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Improving Mathematical Problem-Solving Abilities through Think Pair Share Learning Using Autograph

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Abstract.
There are many studies on technology-supported learning based on cooperative learning in the literature. However, little is known about Autograph-assisted think pair share learning in supporting students' problem-solving abilities for learning in today's technological era. This study aims to examine and analyze the differences in the improvement of students' problem-solving abilities who participate in think pair share learning assisted by Autograph (Auto-TPS) and conventional learning assisted by Autograph (Auto-CL). This study uses quantitative methods with the design used in this study is a nonequivalent control group design involving two groups of students. The sample of this study was 70 students of class IX SMP Al Ulum Medan, Indonesia. Questions to test students' mathematical problem-solving skills found five items. Data analysis includes data processing of test results, namely normality test, homogeneity test, hypothesis testing, and average difference test in the two groups using t-test. The conclusion of this study is that students who study with Auto-TPS get a higher increase in problem-solving abilities compared to students who learn with Auto-CL, with the explanation that the group of students who study Auto-TPS is very good when compared to the group student learning Auto-CL. Research findings related to the application of Auto-TPS can be an alternative learning model in the current technology-era learning situation.

Keywords: autograph, mathematics, problem-solving abilities, think pair share learning

1. INTRODUCTION

Education is a tool to develop a way of thinking, therefore education is needed both to solve problems in everyday life and to support the progress of science and technology [1, 2]. In learning mathematics, one of the abilities that students need to master is problem solving skills [3, 4]. Problem solving skills are important not only for those who will

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study mathematics in the future, but also for those who will apply it both in other fields of study and in everyday life [5]. In essence, problem solving is a high-level thinking process and has an important role in learning mathematics [6]. In general, learning mathematics in problem solving is studying mathematical problems that are not routine, therefore this ability is classified as a high level ability [7]. So it can be seen that the type of learning with problem solving will be very appropriate to be applied optimally in learning mathematics because it will improve higher-order thinking skills that will train and familiarize students to think creatively, logically, analytically, and systematically [8, 9].

One alternative learning model that is used to deal with difficulties in mathematics and is able to improve mathematical problem solving skills is the cooperative learning think pair share learning model because there is an influence of the think pair share learning strategy on student retention power, and there is an interaction effect of the think learning strategy. pair share and academic ability on students' cognitive learning outcomes [10]. Think pair share (TPS) is a learning strategy that was first developed by Professor Frank Lyman at the University of Maryland in 1981 and adopted by many authors in the field of cooperative learning in the following years [11]. Assuming that all recitations or discussions require arrangements to control the class as a whole, and the procedures used in TPS can give students more time to think, to respond and help each other so that the teacher predicts only completing a short presentation or students reading assignments, or situations that become question mark [12].

Cooperative learning is very important, this is because in learning situations, students are usually seen as individualistic, characterized by students tending to compete individually, being closed to friends, paying less attention to classmates, hanging out with only certain people, wanting to win on their own, and so on [13]. If this situation is left unchecked, it is possible to produce citizens who are selfish, inclusive, introverted, less sociable in society, indifferent to neighbors and the environment, lack of respect for others, and do not want to accept the strengths and weaknesses of others [14]. For this reason, cooperative learning strategies are expected to be able to improve the quality of learning, namely one type of learning model that will be used in this study is cooperative think pair share [15].

Besides that, think pair share (TPS) provides more time for students to think and discuss to find more appropriate answers and teach students to help each other or work together with group members so that students who are less able will be assisted by students who are capable in academic matters. , so that students who are less capable in terms of academics will be able to understand the TPS type cooperative subject

matter with the Autograph software media helping students determine the image of the transformation [16]. Think pair share learning model can have a positive impact on the learning achieved by students including one of the factors that make students able to play an active role in expressing their ideas during the learning process is to use a learning approach that is in accordance with the material and characteristics of students so that learning is carried out get quality [10, 17]. In addition, the use of technology is one solution to increase student activity in learning [18]. Schools should apply technology in every educational activity [19], not only as a mathematical calculation tool, but has been used as a learning medium that helps teachers explain a concept in class so that the use of technology can guide students through the development of mathematical topics [20, 21].

