Enhancing students’ mathematical representation and self-efficacy through situation-based learning assisted by geometer’s sketchpad program

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Abstract. This research was conducted based on the problem of a lack of students’ mathematical representation ability as well as self-efficacy in accomplishing mathematical tasks. To overcome this problem, this research used situation-based learning (SBL) assisted by geometer’s sketchpad program (GSP). This research investigated students’ improvement of mathematical representation ability who were taught under situation-based learning (SBL) assisted by geometer’s sketchpad program (GSP) and regular method that viewed from the whole students’ prior knowledge (high, average, and low level). In addition, this research investigated the difference of students’ self-efficacy after learning was given. This research belongs to quasi experiment research using non-equivalent control group design with purposive sampling. The result of this research showed that students’ enhancement in their mathematical representation ability taught under SBL assisted by GSP was better than the regular method. Also, there was no interaction between learning methods and students prior knowledge in student' enhancement of mathematical representation ability. There was significant difference of students’ enhancement of mathematical representation ability taught under SBL assisted by GSP viewed from students’ prior knowledge. Furthermore, there was no significant difference in terms of self-efficacy between those who were taught by SBL assisted by GSP with the regular method.

1. Introduction
The mathematics education program is one of the efforts to fulfil the goal to educate the life of the nation and to develop the Indonesian people completely. To achieve the goals of national education, referring to Bloom's taxonomy \([1]\), mathematical skills include the cognitive, affective and psychomotor aspects. Therefore, in addition to improving the cognitive aspects of students, increasing the affective aspect of the psychological aspects associated with the attitude of students as well as supporting success in the process of learning mathematics is a must.

In the process of interaction with the environment, one's performance depends on the interaction between behavior, personal factors, and environmental conditions. A person who has a high ability of a field may feel that he has not been able to do because he feels that people around of the environment are better than him. In fact, what he felt was not necessarily in accordance with the truth. Therefore, self-assessment is closely related to the self-efficacy of the student's ability.
Self-efficacy is a psychological aspect that gives a significant influence on the success of students in completing tasks and the questions of problem-solving questions well. [2] suggests that self-efficacy affects an action, effort, persistence, and flexibility in difference and realization in the goals of the individual. So the self-efficacy associated with a person's ability that determines often the outcome before the action takes place.

Self-efficacy has a function as a tool to assess students' success in solving mathematical problems. Self-efficacy has an influence in the choice of behavior, great effort and persistence, as well as patterns of thinking and emotional reactions. In solving difficult problems, individuals who have doubts about their ability will reduce their struggle, even tend to give up. Individuals with high self-efficacy regard failure as a lack of effort, whereas individuals with low self-efficacy consider failure to be from lack of their ability.

In determining mathematical achievement, especially to perform tasks in the form of questions of mathematical representation, between the ability of mathematical representation and self-efficacy has a positive relationship of mutual support. This is consistent with the results of the Betzdaz Hacket study in 1983 [3] that with a high self-efficacy, in general that a student will more easily and successfully transcend the mathematical exercises given to him, the end result of the learning reflected in academic achievement also tends to be higher in comparison to students with low self-efficacy. Fennema and Sherman [4] stated that belief in a person's ability to learn mathematics has been found to have a strong positive correlation with mathematical achievement.

Mathematics education is one of the efforts to educate the nation's life [5,6], this appropriate with [7]. The low ability of mathematical representation and self-efficacy as reported by TIMSS in [8], and PISA 2012 provides an overview of the student's ability in Indonesia. Situation-based learning as examined by [9], and [10] expected to be one of the applicable learning alternatives. The research on Geometer's Sketchpad Program (GSP) has been done by [11,12], and [13].

In improving the ability of mathematical representation and self-efficacy of the students based on the study of situation-based learning (SBL) study which combined with the aid of geometer's sketchpad program (GSP) which consists of creating mathematical situations stage, posing mathematical problem, solving mathematical problem and applying mathematics stage can facilitate and provide convenience to students to be able directly interact in the process of learning to teach math at school.

2. Methods
Situation-Based Learning (SBL) as expressed by [14] that "Situation-Based Learning provides a powerful and flexible new approach to constructivism learning paradigm". This is also reinforced by [15] that Situation-Based Learning has a significant impact on the thinking process because there are many things students can learn from a situation, where they are studying [10]. The goals of SBL according to [9] are "to train students 'ability to pose problems, and then promote students' ability to coordinate the development on problem posing, problem understanding and problem solving from mathematics angle".

In its implementation, Situation-Based Learning (SBL) consists of 4 stages of learning process, namely 1) creating mathematical situations; 2) posing mathematical problem; 3) solving mathematical problem; and 4) applying mathematics, agree with [9,10]. Based on these stages, as for the steps in SBL-assisted GSP in this study can be arranged as follows:

2.1. Teacher creates a situation
In this step, through observation and analysis activities, teachers create mathematical situations. The situation starts from a simple situation, then develops in a more complex situation using the assist of the Geometer's Sketchpad Program (GSP). This is done to help teachers to clarify the subject matter, to stimulate learners to dialogue with themselves, to stimulate and experience learners [16].
2.2. **Students present a mathematical problem**

Based on the mathematical problems that teachers have created with the assist of Geometer's Sketchpad Program (GSP) in the previous stage, with investigating and guessing activities, students perform problem posing mathematical activities. This is to increase students’ awareness of a problem from the situation at hand. The Geometer's Sketchpad Program (GSP) at this stage is used to provide students with the opportunity to learn directly and create simple theories using geometric ideas, allowing students to make their own choices, searching information by constructing geometric objects and make generalizations of the information.

