

Student's mathematical communication ability after applying missouri mathematics project with problem solving approach

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Abstract. This research aimed to describe the effectiveness of the Missouri mathematics project learning with problem solving approach viewed from student's mathematical communication ability. This research was quasi experiment with design nonequivalent group pretest-posttest. This research was conducted in junior high school Soppeng regency Sulawesi Selatan. The population of reseach was all students of the eight grade with characteristics range of age 14-15 years and derived from different educational background of their parents. Out of the population was drawn at random two classes as experiment class and control class. On experiment class was taught using missouri mathematics project learning with problem solving approach and on control class was taught using only missouri mathematics project learning. The effectiveness of missouri mathematics project learning with problem solving approach and missouri mathematics project learning used one sample t-test. Futhermore, the difference of missouri mathematics project learning with problem solving approach and missouri mathematics project learning used Anova and the excellence test used t-test of two samples independent. The research result showed that (1) missouri mathematics project learning with problem solving approach was effective viewed from mathematical communication ability, (2) between missouri mathematics project learning with problem solving approach and missouri mathematics project learning there was significant difference viewed from mathematical communication ability, and (3) missouri mathematics project with problem solving approach was more excellence than missouri mathematics project learning.

INTRODUCTION

Research by Partnership for 21st Century Skills [1] mentions that one of the skills needed to meet the challenges of life in the 21st century is communication skills. No exception in the world of education, one of purpose the learning objectives is that students have communication skills. Therefore, the curriculum of education, especially mathematics education in many countries such as USA and Indonesia, the ability of mathematical communication is a competence that must be developed [2, 3]. Communication in mathematics is important because it is a requirement to develop mathematics [4]. It is supported by opinion [5] that mathematical communication helps students to build their mathematical knowledge and it helps them to understand mathematical concepts. Students who communicate their idea to others help deepen their mathematical concepts understanding [6]. The statement shows that communication has an important role for the development of mathematics.

On the other side on learning, through communication teachers can see, understand, and measure the extent to which the level of students understanding of the material has been taught. This is reinforced by opinion [7] that through communication in learning mathematics, teacher will get enough data, information, and fact about student

understanding mathematical concept which they have learned. Meanwhile, the Ministry of Education Singapore [8] explains that mathematical communication is needed to complement other mathematics skill, for example problem solving ability. Mathematical communication is needed to interpret the problem which is given. It is mean that mathematical communication helps students to express ideas and gives precise argument in solving problem. Result of the research [5] also indicates that class which apply learning with using mathematical communication influence student's mathematics performance.

The reality at schools shows that mathematical communication ability is one of mathematics skill which must be improved. Mostly students when they solve the problem, they confuse to use precise concept and precise formula in solving problem. They also can not give precise reason or argument why they use that mathematics concept to solve the problem. From interview with mathematics teacher of VIII grade SMP Negeri 1 Marioriawa, he stated that students also have difficulty when they try to solve word problem. They are difficult to change the word problem into the mathematics form.

Mathematical communication is the way students to express ideas and mathematical concepts by using text, numbers, tables, pictures, diagrams or mathematics symbols [9]. Meanwhile, Kennedy, Tipps, & Johnson [10] divide communication in mathematics into two aspects namely oral communication and written communication. Oral communication in the form of discussion about idea of mathematics between students and communication in writing can be seen from the ability of students to present idea or mathematical information using tables, diagrams, even to the use of mathematical model in solving mathematical problem. In line with the opinion of Mallet [11] that one of the way to develop the ability of mathematical communication is to translate a problem into mathematical language (make a mathematical model).

More specifically described by the Los Angeles Country Office of Education [12] that communication in writing is a student's skill in solving mathematical problem. It describes student's ability applying and connecting many concepts to solve math problems. Then, communication in mathematics can be: (a) reflecting and clarifying mathematical ideas, (b) connecting daily language with mathematical language using symbols; (c) using reading, listening, interpreting skills, and evaluating mathematical ideas, and (d) using such mathematical idea to make strong conjectures and arguments [12]. Based on the above description, the ability of mathematical communication will be measured in this study is ability of mathematical communication in writing with attention three aspects, namely (a) the ability to identify and write information needed in solving problems by using notation, symbol, or mathematical term; (b) the ability to translate essay or word problems into the picture or sketch and create mathematical models; (c) the ability to use precise mathematical concepts in solving the problem.

Based on the importance of communication in learning mathematics and facts that occur, so action or solution to develop and even improve student's mathematical communication ability is needed. One of the ways that teachers may take is to choose a model or an approach in learning that facilitates students to develop and improve their mathematical communication ability. One of them is by applying missouri mathematics project learning with problem solving approach.