The development of education in the 21st century cannot be separated from technological developments. In the era of globalization, technological progress is increasingly rapid, especially information and communication technology (ICT), one of which is computers [22–24]. Utilization of mathematics learning using technology or more often called ICT-based learning provides convenience and is able to make the delivery of learning more interesting for students so that students never get bored, are very patient in carrying out instructions, as desired [25, 26]. Media technology provides a positive role in a learning process that can help learning in the classroom. Many have been created, one of which is Autograph software [27].

Autograph design involves three principles in learning and learning, namely flexibility, repetition, and drawing conclusions so that it will help students in conducting experiments so that it is possible to find new things [28]. With the use of Autograph in learning mathematics, it is also hoped that learning can be more interesting and interactive so that it can be used as a solution to improve the quality of student learning [29]. By applying the Think Pair Share (TPS) cooperative learning model using Autograph Software, it is hoped that student learning will be more meaningful, give a strong impression on students, can help students overcome student difficulties in order to understand and solve mathematical problems so that they can be used to develop skills. student mathematical problem solving [30]. Based on the description above, this study aims to examine and analyze the differences in the improvement of students' mathematical problem solving abilities who participate in learning with think pair share learning assisted by Autograph (Auto-TPS) and conventional learning assisted by Autograph (Auto-CL).

2. RESEARCH METHOD

This research is a quasi-experimental study to examine the improvement of students' mathematical problem solving skills through learning think pair share using Autograph (Auto-TPS). This research was conducted on two groups of students, namely the experimental group and the control group. The experimental group is a group of students who learn geometry transformation using the think pair share model using Autograph (Auto-TPS), while the control group is a group of students who learn geometry transformation using conventional learning assisted by Autograph (Auto-CL). The design used in this study is the Nonequivalent Control Group Design which involves two groups of students [31–33].

This research was conducted in one of the junior high schools in the city of Medan. The research was carried out on class IX students, totaling five classes so that to select the research sample, a random draw was conducted to select two classes. The conditions and characteristics of students in each class are the same, this is based on information from the curriculum field that at the time of division of class IX students, students were evenly distributed to each class. From the five existing classes, two classes were randomly selected to be used as an experimental class and a control class respectively. The number of samples in this study were 70 students consisting of 35 students consisting of 12 male students and 23 female students as the experimental class and 35 students consisting of 16 male students and 19 female students as the control class.

In this study, several data collection instruments were used, namely test questions. A test question is a tool or procedure used to find out or measure something in an atmosphere, in a way and with predetermined rules [33]. In this study, the test questions consisted of a mathematical problem solving ability test. The questions to test students' mathematical problem solving skills are 5 items. Guidelines for scoring mathematical problem solving abilities using scoring guidelines are based on the problem solving process carried out by students, namely starting from understanding the problem, making problem solving plans, performing calculations, and re-examining all problem solving steps that have been done [34]. In addition, the researcher also gave a score very carefully in connection with this mathematical problem solving problem, students could answer in various ways/alternative solutions.

The mathematical problem solving ability test questions were tested for their content validity, then the test questions were tested on class IX students who had received the material to be tested for further testing of reliability, validity, Difficulty Index, and

Distinguishing Power of the test questions. To measure the validity of the test items of the test results, the product moment correlation formula is used [31]. Based on the results of the calculation of the reliability of the instrument, it was found that the level of reliability for the mathematical problem-solving ability test kit was high, namely Cronbach's alpha value of 0.70 and the average mathematical problem-solving ability test questions were given, the distinguishing power had good qualifications, namely the average discriminatory index of 0.50. In the research there are 3 stages, namely the preparation stage, the implementation stage and the data analysis stage [31]. At the preparatory stage of this research, the research sample was selected in consultation with the school. Then adjust the research time starting from the problem of testing the instrument, adjusting the teaching schedule and choosing the textbooks commonly used in the school plus the textbooks prepared by the researcher as student reference materials. For the experimental class, in addition to textbooks, teaching materials were also provided by the researchers in the form of worksheets. Finally, after all data has been collected, data processing and analysis is carried out for the purposes of drawing conclusions. The data obtained from the test results were then analyzed to be able to interpret the research results. The steps of data analysis include data processing of test results, namely normality test, homogeneity test, hypothesis testing, and average difference test in both groups using t-test.

