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THE EFFECT OF PROBLEM-POSING AND THINK-PAIR-SHARE LEARNING MODELS ON STUDENTS' MATHEMATICAL PROBLEM-SOLVING SKILLS AND MATHEMATICAL COMMUNICATION SKILLS

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Abstract. The main purpose of this study was to compare and examine the effectiveness of problem-posing and think-pair-share cooperatives' learning models on mathematical problem-solving skills and mathematical communication skills. This study was experimental research with a quasi-experimental design. The samples of the study were 41 students for classroom experiments and 40 students for classroom control. The instruments employed in this study were pre-test and post-test. The instruments were made in essay forms which design to measure students' mathematical problem-solving skills. The result of the study showed that problem-posing and think-pair-share are very effective to improve students' mathematical achievements. However, between the problem-posing and think-pair-share, the think-pair-share is more effective than problem-posing, view from the standards of mathematical problem-solving skills and mathematical communication skills of Junior High School students.

Keywords**:** Problem-Posing; Think-Pair-Share; Mathematical Problem-Solving; Mathematical Communication Skills

I. INTRODUCTION

Technology development in the mathematical learning process has gradually change mathematical educational focus from students' mathematical achievement to the improvement of students' various abilities (Tan & Ang, 2016; Umam & Kowiyah, 2018). Although mathematical achievement is important, but it needs to improve other students' abilities nowadays was compulsory Mathematical learning process should continue to improve others' abilities such as problem-solving skills, communication skills, critical thinking skills, and creative thinking skills(Sanders, 2016; Umam, 2018). Paridjo & Waluya (2017) said that mathematical communication skill is vital in learning mathematics. Students should be able to communicate their ideas to others. If students have communication skills, they will be confident in front of the class. Additionally, Umam et al. (2017) had an overview that problem-solving is play a major process during mathematical learning in the classroom. Before communicating the ideas, students have to master the mathematical concepts and problem-solving skills. The higher the problem-solving, the more confident students in communicating their mathematical ideas. Corresponding to this information, this research would accommodate to improve was problem-solving skills and communication skills.

Pugalee (2004) said that nowadays mathematical learning process needs to improve students' mathematical problem-solving skills. Problem-solving skill plays an important rule in the mathematical learning process. Polya (1957) said there are four steps in mathematical problem-solving such as understanding problems, planning, looking back. First, students need to understand the problem. The student should read carefully the problems and identify important information. After selecting the information, students need to construct their understanding about problem (Genarsih, Kusmayadi, & Mardiyana, 2015). Secondly, students should devise a plan for what they were going to do to solve a problem. In devising the plan, students should overview many mathematical concepts

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corresponding to problems prior to choose and apply the appropriate concept.

Thirdly, students need to carry out the plan. This step is important in the problem-solving process. This is where students need to apply their understanding and selective mathematical concept to solve the problem (Genarsih Genarsih, Kusmayadi, & Mardiyana, 2015; Pugalee, 2004). Students usually transform the problem into a mathematical model by using letters, numbers, and other mathematical symbols (Alim, Umam, & Rohim, 2015; Csíkos, Szitányi, & Kelemen, 2012). In the last step, students should look back into their work. Basically, the student needs to check out whether the answers make sense (Garderen, 2006; Yerushalmy, 2001). They should evaluate their answer by looking back from the first step until the end. If students found any mistake in any step, they should revise their answers. However, if they had believed that the answers had represented the appropriate solving, they should write their final answer.

Another important aspect of problem-solving skills was mathematical communication skills. Paridjo & Waluya (2017) overviewed that mathematical communication skill is important in the mathematical classroom activity. Students who can communicate their mathematical concepts will be more confident than others (Umam & Supiat, 2019). This is mainly because students can share their ideas with their peers. If their ideas were incorrect, they can quickly revise their answer. Students who can communicate their mathematical ideas to their friends will change will be the way students interact with their assignments.

Mathematical Communication skills need to improve not only written communication but also verbal communication. In written communication, the teacher should encourage students to communicate their ideas by using words, figures, mathematical symbols, tables and many other forms that represented students' mathematical thinking process. If students' written communication were merely low, the teacher should be able to evaluate their answers by giving constructive feedback. Muir & Geiger (2016) and Wang (2017) said that teachers' feedbacks will motivate students to revise and improve their mathematical competences. Meanwhile, mathematical verbal communication can be increase through posing problems and ask students to comment on a particular concept or problem. Posing a question to students gives teachers an important opportunity to evaluate students' mathematical understanding. The student who dares to communicate their mathematical ideas will continue to grow their competence in the future (Umam, 2011). Although students had a lot of mistakes, they can quickly revise their answers, as they get it.

