Problem Solving Reasoning and Problem Based Instruction in Geometry Learning

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Abstract. This research aims to analyze the comparison Problem Solving Reasoning (PSR) and Problem Based Instruction (PBI) on problem solving and mathematical communication abilities viewed from Self-Regulated Learning (SRL). Learning was given to grade 8th junior high school students. This research uses quasi experimental method, and then with descriptive analysis. Data were analyzed using two-ways multivariate analysis of variance (MANOVA) and one-way analysis of variance (ANOVA) with different cells. The result of data analysis were learning model gives different effect, level of SRL gives the same effect, and there is no interaction between the learning model with the SRL on the problem solving and mathematical communication abilities. The t-test statistic was used to find out more effective learning model. Based on the test, regardless of the level of SRL, PSR is more effective than PBI for problem-solving ability. The result of descriptive analysis was PSR had the advantage in creating learning that optimizing the ability of learners in reasoning to solve a mathematical problem. Consequently, the PSR is the right learning model to be applied in the classroom to improve problem solving ability of learners.

1. Introduction
Geometry is sometimes thought of an investigation or discovery of pattern and relationship in shape, size and place (position) [1]. In other words, in geometry will be studied the relationship between point, line, plane and space to conduct the investigation. There are many activities related to geometry that are easy to find in everyday life. For example, when someone wants to go somewhere by looking at the map, he will measure and estimate the shortest distance that can be taken to save time. The example shows that geometry is a part of mathematics that is often applied in human life.

Polyhedron is one part of a geometry consisting of prisms and limas. In Indonesia, Polyhedron has been introduced since elementary school to high school level. The complex problem is in categorizing Polyhedron. During interviews with students and teachers, the researchers gave some pictures of Polyhedron. When students are given Figure 1 and 2, they answer with confidence that the shapes in Figure 1 are cubes while Figure 2 is a prism. When the researcher asked "are prisms a cube?" they answer "no". When researchers ask "is the cube a prism?" they also answer "no". There are even teachers who answer the same. This shows that in the learning of geometry there is still a mistake in understanding the concept. Therefore, the need for an alternative learning that is able to overcome the problem is Problem Based Learning (PBL). PBL is an instructional learner-centered approach that
empowers learners to conduct a research, integrate theory and practice, and apply knowledge and skill to develop a viable solution to defined problem [2]. Based on the definition, it can be seen that the PBL focuses on the students to conduct independent activities and compile their knowledge of these activities.

1.1 PSR and PBI
Reasoning encompasses the cognitive procedures we use to make inferences from knowledge and draw conclusions [3]. Reasoning is a part of thinking that is above the level of retention or recall, reasoning includes: basic thinking, critical thinking, and creative thinking [4]. The problem-solving learning model is a learning model that focuses on teaching and problem-solving skills followed by skill enhancement [5]. Problem solving is one of the problem-based teaching strategies where teachers help learners to learn to solve problems through hands-on learning experiences [6]. Hands-on learning is a learning that requires active learners to solve problems.

Based on the description above, PSR is a problem solving learning that is learning that focuses on teaching and problem-solving skills followed by strengthening of skills through hands-on learning experiences equipped with steps to support reasoning ability include: (1) basic thinking; (2) critical thinking; and (3) creative thinking.

The problem-based teaching (PBI) is a learning approach whereby learners work on authentic issues with the intent to develop their own knowledge, develop inquiry and higher-order thinking, develop self-reliance and self-confidence. The goals in PBI learning are: (1) helping learners develop thinking skills and problem-solving skills; (2) learning the role of an authentic adult; (3) being an independent learner [7]. Characteristics of the PBI's learning model are: (1) asking questions or problems; (2) focusing on interdisciplinary linkages; (3) authentic investigation; (4) produce the product / work and show it off; (5) cooperation [8]. The benefits of PBI are: (1) realistic with real life; (2) concepts according to the needs of learners; (3) fostering the nature of the inquiry of learners; (4) strong concept retention; (5) cultivate problem-solving abilities. The weaknesses of the PBI are: (1) complex learning preparation (tools, problems, concepts); (2) difficulty in finding relevant problems; (3) miss-conception often occurs; (4) time consumption, where this model takes a long time in the process of investigation, so much time is consumed for the process [7].

