communication Ability and Self Efficacy.

B. Research Method

The type of research used in this study is a quasi experiment. According to (Sugiyono, 2018) this design has a control group so that it cannot fully control external variables that may affect the implementation of the experiment, this design was developed to overcome the difficulty in determining the control group in the study. The population is not just the number of objects/subjects studied, but includes all the characteristics/properties possessed by the subject or object. In this study, the researcher chose the population to be all students of class X MAN 1 Medan. The sample in this study was class X-15 and X-16 where class X-15 as the experimental class using cooperative learning type numbered heads together and class X-16 as the control class that will be treated with direct learning.

The design used in this study is Pre test-Post test Control Group Design. According to (Sugiyono, 2018) Pre test-Post test Control Group Design in this design there are two groups that are randomly selected, then given an initial ability test to determine the initial state of the difference between the experimental group and the control group. The following is a description of the research design according to the Pre test-Post test Control Group Design plan:

Table 1 Research Design

Experimental Class	Initial Abilities	Treatment	*Posttest*
Experiment	O_1	X	O_2
Control	O_3	-	O_4

Information:

O_1 = Measurement of initial abilities of the experimental group

O_2 = Measurement of the final ability of the experimental group

X = Treatment in the form of providing a cooperative NHT model

O_3 = Initial ability measurement of the control group

O_4 = Measurement of final ability of control group

C. Result and Discussion

In this study, a number of data will be obtained, including (1) the results of the initial mathematical ability test of students, (2) the results of the mathematical communication ability test of students in the experimental and control classes, and (3) the results of the self-efficacy questionnaire of students in the experimental and control classes:

Description of Students' Initial Mathematics Ability

The first mathematical ability exam of pupils was utilized to compare the study sample class to their pre-learning skills. Average and standard deviation calculations were done to assess pupils' math skills. Table 2 summarizes pupils' first maths aptitude descriptive analysis.

Table 2 Description of Students' Initial Mathematics Ability Results

Class	Ideal Score	N	x_{min}	x_{maks}	$\overline{x}$

Experiment	100	31	40	85	65
Control		31	38	88	60

Next, KAM grouping is carried out (high, medium, and low) with the provision that students who have a KAM value ≥ $\bar{x}$+SD are grouped in high mathematics ability, students who have a value ($\bar{x}$-SD<KAM<$\bar{x}$+SD) are grouped in medium mathematics ability, while students who have a KAM value ≤$\bar{x}$-SD are grouped in low ability. The summary of the calculation results is presented in Table 3 below.

Table 3. Description of Student Grouping Based on KAM

KAM Category	Statistics	Learning	
		Numbered Heads Together	Direct
High	N	5	6
	Mean	84	84
	Standard Deviation	1,74	3,34
Medium	AND	21	22
	Mean	66	57
	Standard Deviation	10,67	7,28
Low	AND	5	3
	Mean	42	39
	Standard Deviation	2,72	2,41

Table 3 shows that 5 experimental students had high KAM, 21 middle KAM, and 5 low KAM. The control class included 6 high KAM pupils, 22 middle, and 3 low.

The test criteria used are if the sign value>0.05 then H_0 is accepted, meaning the sample comes from a normally distributed population and if the sign value<0.05, then H_1 is accepted, meaning the sample comes from a non-normally distributed population. The summary results of the calculation of the normality of the initial mathematics ability test using SPSS 30 are presented in tabel 4:

Table 4. Homogeneity Test of Students' Initial Mathematics Ability Test

Tests of Normality				
		Kolmogorov-Smirnov[a]		
	Class	Statistic	df	Sig.
Early Mathematics Skills	Experiment	.148	31	.082
	Control	.145	31	.096

In Table 3, the experimental class significance value was 0.082, which indicates H_0 is acceptable if the sign value is >0.05. In the control class, 0.096 indicates a sign value >0.05, hence H_0 is approved. Thus, this normality test showed that the experimental and control class kids' initial mathematical aptitude test results were sample data from a regularly distributed population.

Description of Students' Mathematical Communication Skills

The students' mathematical communication ability test results show how they performed after being given the Numbered Heads Together learning model in the experimental class and direct learning in the control class. Final posttest results are provided. Complete data and processing are in the appendix. From the processed data, Table 4.displays the lowest (Xmin), highest (Xmax), average ($\bar{X}$), and standard deviation (s) scores for the experimental and control classes.

Table 5. Description of Posttest Results of Students' Mathematical Communication Skills

Class	Ideal Score	N	x_{min}	x_{maks}	$\bar{x}$	SD
Experiment	100	31	63	92	76	7
Control		31	58	85	70	8

Table 5. above shows that the minimum value of the mathematical communication ability in the control class is 58 and the minimum value in the experimental class is 63, the maximum value in the control class is 85 while in the experimental class is 92. The average problem solving ability in the control class is 70 with a standard deviation of 8 and the average experimental class is 76 with a standard deviation of 7. The description of the posttest results of mathematical communication ability based on initial mathematical ability can be seen in table 6 below.

Table 6. Description of Grouping of Students' Initial Mathematical Abilities Based on Mathematical Communication Abilities

KAM Category	Statistics	Learning	
		Numbered Heads Together	Direct
High	N	7	4
	Mean	85	82
	Standard Deviation	3,52	2,62
Medium	AND	19	21
	Mean	76	71
	Standard Deviation	3,56	5,17
Low	AND	5	6
	Mean	65	59
	Standard Deviation	2,08	1,14

According to Table 56 7 students in the experimental class had strong mathematical communication skills, 19 had moderate abilities, and 5 had poor skills. In the control class, 4 students had excellent mathematics communication abilities, 21 had moderate, and 6 had poor.