3. RESULTS AND DISCUSSION

The data processed and analyzed were the results of pretest, posttest, and normalized gain for each mathematical problem solving ability. The following are the average results of the pretest, posttest, and normalization of obtaining problem solving abilities and descriptive statistics. Pretest, posttest, and gain scores for the experimental and control classes are presented in Table 1.

Based on the data in the Table 1, it can be seen that the achievement of the learning that has been carried out is by looking at the percentage of the number of students who get a score above 60%. For the achievement of problem solving skills, in the group of students whose learning is by learning think pair share using Autograph (Auto-TPS) the number of students who get a score above 60% has reached 97.14%, this is a very good achievement, meanwhile in the group of students whose learning with conventional learning assisted by Autograph (Auto-CL) is only 14.29%, is a very poor achievement. While the students' initial mathematical problem solving ability, the average score of the two groups is classified as very low, which is below 40%. The pretest score of

Table 1: Average results of pretest, posttest, and normalized gain problem solving ability and descriptive statistics of pretest, posttest, and gain scores for experimental and control classes.

	N		Auto-TPS		
			Pretest	Posttest	Gain
Problem Solving Ability	35	$\overline{x}$	14.26 (28.5%)	35.89 (71.7%)	0.29
		S	2.81	3.25	
		L	0%	97.14%	
	N		Auto-CL		
			Pretest	Posttest	Gain
	35	$\overline{x}$	14.06 (28.1%)	24.37 (48.7%)	0.29
		S	2.86	4.51	
		L	0%	14.29%	

Table 2:

Score	Class	Mathematical Problem-Solving Ability			
		X_{min}	X_{max}	$\overline{x}$	S
Pretest	Auto-TPS	9	20	14.26 (28.52%)	2.81
	Auto-CL	8	19	14.06 (28.12%)	2.86
Posttest	Auto-TPS	29	42	35.83 (71.66%)	3.25
	Auto-CL	15	35	24.37 (48.74%)	4.51
Gain	Auto-TPS	0.49	0.77	0.61	0.73
	Auto-CL	0.12	0.52	0.29	0.09

mathematical problem solving ability is the score obtained before the learning is given, both the experimental class and the control class. The posttest score of mathematical problem solving ability is the score obtained after learning is given, both experimental class and control class.

To find out whether or not there is an average difference in the scores of the pretest, posttest, and gain results of the two groups, a statistical analysis of the test of the difference between the two averages was carried out, but first, normality and homogeneity tests were carried out. In this study, for statistical analysis, researchers used the SPSS 17 program where the normality test used the Shapiro Wilk test. In the following, the normality tests for pretest, posttest, and obtaining mathematical problem solving abilities are presented in Table 2.

Based on the Table 2, it can be seen that the significance value in the Shapiro Wilk column for the class whose learning is Auto-TPS is 0.285 and the class whose learning is

Table 3: Normality test pretest, posttest, and gain mathematical problem-solving ability.

	Class	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Pretest	Auto-TPS	.136	35	.097	.963	35	.285
	Auto-CL	.123	35	.200	.960	35	.224
Posttest	Auto-TPS	.113	35	.200*	.981	35	.782
	Auto-CL	.129	35	.148	.982	35	.825
Gain	Auto-TPS	.101	35	.200*	.975	35	.592
	Auto-CL	.079	35	.200*	.983	35	.840

Auto-CL is 0.224. Everything is greater than value α = 0,05, this means that the students' score data from the pretest (initial test) of mathematical problem-solving abilities are normally distributed. Then for the results of the post-test (final test) the class whose learning is Auto-TPS and the class whose learning is Auto-CL are all greater than the score α = 0,05, this means that the data score of students' mathematical problem solving ability is normally distributed. Meanwhile, the normalized gain data whose learning is Auto-TPS and the class whose learning is Auto-CL are all greater than the value of α = 0,05, this means that the data gain is normalized for the ability to solve mathematical problems with a normal distribution. The following results of the homogeneity test of pre-test, post-test, and the acquisition of mathematical problem solving are presented in Table 3.