The above explanation has shown us that mathematical problem-solving and communication skills are compulsory for students. Siswono (2010), problem-posing learning provides a good opportunity for the student to pose a question to their peers about the lesson. Students can ask their peers to respond to their questions. Giving answers and posing a question at the same time will improve the student's mathematical communication and problem-solving skills. While think pair sharing learning also provides the opportunity for students need to analyze their answers and sharing their answers to their peers, as well. Think-pair-share cooperative learning model facilitates students to enhance their problems solving skills through communicating their mathematical ideas to their friends. Tint & Nyunt (2015) revealed that cooperative learning has improved students' learning achievement. This research will examine the effectiveness of problem-posing and think-pair-share cooperative's learning models on mathematical problem-solving skills and mathematical communication skills.

II. Methodology

This study was experimental research with a quasi-experimental design. This research was conducted in two experimental classes that have the same characteristics such as learning habits and the average scores of mathematics achievement. Teachers use the problem-posing learning model in the first class while teaching used think-pair-share models in the second class. During the treatment in two experimental classes, we have provided two different supporting books to improve mathematical problem-solving and communication skills. The population in this study are all students of class VIII which is approximately about 81 students Junior High School consisted of 41 students in the first experimental class and 40 students in the second experimental class. The instruments were made in essay forms which design to evaluate students' mathematical problem-solving and communication skills. Problem-solving instruments were developed through a series of daily life around students' environments and instructed students to think carefully in applying an appropriate mathematical concept for given problems.

Data in this research were analyzed using descriptive and inferential statistics. Descriptive data analysis will focus to present the mean, standard deviation, variants, minimum score and maximum score which is presented the data before and after treatment in two experimental classes. The examinations test was conducted in essay forms. Data also will demonstrate the improvement of mathematical problem-solving and communication skills from two experimental classes (class using problem-posing and think-pair-share).

To examine the difference between mathematical problem-solving and communication skills in two experimental classes, we calculate data from the pre-test and post-test using statistic t-test, MANOVA, and t-Benferroni Test. The data were analyzed using software SPPS for windows version 20.

III. Results and Discussion

Data represent the comparison of students' mathematical achievement in two experimental class (before and after the treatment) that be presented in Table I. From Table I, we

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can see that the mean score of two class which is taught by using problem-posing model and think-pair-share learning model before treatment did not achieve the standard of mathematical achievement.

TABLE I
DATA OF STANDARD COMPETENCY ACHIEVEMENT

Description	Problem-posing		Think-pair-share	
	Pretest	Posttest	Pretest	Posttest
Mean*	50.23	87.09	49.79	82.67
Theoretical Score	100	100	100	100
Maximum Score	68.54	88.79	62.72	96.29
Minimum Score	39.34	76.15	32.91	57.89
Deviation Standard	8.72	8.19	7.78	8.94

*Ideal score 100

From Table I, we can overview that the teaching treatment has significantly influenced the mean score of two classes which exceeds 75. The class which is taught by problem-posing showed that their mean score is 88.79 while the class which is taught by think-pair-share showed that their mean score is 88.79. These results supported that learning with a discussion form had encouraged students to improve their learning achievements (Ainley & Ainley, 2011; Lee & Lai, 2017; Lee, 2018). As consequently, we can inference that the mean score of the class using the think-pair-share learning approach gets higher the class using the problem-posing learning approach.

The result of students' mathematical problem-solving skills for problem-posing and think-pair-share is presented in Table II. From Table II, we can see that the mean score of students' mathematical problem-solving skills from two experimental classes which were taught by using the problem-posing model and think-pair-share learning model before treatment did not achieve the standard of mathematical achievement.

TABLE II
DATA DESCRIPTION OF MATHEMATICAL PROBLEM-SOLVING SKILLS

Description	Problem-posing		Think-pair-share	
	Pretest	Posttest	Pretest	Posttest
Mean Score*	57.23	85.21	49.79	88.47
Theoretic Maximum Score	63.12	96.18	62.14	97.13
Theoretic Minimum Score	27.89	65.08	23.14	67.13
Deviation Standard	10.42	7.43	12.84	10.56
Variants	135.12	62.74	182.17	151.01

*Ideal Score 100

From Table II, we can overview that the teaching treatment has significantly influenced the mean score of two classes which exceeds 75. The class which is taught by problem-posing showed that their mean score of students' mathematical problem-solving skills is 87.21 while the class which is taught by think-pair-share showed that their mean score of students' mathematical problem-solving skills is 88.47. As consequently, we can inference that the mean score of the class using the think-pair-share learning approach gets higher the class using the problem-posing learning approach.

The result of students' mathematical communication skills for problem-posing and think-pair-share is presented in Table III. From Table III, we can see that the mean score of students' mathematical communication skills from two experimental classes which were taught by using the problem-posing model and think-pair-share learning model before treatment did not achieve the standard of mathematical achievement.

