Students' Proportional Reasoning Ability in Junior High School Using Collaborative Problem Solving

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Abstract. The aim of this study is to analyze the influence of collaborative problem solving on the enhancement of mathematical proportional reasoning ability. The problems underlying this study include the proportional reasoning ability of students is still low so innovation in learning that can develop students' proportional reasoning abilities. The method used is quasi-experiment with non-equivalent control group design. The sampling technique is purposive sampling. Quantitative analysis was performed by calculating the N-gain using the normality test, and t-test. Research results of this study are (1) The enhancement of mathematical proportional reasoning ability of students who received collaborative problem solving is better than students who received conventional learning, (2) There is difference of mathematical proportional reasoning ability of students who received collaborative problem solving and students who received conventional learning, (3) The average of N-gain proportional reasoning ability are 0.33 in the experimental class and 0.22 in the control class.

Keywords: Collaborative Problem Solving, Proportional Reasoning Ability

1 Introduction

Mathematical proportional reasoning ability is one of the most important and fundamental skills in mathematics. Based Permendiknas 22 year 2006, mathematical reasoning skills of students are one factor that must be mastered by the students after they learn it. Sriraman and Lesh [1] mentioned that there are three things that are most useful and relevant to mathematical thinking at the elementary level or in everyday life including proportional thinking, estimation and modeling mathematical activities related to conceptual development in proportional thinking. Proportional reasoning ability is one of the abilities that has the most benefits in daily life. Lanius and Williams [2] also argue that proportional reasoning is described as one of the most commonly applied mathematical concepts in the real world. As one of the mathematical concepts that are widely used in daily life, it is important that proportional reasoning be developed as early as possible. Cape and Tobin [3] stated that proportional reasoning is one of the components used to detail the ability of logical thinking contained in the Test of Logical Thinking. Mathematical thinking is a thought process that requires expertise in compiling a logical reason in dealing with a situation. The thought process is related to all types of mental activities such as abstraction, problem solving, proof, generalization, and reasoning.

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Some research on proportional reasoning shows that the teacher's knowledge of proportional reasoning is still not good [4]. Based on preliminary research conducted by providing tests in the form of questions related to the concept of ratio and proportion of students, the results are obtained that for questions related to the concept of rate some students have not been able to interpret the context between two different units. Another finding in the research is that students generally still have difficulty in completing procedures algorithmically in the concept of proportion, because understanding the definition of proportion is still something foreign. Proportional reasoning is the activity of students in constructing two relations of change in a quantity with another quantity.

Proportional reasoning is very important if applied in mathematics learning because it is closely related in solving mathematical problems, the importance of proportional reasoning is "that fractions, percentages, ratios, decimals, scales, algebra, and opportunity requires proportional reasoning" [2]. The importance of proportional reasoning requires students to understand it, but in reality, students in working on a problem that is not in accordance with proportional reasoning are likely from them using the fast way of using logic not using procedures that are in proportional reasoning, there are only a few students who use proportional reasoning from some many students are in the class.

Mathematical proportional reasoning skills of students can be improved through learning that requires the involvement of students in constructing their own knowledge. One of them is by collaborative problem solving learning. Collaborative problem solving is a learning that begins with the presentation of problems to students to be solved collaboratively by individuals and groups. Collaborative problem solving learning has several characteristics, such as: 1) a group has a goal to solve new problems with collaborative work, 2) solutions or problem solving can be evaluated during the process of solving and solutions can be seen by other groups as a comparison, 3) each member in the group has a different role and 4) each member in the group has a sense of interdependence, learning that has characteristics like this can facilitate students who are not skilled, uncooperative or counterproductive by students who are strong in draws different perspectives, helps identify problems, establishes roles, elicits group communication and guides groups to overcome troublesome obstacles so that the achievements of other students' dispositions become better [5].

Collaborating can facilitate students to construct creative ideas in listening to information that is raised through reasoning and being able to analyze the information to find the main ideas, see relationships and other information. Collaborating can also help students to be actively involved in interacting and collaborating as a structure in building ideas individually or in groups in solving problems. Students who have a variety of mindset can complement each other and improve their weaknesses. The main thing to consider in collaborating is how the teacher acts as a facilitator in directing and controlling students when collaborating, so that the collaboration process can run optimally and diversity of opinions through constructive ideas that are transformed can be found solutions to the problems given, and the formation of attitudes and individual student abilities.