2.3. **Students solve mathematical problems**

From the problems that can be expressed by the students in the second learning stage, the teacher sort through the level of the problem, which problem should be followed up to be resolved.

2.4. **Students perform applying mathematics process**

Applying mathematics learning step is expected to become a positive habit, which eventually becomes the character of student learning so that formed self-efficacy that affect decision making, and influence the action that will do. A person will tend to run something when he feels competent and confident, and will avoid it if not feel competent and confident.

Based on the description of Situation-Based Learning (SBL) with Geometer's Sketchpad Program (GSP) above, Situation-Based Learning (SBL) in this research uses teaching materials in the form of Student Worksheets which have been prepared based on SBL characteristics combined in several visualization with GSP as an assistant for teachers to present mathematical situations that can stimulate students to present the mathematical problems that they find.

This research is Quasi Experiment research. The design used in this study is the design of non-equivalent control group (nonequivalent control group design). [17] states that for the Quasi Experiment design with nonequivalent pre-test and post-test control group design, the experimental and control groups are selected without random procedures. Both groups receive both pre-test and post-test, but the experimental group is given treatment.

In this study, the experimental class is a group of students who have taught under SBL assisted by GSP and the control class is a group of students under regular method. The existence of this control class is as a comparison, to what extent changes due to the treatment of the experimental class. The design of this research is as follows:

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O X O
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Legend:
- O : Pre-test or post-test ability of mathematical representation
- X : Situation-Based Learning (SBL) assisted by Geometer's Sketchpad Program (GSP)
- - - : Research subjects are not grouped at random.

3. **Results and Discussion**

This study aims to examine and describe the ability of mathematical representation as well as mathematical self-efficacy of students who were taught under situation-based learning (SBL-GSP class) and regular method (regular class). The result of the research on students’ mathematical representation was obtained from pre-test, post-test and N-gain. The result of pre-test of mathematical representation was obtained before the learning was given in both SBL-GSP and Regular class. Post-test results of mathematical representation capability were obtained after the learning of Situation-Based Learning (SBL) assisted by Geometer's Sketchpad program (GSP) in the SBL-GSP class and regular class.

The results of the calculation test the average difference of N-gain can be seen in Table 1 below.
Table 1. Average N-gain Difference Test Results

|                  | t-test for Equality of Means | Information                |
|------------------|------------------------------|----------------------------|
|                  | t   | df  | Sig. (2-tailed)/2 |                      |
|                  | 4.862 | 40 | 0,000            | H₀ is rejected.     |

Based on the result of the statistical test in Table 1 above, it’s clearly obtained the value of Sig. (2-tailed)/2 is 0.000. In other words, H₀ is rejected. From the computation result, we can claim that the students’ enhancement in their mathematical representation ability taught under SBL assisted by GSP was better than by regular method. Thus it is proven that the hypothesis which states that students’ enhancement in their mathematical representation ability taught under SBL assisted by GSP is better than under regular method.

When viewed on the basis of students’ prior knowledge and learning methods, the results of the calculation of the average difference test of N-gain can be seen in Table 2 below.

Table 2. Average Differential Test Results of N-gain based on students’ prior knowledge and Learning methods.

| Sources                        | df | Mean Square | F      | Sig. |
|--------------------------------|----|-------------|--------|------|
| Students’ prior knowledge      | 2  | 0.314       | 13.231 | 0.000|
| Learning methods               | 1  | 0.884       | 37.278 | 0.000|

Based on the results in Table 2 above, it can be seen that students’ prior knowledge have a sig. value 0.000 < α = 0.05 so H₀ is rejected. This means that students’ enhancement in their mathematical representation ability taught under SBL assisted by GSP was better than under regular method viewed from students’ prior knowledge (high, average, and low level).

To show there was no interaction between learning process that was used with students’ prior knowledge to improve students’ mathematical representation ability, the calculation result of interaction between learning process and students’ prior knowledge was done and it can be seen in Table 3 below.

Table 3. Interaction Test Results between Learning process and students’ prior knowledge.

| Sources                        | df | Mean Square | F      | Sig. |
|--------------------------------|----|-------------|--------|------|
| Learning method * students’ prior knowledge | 2  | 0.027       | 1.130  | 0.334|

Based on the results in Table 3, it can be seen that the interaction between the learning process used with the students’ prior knowledge have a Sig value 0.334 > α = 0.05 so that H₀ is accepted. It means that, there was no interaction between the learning methods (Situation-Based Learning (SBL) assisted by Geometer's Sketchpad Program (GSP) and regular method) with the students’ prior knowledge in student enhancement of mathematical representation ability.

Furthermore, to see the difference of students’ self-efficacy in the SBL-GSP and regular method classes after learning. The researchers provide the test result in the Table 4 below.

Table 4. Average Differential Test Results of N-gain.

|                  | t-test for Equality of Means | Information          |
|------------------|------------------------------|----------------------|
|                  | t   | df  | Sig. (2-tailed)/2 |                  |
|                  | 4.837 | 40 | 0.204            | H₀ is accepted   |
From table 4 above, we can see that the value of sig. (2-tailed)/2 is 0.204 > \alpha = 0.05 so that H_0 is accepted. This means, there was no significant difference in terms of self-efficacy between those who were taught by SBL assisted by GSP and regular method.

4. Conclusion
Based on the results and discussion, it can be concluded that students’ enhancement in their mathematical representation ability taught under SBL assisted by GSP was better than by regular method that viewed from the whole as well as students’ prior knowledge in high, average, and low category. Also, there was no interaction between learning methods and students prior knowledge in student’ enhancement of mathematical representation ability. Furthermore, there was no significant difference in terms of self-efficacy between those who were taught by SBL assisted by GSP and regular method.

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