TABLE III
DATA DESCRIPTION OF MATHEMATICAL COMMUNICATION SKILLS

Description	Problem-posing		Think-Pair-Share	
	Pretest	Posttest	Pretest	Posttest
Mean Score*	53.65	85.04	51.50	88.32
Theoretic Maximum Score	67.12	95.02	70.94	97.35
Theoretic Minimum Score	25.84	65.78	28.62	65.63
Deviation Standard	11.23	14.69	15.65	13.57
Variants	135.25	119.67	173.26	101.27

*Ideal score 100

From Table III, we can overview that the teaching treatment has significantly influenced the mean score of two classes which exceeds 75. The class which is taught by problem-posing showed that their mean score of students' mathematical communication skills is 87.21. Siswono (2004) and Umam (2011) also revealed that the problem-posing learning method has increased students' mathematical achievements.

Siswono (2004) identified that problem-posing learning can promote students' creative thinking. On the other hand, the class which is taught by think-pair-share showed that their mean score of students' mathematical communication skills is 88.47. As consequently, we can inference that the mean score of students' mathematical communication skills class using the think-pair-share learning approach gets higher the class using a problem-posing learning approach (Li & Shahrill, 2018; Siswono, 2004; Tint & Nyunt, 2015).

The effectiveness of the learning model (problem-posing and think-pair-share) will be calculated in three different aspects, namely, (1) standard mathematical achievements, (2) mathematical problem-solving skills, and (3) mathematical communication skills that were presented in Table IV. Data from Table IV has shown us that the t-value of three different aspects were lower than 0.05. This value can be interpreted statistically that H_0 was rejected. As consequently, both problem-posing and think-pair-share

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learning models were effectively viewed from three different aspects such as standard mathematical achievement, mathematical problem-solving skills, and mathematical communication skills.

TABLE IV
RESULT OF ONE-SAMPLE T-TEST

Aspect	Problem-posing		Think-Pair-Share	
	Pretest	Posttest	Pretest	Posttest
Standard Mathematical Achievements	10.662	0.00	10.999	0.00
Mathematical Problem-solving Skills	8.713	0.00	3.655	0.00
Mathematical Communication Skills	7.722	0.00	6.444	0.00

MANOVA test will be conducted to see whether there is any difference in the initial ability from two experimental classes both before and after the treatment. The MANOVA Result is presented in Table V. Table V has shown us that the data F significance value of the class (before treatment) has greater than 0.05. It can be inferences that there is no difference in the initial ability between problem-posing and think-pair-share class (before the treatment) which is viewed from the standard mathematical achievement, mathematical problem-solving skills, and mathematical communication skills.

TABLE V
MANOVA RESULT DATA BEFORE AND AFTER TREATMENT

	F	*Sig.*
Class (before treatment)	0.483	0.525
Class (after treatment)	9.202	0.000

On the other hand, the data F significance value of the class (after treatment) has lower than 0.05. After the treatment, there is a difference in the effectiveness between problem-posing and think-pair-share class (after treatment) which is viewed from the standard mathematical achievement, mathematical problem-solving skills, and mathematical communication skills.

The function of t-Benferroni was conducted to evaluate the different effectiveness between class using the problem-posing method and class using the think-pair-share learning model. The results of the t-Benferroni test are presented in Table VI.

TABLE VI
THE RESULTS OF T-BENFERRONI TEST

	t-Benferroni	$t_{\left(\frac{\alpha}{p};n_1+n_2-2\right)}$
Standard mathematical achievement	3.75	2.30
Mathematical problem-solving skills	3.36	2. 30
Mathematical communication skills	3.05	2. 30

Data from Table VI has shown us that t-Benferroni > t_{tab}. This result can be interpreted statistically that the think-pair-share cooperative learning model is more effective than the problem-posing learning method which is seen from the standard mathematical achievement, mathematical problem-solving skills, and mathematical communication skills. These results are corresponding with the theoretical review which revealed that think-pair-share cooperative learning is more effective than problem-posing learning method which is seen from three different aspects.

Our research reveals that the think-pair-share cooperative learning model has significantly influenced students' achievement, mathematical problem-solving skills, and mathematical communication skills. A few research (Khaleel & Hamdan, 2017; Li & Shahrill, 2018; Tint & Nyunt, 2015) have reported that think-pair-share has gradually improved students to be active in the classroom activities. Tint & Nyunt (2015) who said that the think-pair-share cooperative learning has promoted their students to be active in the classroom computer-based learning environment. Although, learning with the computer, think-pair-share cooperative learning has encouraged students to communicate with their peers during the learning process. This indicated that the think-pair-share learning model can be used either in usual learning environment or computer-based learning environment.

IV. CONCLUSIONS

Students' mathematical achievement has significantly improved in two experimental classes. Data have shown that the students' mean score in think-pair-share cooperative learning class gets higher than the students' mean score in problem-posing method class. The think-pair-share cooperative learning model has encouraged students to promote their mathematical problem-solving skills and mathematical communication skills. The problem-posing learning method has promoted student's abilities both mathematical problem-solving skills and mathematical communication skills. The statistical results had shown us that the think-pair-share cooperative learning model is more effective than the problem-posing learning method which is seen from the standard mathematical achievement, mathematical problem-solving skills, and mathematical communication skills.

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