Collaborative learning involves intellectual efforts together to find mutual understanding, solutions, meanings, and produce a product based on mutual agreement [6]. Collaborative learning is learning that is carried out in groups, but the main goal is not to achieve the unity obtained through group activities, but students in groups are encouraged to find a variety of opinions or ideas issued by each individual in the group.

2 Experimental Method

The research method used in this research is an experimental design with pre-test-post-test and control group by implementing the learning collaborative problem solving to study the ability of proportional reasoning mathematics students. The method which is used is quasi-experiment with non-equivalent control group design. The sampling technique is purposive sampling. Instruments which is used are pre-test, post-test, and observation sheet. Data analysis was conducted by using SPSS 16 software. In more detail, the research was aimed to improve the ability of proportional reasoning mathematics students after learning collaborative problem solving and conventional learning and see the average of n-gain proportional reasoning ability in both the classroom and also show difference of mathematical proportional reasoning ability of students in both the classroom. The subjects of this study were 58 students in grade 7 of SMPN 3 Kuningan.

3 Result and Discussion

Mathematical proportional reasoning ability test data were obtained from 58 students, consisting of 28 experimental class students who received learning with the collaborative problem solving and 30 control class students who received conventional learning. The analysis of N-gain scores on mathematical proportional reasoning ability using normalized gain data, normalized gain data also shows the classification (quality) of increasing student scores compared to the ideal maximum score. The average N-gain illustrates the improvement of students' mathematical proportional reasoning ability in the experimental class and the control class.

Table 1 show that the results of the experiment class calculation have a higher average N-gain score than the control class. Classification of N-gain scores for the two classes is different, the experimental mean is in the medium category while the control class is in the low category, with a difference in score of 0.11. However, to ensure whether it is true that the enhancement of mathematical proportional reasoning ability of the experimental class students is better than the control class students, it is necessary to carry out advanced statistical tests. Statistical tests are needed to see the hypothesis which states "the enhancement of mathematical proportional reasoning ability of students who received collaborative problem solving is better than students who received conventional learning" that is the test of the difference in the average N-gain score, before testing the N-gain score data must meet the prerequisite test for normality.

Table 1. Average N-Gain Classification of Mathematical Proportional Reasoning.

Class	Mean	Classification
Experiment	**0.33**	**Medium**
Control	**0.22**	**Low**

Table 2 show that the results of the calculation of the N-gain score of the students' mathematical proportional reasoning ability of the collaborative problem solving learning is normally distributed with $0.088 > \alpha = 0.05$ while the conventional class has a value of $0.121 > \alpha = 0.05$ normally distributed. Because two class shows that the N-gain score data mathematical

proportional reasoning ability is normally distributed, the two average gain difference test uses parametric test is t-test.

Table 2. Normality Test for N-gain Score.

Class	Kolmogorov- Smirnov[a]			Conclusion
	Statistic	Df	Sig.	
Experiment	0.133	28	0.088	Normally distributed
Control	0.128	30	0.121	Normally distributed

Table 3 show that results of t-test, the p-value or Sig. (2-tailed) which is 0.016 for the one-party test Sig. (1-tailed) which is $\frac{0.016}{2} = 0.008$. Then obtained Sig. (1-tailed) $0.008 < \propto = 0.05$. This shows that H_0 is rejected, meaning enhancement in students' mathematical proportional reasoning ability that implement collaborative problem solving are significantly better than conventional class. The average post-test of students' mathematical proportional reasoning ability in the experimental class and the control class.

Table 3. Test of Difference in N-gain Score.

t-test for Equality of Means				Explanation
t	df	Sig. (2-tailed)	Sig. (1-tailed)	
1.387	56	0.016	0.008	H_0 Rejected

Table 4 show that the results of the experiment class calculation have a higher average score posttest than the control class. The average posttest in experiment class is 45.64 while control class is 35.60. However, to ensure whether it is true that the difference of mathematical proporsional reasoning ability of students who received collaborative problem solving and students who received conventional learning, it is necessary to carry out advanced statistical tests.

Table 4. Average Posttest of Mathematical Proporsional Reasoning.