The learning of missouri mathematics project according to Good, Grouws, & Ebmeier [13] is classroom oriented learning by utilizing the use of exercises to improve student learning achievement. Further Jannah, Triyanto, & Ekana [14] said that the missouri mathematics project is a learning model designed by combining learning independence and collaborative work among students. This is because development of the material activities by students with the help of teacher in group and solve exercises with various types of problem that are done in grouply or independently. In line with Rahmi & Rahmi [15] research result that the application of missouri mathematics project learning is effective to develop and improve student's mathematical communication ability. The result indicates that there is an increase of student activity during the learning that is equal to 75%. It indicates that when the learning takes place, the students are active to build their knowledge and improve their mathematical communication ability.

If missouri mathematics project learning is combined with problem solving approach, it will add meaningfulness of student learning. This is due the development of materials and practice questions packed in the form of giving and solving problem. Problem solving learning is a learning approach that aims to help students learn to solve problem through hands-on learning experience [16]. Problem solving is also defined as learning that uses the problems of daily activities and problem situations that are simulated as a context for learning mathematics [17, 18]. The problem in problem solving can also be non-routine problem. Non routine-problem is problem where there is no direct access or a sure way to solve it [19]. It can happen when the students have not been studied that subject, so they develop a way to solve the problem by trial. Thus, missouri mathematics project learning with problem solving approach, the problem is given in form non-routine problem or real problem.

Learning through problem solving is not using mathematics to solve the problem, but learning mathematics through solving the problem so that new knowledge is acquired [20, 21]. Practice on learning, problem solving approach has four steps to solve the problem: (a) understand the problem, (b) devise a plan, (c) carry out the plan, (d) looking back [22]. In line with [22], Natusaka [23] divided the problem solving steps into four steps: (a)

identify problem, (b) develop solution, (c) discussion through presentation of result, (d) drawing conclusion. The steps of missouri mathematics project learning with problem solving approach in this research are (a) review the previous learning, (b) subject development through problem solving (controlled exercise), (c) seatwork (individual work), and (d) closing. Based on the description above, so the aim of this research is to describe the effectiveness of missouri mathematics project learning with problem solving approach viewed from student's mathematical communication ability.

EXPERIMENTAL METHOD

This research was a quasi experimental research. The design used in this quasi-experimental research was pretest posttest with non equivalent groups. This research was conducted in SMP Negeri 1 Marioriwawa, Soppeng regency Sulawesi Selatan. Population of research was students in eight grade with a range of age 14-15 years and with characteristics derived from different educational background of their parents. Out of the population was drawn at random two classes as experiment class and control class. On experiment class (VIII A) was taught using missouri mathematics project learning with problem solving approach and one other class as control class (VIII B) was taught using missouri mathematics project learning.

Procedure in this research started from giving pretest to two classes (experiment class and control class) to notice priorknowledge students whether they are same or not. Then, on experiment class gave a treatment missouri mathematics project learning with problem solving approach. On control class was applied missouri mathematics project learning. The lessons were carried out during eight meetings with attention the suitability between basic competence and time allocation. After the learning was done for eight meetings, the students were given posttest to notice the effect of the learning that had been applied.

The data in this study were collected by using test and non test techniques. The test instrument in this study was test of mathematical communication ability in the form essay consisting of three problems in which each problem consists of three questions. These three questions serve to measure each aspect of mathematical communication ability in this study that was: (a) the ability to identify and write information needed in solving problems by using notation, symbol, or mathematical term; (b) the ability to translate essay or word problems into the picture or sketch and create mathematical models; (c) the ability to use precise mathematical concepts in solving the problem. In solving test of mathematical communication ability, students were given time for 2x40 minutes. Meanwhile, for nontest instrument was an observation sheet to measure the extent to which the learning was done. Observation sheets of learning execution made in the form of checklist. The validity of instrument in this study was content validity obtained from expert judgment. The content validity of this study was face validity and logical validity.

Technique of data analysis in this study consisted of descriptive analysis and inferential analysis. Descriptive analysis was done by calculating descriptive statistic such as mean, standard deviation, minimum value and maximum value that might be obtained by students. Meanwhile, for inferential analysis, the data analysis technique consisted of three analyzes, namely: (1) effectiveness test used *one sample t-test*, (2) difference test used *ANOVA*, and (3) excellence test used *t-test of two samples independent*. Normality test and homogeneity test were assumption test which had to be fulfilled before inferential analysis. Normality test used *Kolmogorov-Smirnov* and homogeneity test used *levene test* at significance level of 5%.

RESULT AND DISCUSSION

The process of learning mathematics by using missouri mathematics project learning with problem solving approach and missouri mathematics project learning in this research was conducted in accordance with the lesson plan that had been prepared. However, during the process of learning and data collecting was often encountered several obstacles such as the allocation of time was not maximal so that there were some learning stages that was not implemented, the activities outside the school that must be followed by some students so affecting the results of research.