Table 4: Homogeneity test results pretest, posttest, and gain mathematical problem solving.

Problem Solving		Levene Statistic	df1	df2	Sig.
Pretest	Based on Mean	.158	1	68	.692
	Based on Median	.243	1	68	.624
	Based on Median and with adjusted df	.243	1	66.964	.624
	Based on trimmed mean	.197	1	68	.659
Posttest	Based on Mean	3.916	1	68	.052
	Based on Median	3.666	1	68	.060
	Based on Median and with adjusted df	3.666	1	62.687	.060
	Based on trimmed mean	3.840	1	68	.054
Gain	Based on Mean	1.411	1	68	.239
	Based on Median	1.227	1	68	.272
	Based on Median and with adjusted df	1.227	1	65.753	.272
	Based on trimmed mean	1.361	1	68	.247

Based on the Table 3, in the significance column (*sig.*) the results obtained 0.692, this indicates that the results of the pretest of the mathematical problem-solving ability test of the two groups have the same variance or are called homogeneous. Then the posttest results, in the significance column (*sig.*) results obtained 0.052, This shows that the results of the post-test of the mathematical problem-solving ability of the two groups have the same variance or are called homogeneous. Next, in the significance column (*sig.*) results obtained 0.239, This shows that the normalized gain for the mathematical problem-solving ability of the two groups has the same variance or is called homogeneous.

After testing for normality and homogeneity of variance, the two-mean difference test was then tested between the group that taught Auto-TPS and the class that taught Auto-CL. Because in the initial test the data is normally distributed and the variance is the same, then the Independent Sample t-test is used. The following is a different test of the average pretest, posttest and gain in solving mathematical problems presented in Table 4.

TABLE 5: Test the difference in average pretest, posttest and gain mathematical problem solving.

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	**Sig.**	**t**	**df**	**Sig. (2-tailed)**	**Mean Difference**	**Std. Error Difference**
Pretest	Equal variances assumed	.16	.69	.30	68	.77	.20	.68
	Equal variances not assumed			.30	68	.77	.20	.68
Posttest	Equal variances assumed	3.92	.052	12.2	68.0	.000	11.5	.939
	Equal variances not assumed			12.2	61.8	.000	11.5	.939
Gain	Equal variances assumed	1.4	.23	15.9	68.	.000	.31552	.01979
	Equal variances not assumed			15.9	65.0	.000	.31552	.01979

In the Table 4, it can be seen that the probability value of *sig.(2-tailed)* = 0.770 greater than α. This means the null hypothesis (H_0) accepted and showed that there was no difference between the initial mathematical problem-solving abilities of the two groups. Then in the post-test it can be seen that the probability value of $\frac{1}{2}$ *sig.(2-tailed)* = 0.000 greater than α. This means the null hypothesis (H_0) rejected and showed that there was a difference between the final mathematical problem solving ability of the experimental group and the control group. Furthermore, the gain shows that the probability value $\frac{1}{2}$

sig.(2-tailed) = 0.000 smaller than α. This means the null hypothesis (H_0) rejected and shows that the increase in the mathematical problem solving ability of students who learn Auto-TPS is better than the group of students who learn Auto-CL.

In the group of students whose learning was Auto-TPS, the number of students who experienced an increase in problem solving abilities above the normalized gain score of 0.50 was 90.26%. Meanwhile, in the group of students who studied Auto-CL, the number of students who obtained a normalized gain score on problem solving abilities above 0.50 was 62.74%. If it is displayed in a table it will look as follows. The following is the percentage of students with n-gain scores above 0.50 presented in Table 5.

TABLE 6: Percentage of number of students with n-gain score above 0.50.