Class	N	Minimum	Maximum	Average	Standard Deviation
Experiment	28	23	87	45.64	15.39
Control	30	10	71	35.60	17.22

The results t-test show there are differences in proportional reasoning ability between students who get collaborative problem solving learning models and students who get conventional learning models. This happens because of factors that influence and, among other things, environmental factors or learning conditions between the experimental and control classes. This is indicated by the problems presented by researchers both in the experimental class and in the control class can be solved when students are in groups. This is in accordance with the opinion of Dunn & Dunn [7] which explains that each student has an effective learning

environment or condition that affects the learning outcomes, such as the amount of light, a hard or soft seat, the surrounding environment quiet or noisy and work alone or with friends. The two factors of learning styles, both in the experimental class and in the control class the majority of students have a visual learning style, it is seen from the enthusiasm of students who when given the problem contained in the picture. This is consistent with McCarthy's opinion; Swisher & Schoorman [7] students learn better through several ways than others, such as visual, auditory, audio visual and so on.

Student mathematical proportional reasoning can be improved not only on the activity of students but also of teachers' creativity in the learning process. Stronger involvement of teachers is very important in promoting students' mathematical reasoning ability and overall presented the students with the opportunity to improve the process of their reasoning, a central aspect of the environment that allows them to understand the math [8]. Here are examples of problems with mathematical proportional reasoning skills students presented: "Pak Slamet's land is rectangular, has a floor plan with a length of 7 cm and a width of 5 cm. If the scale of the plan is 1: 1500, what is the actual land area of Mr. Slamet in m^2? "

From examples of problems of mathematical proportional reasoning ability is seen the thinking process conducted experiments in mind with the results at each step in a string of experiments that have been known by the reasoner from the experience. Some answer from the student about mathematical proportional reasoning as shown in **Figure 1.**

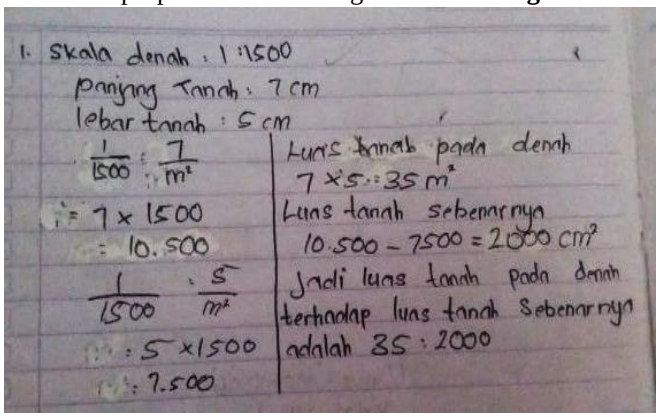

Fig 1. Some Answer of Mathematical Proportional Reasoning

The answer from student of mathematical proportional reasoning its to less about manipulate mathematics and provide reasons or evidence against some solutions. In accordance with Pereira & Ponte in the current intervention, the set of principles presented constitutes a promising environment to develop students' abilities to make appropriate generalizations and justifications [8]. By generalizing and justifying, students develop their mathematical proportional reasoning and it can be better equipped to deal with mathematical proof later.

The results of student work in the experimental class show that students in solving proportional reasoning questions only include six indicators, namely: 1) Explaining the direction of change in quantity (type of comparison); 2) Identifying multiplicative relationships (multiplication); 3) Using strategies based on multiplicative concepts (multiplication) in solving problems that contain proportional situations; 4) Show the ratio contained in the problem; 5)

mentioning quantities that change and mention things that do not change or are made fixed in the situation of the problem; 6) Re-examine the settlement and provide conclusions. While the results of student work in the control class show that students in solving proportional reasoning questions only include four indicators, namely: 1) Explaining the direction of change in quantity (type of comparison); 2) Identifying multiplicative relationships (multiplication); 3) Using strategies based on multiplicative concepts (multiplication) in solving problems that contain proportional situations; 4) Show the ratio contained in the problem, and students do not mention two indicators, namely 1) mentioning quantities that change and mention things that do not change or are made fixed in the situation of the problem; 2) Re-examine the settlement and provide conclusions.

4 Conclusion

The results of the data analysis above show that the enhancement of students' mathematical proportional reasoning ability who learn with collaborative problem solving learning is better than conventional learning. This means that collaborative problem solving learning has a positive influence and provides a good contribution to students' mathematical proportional reasoning abilities. The enhancement in proportional reasoning ability in the collaborative problem solving class is caused by the learning process where students are trained to solve math problems by using logical arguments and connecting facts, pictures and information given to the problem. From literature described previously, it appears that the mathematical proportional reasoning ability is one of the basic competencies of mathematics in addition to the understanding, communication and problem solving. Understanding the concept of learning should be a priority because the main capital to be able to have mathematical proportional reasoning abilities.

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