2. Methods
This research used a quasi-experimental methods, and then with descriptive analysis. The data were analyzed using two-way MANOVA and one-way ANOVA with different cells to determine the effect of two independent variables on two dependent variables. The independent variables in this research are learning model and Self-Regulated Learning (SRL), while the dependent variables are problem solving ability and mathematical communication ability on Polyhedron discussion.
Learning model applied to grade 8th of junior high school students year 2016/2017 in Magelang City, Central Java, Indonesia. Sampling technique in this research is Cluster Random Sampling and got experimental group 1 given PSR model, and experiment group 2 given PBI model. Data collection in this research using test method and questionnaire. The test method is used to get the data of problem solving and mathematical communication abilities of the students done twice. The questionnaire method is used to get student's SRL level data. Descriptive analysis was conducted to determine and describe the advantages of more effective learning models are applied in Polyhedron learning.

3. Result and Discussion
The prerequisite test results that all samples were from normally distributed populations. The results of the equilibrium test show that the two experimental groups have the same problem-solving and mathematical communication abilities. Then, data were analyzed using two-way MANOVA with different cells.

Table 1 is a overview of MANOVA that indicating that \( H_{0A} \) is rejected because \( F_{\text{obs}} > F_{\text{tab}} \), meaning that there is a difference in the effect of the learning model on problem-solving and mathematical communication abilities. Therefore, it is necessary to do further test using ANOVA to know the effect difference of learning model on each dependent variable. In the same table shows that \( H_{0B} \) and \( H_{0AB} \) are not rejected because \( F_{\text{obs}} < F_{\text{tab}} \), meaning there is no difference effect in level of SRL, and there is no interaction between learning model with SRL on problem-solving and mathematical communication abilities.

There are several reasons why there is no difference effects in level of SRL on problem-solving and mathematical communication abilities, one of which is the characteristics of students in the samples classified as an independent learner. The statement was according with the opinion of the guidance and counseling teachers who explained that most of the students in the school where the research always take the initiative in learning, both in daily and private lessons outside school hours. In other words, most students of the samples have a high level of learning independence.

The main factor causing no interaction between learning model and SRL is the less of good cooperation between researchers with students. This is because the study only takes no more than two months. The absence of long-term attachment makes the researcher difficulty in understanding the characteristics of each learner which will certainly affect the selection of appropriate attitude toward the learners.

Table 1. Overview of MANOVA

| Source | \( F_{\text{obs}} \) | \( F_{\text{tab}} \) | Decision |
|--------|------------------|------------------|----------|
| Factor A (learning model) | 7.198 | 3.070 | \( H_{0A} \) rejected |
| Factor B (SRL) | 1.334 | 2.450 | \( H_{0B} \) not rejected |
| AB (interaction of learning model with SRL) | 2.225 | 2.450 | \( H_{0AB} \) not rejected |

Table 2 is overview of ANOVA shows that there is a difference in the effect of learning model on problem solving ability and there is no difference effect of learning model on mathematical communication ability. Because the learning model gives different effects on problem solving ability, it is necessary to do further test to find out more effective learning model using \( t \)-test statistic. The test gives results that regardless of the level of the SRL, the PSR learning model is more effective than the PBI learning model on problem-solving ability.

Table 2. Overview of ANOVA

| Dependent variable | Source | \( F_{\text{obs}} \) | \( F_{\text{tab}} \) | Decision |
|--------------------|--------|------------------|------------------|----------|
| Problem solving ability | Factor A (learning model) | 8.950 | 4.080 | \( H_{0A} \) rejected |
| Mathematical communication ability | Factor A (learning model) | 1.872 | 4.080 | \( H_{0A} \) not rejected |
3.1. The reasons why PSR is more effective than PBI
From the previous data analysis, it was found that the PSR learning model is more effective than PBI in problem solving ability. At this section, we will explain the advantages of PSR and PBI learning models by analyzing the results of the Student Activity Sheet (LAS) when the learning model is applied.

Photograph 1 is an answer of student activity on learning geometry using PSR, while photograph 2 is the answer of student activity on learning geometry using PBI. Photograph is one step in finding the formula to determine the volume of the cube. In photograph 1 it can be seen that the student's ability to describe the reason for finding the formula is better than photograph 2. This shows that PSR is able to optimize the students to hone their brain ability to solve a given question or problem.

4. Conclusion
Based on the result of the research, can be concluded that PSR is the right learning model to be applied in the classroom to improve problem-solving ability of learners. Because, PSR better optimize students in reasoning than PBI, so PSR is very influential for increasing problem solving ability.
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