Student Group	Percentage of Number of Students with N-Gain Score above 0.50
	Problem solving ability
Auto-TPS	90.26%
Auto-CL	62.74%

The results of data analysis in this study provide information that students whose learning Auto-TPS mathematical problem solving abilities have increased significantly. Learning with think pair share provides broad opportunities for students to conduct their investigations and analyzes to be able to obtain the data and information needed in order to find the solution they are looking for. This step in acquiring knowledge has indirectly trained students to be scientific and logical in solving problems and drawing conclusions. This is in accordance with the statement that thinking pair share learning can train and develop students' thinking skills and activities, because students build knowledge through self-exploration and student knowledge can also develop through the transfer of mindsets with other students, so students are able to combine and compare their own mindset with the mindset of other students [35]. In the implementation of learning with think pair share, students feel more serious in conducting data analysis, this is because in thinking pair share learning has been given computer media that has been facilitated by Autograph software that can be used in exploring the geometry transformation material given to students. Findings in the field include students feeling like they don't have time to joke, make noise and activities that are not useful, and other bad things. They were just engrossed in discussing with their group of friends by taking turns analyzing geometric transformations on the computer with their Autograph software. Even without complete and detailed instructions from the teacher, students have been able to divide tasks among group members, they try their best to be able to prove the hypothesis of the material being studied.

Autograph software is not geometry software that provides all types of measurements, so learning with the help of this software still requires student competence in performing manual calculations and describing algorithms as needed. This makes students complement each other in their work, if one person is exploring the Autograph, the others are ready to wait for the calculation command to do. The students' activities in the Auto-TPS learning were quite good, they did not state that they were tired of the learning, but felt happy and challenged. The curiosity of students also increases, this can be seen when they are very serious and do not get bored to investigate the problems given by the teacher with the help of Autograph. The mathematical problem solving ability of students who studied with Auto-TPS learning in this study improved better when compared to the mathematical problem solving abilities of students who learned Auto-CL. This is because in Auto-TPS learning students can freely do the think stage (individual thinking), pair stage (pairs), (3) share stage (sharing) the problems they face with the help of Autograph.

In the group of students whose learning was Auto-TPS, the average increase in problem-solving ability scores increased by 43.2%, from an average pretest score of 28.5% to 71.7% in the final test of problem-solving skills. Meanwhile, in the group of students who learned Auto-CL, the increase was only 20.6%, from an average pretest score of 28.1% to 48.7% in the final test of problem-solving skills. The number of students who have scored above 60% in the class where Auto-TPS learning in the final test has reached 97.14%, while in the group of students whose learning Auto-CL is only 14.29%. This provides information that the achievement of the group of students who learn Auto-TPS is very good when compared to the group of students who learn Auto-CL.

Students get scientific steps from the results of their interactions with computers and other students who are equipped with the Autograph program, so that in the problem solving process they feel more confident. With the help of Autograph software, it turns out that students are more challenged to immediately take problem-solving steps, they are very enthusiastic in preparing problem-solving plans, then implementing the plan. Students are better trained to do scientific things in solving problems given by the teacher [36]. The condition of students in this study is in accordance with the statement that with think pair share learning the learning process situation becomes more stimulating, can develop individual and group talents or skills, and gives students freedom to study and think individually, thus making students more understanding and actively discussing with members. groups to find concepts and solve problems [37]. Students are increasingly aware of the benefits of mathematics after learning problem-solving questions, because in problem-solving questions, mathematical material is connected

with technology practice directly and in everyday real life, so that learning is felt to be more contextual. Students are well aware of the importance of mastering mathematics as a provision in living their lives in the future.

4. CONCLUSION

The results showed that the criteria for increasing mathematical problem solving abilities provided information that the achievement of the group of students who learned Auto-TPS was very good when compared to the group of students who learned Auto-CL. The application of Auto-TPS and Auto-CL each has a significant effect on students' mathematical problem solving abilities, where students who study with Auto-TPS get a higher improvement than students who learn with Auto-CL. This study has limitations, namely the research subject is only in class IX junior high school students. So it is necessary to do research again in applying the think pair share learning model at other school levels. In addition, the aspect of mathematical ability is only limited to students' mathematical problem solving abilities, so that measurements on higher mathematical aspects need to be followed up. Based on the research findings and the limitations of this study, further research can develop a think pair share learning model as an alternative learning model in learning situations in today's era. The teacher must be a facilitator, mediator, director-motivator, and evaluator in cooperative learning. The selection and use of various supporting applications that can regulate the delivery of learning information to students can be a researcher's effort to direct students to the learning experience of investigating and solving mathematical problems. The implications of the results of this study can be used as consideration for teachers in implementing mathematics learning in the current era of education.

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