Test criteria: if sign value >0.05, data group variance is homogenous; if sign value <0.05, variance is not homogeneous. The following SPSS 30 findings show the homogeneity of pupils' early maths ability using the Levene test.

Table 7. Results of the Homogeneity Test of Communication Skills

		Levene Statistic	df 1	df2	Sig.
Communication Skills	Based on Mean	1.532	1	60	.221
	Based on Median	1.385	1	60	.244
	Based on Median and with adjusted df	1.385	1	59.63	.244
	Based on trimmed mean	1.522	1	60	.222

Based on table 6 .above, it is obtained that the significance value for the experimental class and control class is 0.221. This means that 0.221> 0.05, so it can be concluded that the three data used (initial mathematical ability, learning model and mathematical communication ability) are homogeneous. So that the assumption of homogeneity in the two-way anova test is met.

Description of Student Self Efficacy Questionnaire Results

Based on data from the results of the learning independence questionnaire, the lowest score (x_min), highest score (x_max), average score ( ), and standard deviation (SD) for the experimental group and control group were obtained as shown in Table 8 below:

Table 8 .Description of Student Self-Efficacy Questionnaire Results

Class	Ideal Score	N	x_{min}	x_{maks}	$\overline{x}$	SD
Experiment	100	31	61	91	75	31
Control		31	57	84	70	31

Table 7 above shows that the minimum value of self-efficacy in the control class is 57 and the minimum value in the experimental class is 61, the maximum value in the control class is 84 while in the experimental class it is 91. The average problem-solving ability in the control class is 70 and the average in the experimental class is 75.

Table 9. Description of Student Self Efficacy Questionnaire Grouping

Statistics	Learning

KAM Category		*Numbered Heads Together*	Direct
High	N	7	9
	Mean	85	80
	Standard Deviation	3,52	1,18
Medium	AND	19	15
	Mean	76	68
	Standard Deviation	3,56	4,50
Low	AND	5	7
	Mean	65	59
	Standard Deviation	2,08	1,67

From the recapitulation of Table 9 above, it was obtained that in the experimental class there were 7 students who had high mathematical communication skills, there were 19 students who had moderate mathematical communication skills, and 5 students who had low mathematical communication skills. While in the control class there were 9 students who had high mathematical communication skills, there were 15 students who had moderate mathematical communication skills, and 7 students who had low mathematical communication skills.

Discussion

According to the ANOVA calculation, KAM, the numbered heads together learning model, and direct learning all had an effect on students' mathematical communication skills and self-efficacy, but KAM and the learning model did not interact. According to (Windi, Perkasa, 2019), the learning model is a roadmap for instructors to follow that provides a theoretical foundation for thinking about learning goals, teaching behaviour, and the learning environment. The researcher employed numbered heads and direct learning models in this investigation. The experimental class employed numbered heads together learning whereas the control class used direct learning. The numbered heads together model begins with the teacher arousing students' interest by asking questions about the material, then students are divided into heterogeneous groups of 4-6 people and given a head number to solve a problem by seeking information from various sources while supervised by the teacher, who acts as a facilitator.

From descriptive data analysis in the experimental class employing numbered heads, mathematical communication skills averaged 76 with a maximum of 92 and a low of 63. 7 pupils had high communication skill ratings, 19 average, and 4 poor with a standard deviation of 7. The control class employing direct learning had an average mathematical communication skill of 70, ranging from 85 to 58. Four students had high communication skill ratings, 21 average, and 6 poor with a standard deviation of 8. Based on the hypothesis test data, a Sig value of 0.666> 0.05 was obtained, indicating that Ha was accepted, that the NHT type cooperative learning model had a significant effect on students' mathematical communication

abilities in class XI of SMA Negeri 1 Angkola Selatan. (Fauza, 2020) found that the numbered heads together learning approach improved students' mathematics communication abilities in class VII SMP Negeri 12 Pematangsiantar learning sets.

The study found that numbered heads together learning improves students' mathematics communication abilities more than direct learning. According to the research, pupils in the experimental class learned quicker than those in the control class. The numbered heads together approach encourages students to actively talk with their peers, which helps them recall more than the control class, which promotes teacher-centered learning. According to the self-efficacy questionnaire, control class students had an average self-efficacy of 70, ranging from 84 to 57. Nine students had high self-efficacy ratings, 15 average, and 7 low with a standard deviation of 8. The experimental class averaged 75 self-efficacy, ranging from 91 to 61. High self-efficacy ratings were 7 students, medium 20 students, and low 4 students with a standard deviation of 7. High, medium, and low KAM values impact students' mathematics communication abilities and self-efficacy. This is shown by the average self-efficacy scores of high, medium, and low category KAM scores: 84, 74, and 63, respectively. High KAM scores correlate with greater mathematical self-efficacy ratings than medium and low KAM values. Application of the numbered heads together paradigm has a greater impact than direct learning.

D. Conclusion

Based on data analysis, findings, and discussions in the preceding chapter, various inferences were drawn about students' basic mathematical ability, communication skills, and self-efficacy. Some findings: Initial mathematical talents affect pupils' mathematical communication. Initial math skills affect kids' self-efficacy. The numbered heads together cooperative learning approach and direct learning affect students' mathematics communication skills. Direct learning and the numbered heads together cooperative learning paradigm affect students' self-efficacy. There is no relationship between basic math skills and learning methods on math communication. Learning models do not affect self-efficacy based on starting mathematical competence. Based on the research results and conclusions above, it can be suggested. For other researchers who want to conduct research to measure students' mathematical communication skills and Self-ability to pay more attention to each indicator of students' mathematical communication skills and Self-ability in order to enrich knowledge about students' mathematical communication skills and Self-ability.

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