The results in this study consisted of two parts, namely the description of research results and hypothesis testing. The data described were pretest and posttest score of students' mathematical communication ability. Description of mathematical communication ability data for both classes can be seen in table 1.

TABLE 1. Description of Data Mathematical Communication Ability

Description	MMP-PS Class		MMP Class	
	Pretest	Posttest	Pretest	Posttest
Mean	10.27	28.77	9,52	27.22
Standart Deviation	3.82	4.42	4.26	3.96
Maximum Score Ideal	36	36	36	36
Maximum Score	17	36	21	36
Minimum Score Ideal	0	0	0	0
Minimum Score	4	19	3	15

The data in table 1 above notice that average of mathematical communication ability test results before being given treatment in the MMP-PS class (missouri mathematics project learning with problem solving approach) class and MMP (missouri mathematics project learning) class have not reached average score of 27 (27 is minimum average of class), whereas after being given treatment on MMP-PS class, average score of mathematical communication ability has reached 27. Based on table 2 it can be seen also standard deviation in MMP class both before and after treatment is higher than MMP-PS class, but overall in both classes have increased in mathematical communication ability.

In addition to being described at each level category, pretest and posttest results of mathematical communication ability were also described in every aspect measured on students' mathematical communication ability. The result of description on each aspect of mathematical communication ability can be seen in table 2 below.

TABLE 2. Average Pretest and Posttest Results of MMP-PS and MMP Classes Based on Mathematical Communication Ability Indicators

Indicator	MMP-PS Class		MMP Class	
	Pretest	Posttest	Pretest	Posttest
Ability to identify and write down information needed in solving problems by using notation, symbol, or mathematical term	1.70	3.74	1.43	3.55
Ability to translate essay or word problems into the picture	1.64	3.34	1.80	2.96
Ability to create mathematical models	0	2.18	0	1.22
Ability to use precise mathematical concepts in solving the problem	0.64	2.89	0.54	2.94

Based on table 2 above shows that average priorknowledge of students in every aspect of the two classes is not much different. In the MMPS-PS class and MMP class, there are an enhancement in every aspect of mathematical communication ability. According to the table 2 above, the ability to translate the problem into the picture or sketch and the ability to create mathematical model are the lowest aspect of improvement, that is 1,7 and 2,18 in the MMP-PS class and 0,85 and 1,52 in the MMP class. According to the student's answer, it appeared that they were be able write all informations contained to solve problem using notation, symbols or mathematical terms. However, some students had difficult when they would change the statement or word problem into the picture or sketch. Moreover most students did not understand how to make a mathematical model to solve the problem. However there were also some students who had been able to explain the problem-solving steps although not yet using symbol or mathematical terms. However, overall improvement in the MMP-PS class is still greater than improvement in MMP class for each indicator.

Then, the test results of normality and homogeneity can be seen in table 3 and table 4 below

TABLE 3. Normality Test

Class	Before Treatment value)	(p-	After Treatment (p-value)
MMP-PS	0.200		0.136
MMP	0.107		0.200

Table 3 above shows that the significance value obtained for the overall data is greater than 0,05. It means that before and after treatment the assumption of normality has been fulfilled both MMP-PS class and MMP class.

TABLE 4. Homogeneity Test

	Before Treatment	After Treatment
p-value	0.901	0.556

Based on table 4 above, it is known that the value of significance is greater than 0,05. This means that before and after the treatment was applied in both classes, the assumption of homogeneity has been fulfilled. Because assumption of normality and homogeneity have been fulfilled so it can continue to inferential analysis or hypothesis testing for both classes.

Result of effectiveness test for MMP-PS and MMP can be seen in table 5 below.

TABLE 5. One Sample t-test

MMP-PS Class		MMP Class	
t_{hit}	p-value	t_{hit}	p-value
2,33	.000	1,88	.000

Based on the table 7 above indicates that significance of t in both classes is less than 0,05. It means MMP-PS and MMP is effective viewed from mathematical communication ability.

In line with the results of research Fitri [24] and Rahmi & Rahmi [15] that students' mathematical communication ability can be improved with cooperative learning which one of them is learning with missouri mathematics project. One of the excellence of learning missouri mathematics project is working in groups and independently with various variations of exercise questions [14]. It supports the opinion [13] that students' mathematics learning achievement can be improved by making effective the giving of exercises. Furthermore, in the experimental class (MMP-PS) missouri mathematics project learning is combined with problem solving approach to develop materials. In line with the results of Hodiyanto's research [26] that there is enhancement in the mathematical communication ability in students who are given problem solving learning.

Learning with MMP-PS is effective viewed from of mathematical communication ability because structure of learning arranged in grouply and independently. In practice, MMP-PS requires students to work in groups to understand and develop learning material. Material development is presented in the form of giving problems to each group to be solved in order to find certain mathematical concept. Such learning path according to Mwelse & Wanjala [26] will give students an opportunity to interact with teachers and with other friends. As a result, students can freely construct their knowledge to solve problem and find certain mathematical concepts. Such learning is one of the most meaningful lessons for students [27]. The last phase in this learning is students present their discussion results and apply the mathematical concepts that have found to completing exercises independently.

Further data analysis tested the average difference in posttest result of MMP-PS class and MMP class. Result of Anova test can be seen in table 6 below.

TABLE 6. ANOVA Test

	Before Treatment	After Treatment
p-value	0.538	0.033

Anova test result showed a significance value before treatment is 0,538. It means MMP-PS class and MMP class have same priorknowledge in mathematical communication ability. Meanwhile after treatment, significance value is 0,033. It indicates that there is difference in students' mathematical communication ability in both classes after applied MMP-PS and MMP. Therefore, we did analysis to find which learning was more excellence viewed from mathematical communication ability. The results of the excellence test can be seen in table 7 below.

TABLE 7. Independent Samples t-Test

	t-value	p-value
Value	2.204	0.033

Based on table 9 above, shows that t value = 2,204 is larger than t table ($t_{0,05;43}$) = 1,68 and the significance value 0,033 is smaller than $\alpha = 0,05$. Both of these show that MMP-PS is excellence than MMP. One of the factor that MMP-PS is excellence than MMP is development of material presented in the form of problem solving. In this activity, the students are active in groups to solve the problem given. Before the students solve the problem, they

first discuss to conduct series of activities and answer questions that have been prepared in the worksheet. A series of activities and a number of questions that have been prepared in the worksheet aim to find certain mathematical concepts. Cooperative learning one of them is missouri mathematics project learning, if combine with problem solving approach will be more effective because students can discuss and share their knowledge. So that will be more input in solving problems to find certain mathematical concepts [28]. This is led to other opinions which reveal that learning will be more meaningful for students when they are in a problem-solving situation, where the problem is solved with the help of others or cooperating with their group mates [29].

Furthermore, at the development of material phase, students are not only directly involved in finding certain concepts and solving the problem, but student's activities continue in class discussion. Discussions consist discussion about discovery of concepts and result of solving the problem. In this activities, students are given opportunity to convey the result of their group work, while the other groups are given the opportunity to respond even to the question of the present group. It is useful for students to skillfully solve problem and give arguments related to their work. The next activity is students independently completing the exercise questions that are already available in the student worksheet. Giving exercise aims to notice how far the level of students' understanding of the material that has been studied. Giving exercises also aims to introduce the various variations and forms of questions related to the material being studied. The last phase is closing. In closing activity, teacher guides the students to make conclusion about material which has been studied.

A number of activities at the development phase of MMP-PS material is not included in the development of MMP learning material and this distinguishes the learning activities of MMP-PS and learning activities of MMP. Development of materials on MMP learning is giving materials directly on the student worksheet. Materials to be studied, such as understanding a concept, identifying the elements of the concept, and using formula to solve the problem about the concept are already available on the student worksheet. This causes students do not actively involve to build their knowledge. In development of material phase, students continue to hold discussions related to the result of solving problem that are done in groups. This condition cause MMP-PS is more excellence than MMP.

Nevertheless, there are still limitedness that become obstacles in this research. This research was conducted for eight meetings and then researcher assessed the students' mathematical communication ability. Yet to notice how effective MMP-PS and MMP viewed from students' mathematical communication ability needs long time. In this research, researcher also restricted only the circle subject to measure the effectiveness of MMP-PS and MMP viewed from students' mathematical communication ability, so generalization of results in this research became limited.

CONCLUSION

Based on the results of research and data analysis results can be concluded that missouri mathematics project learning with problem solving approach is effective viewed from students' mathematical communication ability. In addition, between the MMP-PS class and the MMP class there is an average difference in mathematical communication ability after applied MMP-PS and MMP. However, MMP-PS is more excellence than MMP.

According to the result of this research, we suggest to other researchers to further extend the material related to this research to allow for wider generalization. We also suggest to teachers to apply missouri mathematics project learning with problem solving approach by preparing teaching materials, worksheet, and lesson plan to improve students' mathematical communication ability. In addition, missouri mathematics learning with problem solving approach can be an alternative learning to improving students' mathematics learning achievement and to develop other mathematics skills. Researcher also suggest to teachers in improving students' mathematical communication ability, teacher use the problems that can challenge students to give arguments.

ACKNOWLEDGMENTS

The authors would like to thanks to the head master, mathematics teacher, and students of VIII grade SMP Negeri 1 Marioriawa who help in this research.

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