Developing Students’ Mathematical Justification Skill Through Experiential Learning

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Abstract. Scientific skill is a special skill helping students to develop their knowledge. Indirectly, well-developed scientific skill will lead them to actively get involved. This special skill needs to be developed through cognitive skill. One of the developed cognitive skills is justification skill. Such skill is developed through experiential learning. This research involves 26 students in one of Junior High Schools in Serang. This research focuses on topics about line, angle, triangle, and rectangle. This research is quasi experimental research with One Group Pretest Posttest Design using Purposive Sampling technique. The result of analysis shows that students’ mathematical justification skill of Junior High School gives positive contribution through experiential learning.

1. Introduction

The main purpose of giving mathematics subject in high school level is to develop students’ mathematic mindset and to apply it in daily life, so that students are able to deal with life’s changes in the environment that always develops through mathematical thinking.

The development of mathematical thinking skill becomes the main topic of today’s mathematics education. In developed countries such as Japan, Australia, England, and America, mathematical thinking skill becomes the main topic in facing development in science, technology, and art (Wijaya, 2012). Sheffield (2003) states that students need to be taught through mathematical thinking with a series of mathematical unity so that they are able to grow from an experience individual into an expert one such as: lack of knowledge of basic mathematics, actor, counter, questions solver, questions proposer, and questions maker.

An effort that can be done in developing mathematical thinking, according to Kathleen Wilson (2015), is through Moving Students from Conjecture to Proof, which trains students to create some assumptions through curiosity then to prove them so that they can find the truth of solutions they present. Based on his research, it is seen that by motivating students to formulate a conjecture becomes a valid justification will make them expert in critical and creative thinking as well as be able to communicate and to clarify mathematical arguments.

Through learning and teaching process, thinking skill is developed by enriching meaningful experience through mathematical justification skill. Justification becomes a reason why a person has
certain belief, explanation to prove that his belief is true, or how a person knows what he knows. Justification also means doing rational responsibility over claim for the truth of certain belief or opinion. In teaching Mathematics at school, mathematical justification skill needs to be applied in learning process so that students are able to possess skill and implements it in their daily life, resulting in increased learning result.

Learning model with experiential learning begins to be introduced in 1984 by David Kolb. David Kolb (1984). He defines learning as a process how knowledge is created through transformed experience. If a person actively gets involved in learning process, he/she will actively think about what is learned and how to apply what has been learned in a real situation. Learning contexts of experience-based learning can be described as learning process reflecting experience deeply and then there occurred a new understanding or learning process. This is in line with an opinion of Colin M. Beard & John Peter Wilson (2006) stating that experience-based learning uses new experience and learning reaction toward its experience to build understanding and transfer of knowledge, skill, and behavior.

Experiential Learning is an inductive process of which center is on learning and oriented in reflection activity personally about experience, and formulates plan to be applied in what has got from experience (Fathurrohman, 2015). Experiential learning model is arranged and implemented from things owned by the students. This principle is related to experience in implemented task and job as well as learning style that are usually done by the students (Sudjana, 2004). Therefore, this model emphasizing learning got from experience is expected to be able to result effective result so that it can increase mathematical justification skill.

Hamidy and Suryaningtyas (2016) explains that justification skill is an important component to build students’ skill in term of mathematical thinking aspect, deep Mathematics concept understanding, and mathematical communication.

At the first time, De Villiers and Hanna use a term proving to explain about justification skill. However, Staples and Bartlo (2010) expands it through a term justification, since the proving is a form of specification and justification. According to them, justification is used to validate a statement, resulting in insight on phenomena and knowledge systematic aspect. The more carefully a person evaluates a statement and the more maximal he separates relevant and irrelevant issues, the more critical the person’s critical thinking. Thus, mathematical justification needs skills including careful listening and reading skills, searching and finding hidden assumptions, and investigating consequences of a statement.

Mathematical justification has become one of the tools used in daily life to solve some problems since it involves logical thinking, interpretation, analysis, and information evaluation to enable someone to make valid decision. Mathematical justification is an active process in increasing students’ performance at school.

Mathematical justification, according to Lestari (2015), is as follow:

   a. Reading and understanding mathematical proving.
   b. Presenting proof for truth of a statement mathematically.
   c. Developing mathematical argument to prove or to argue a statement.
   d. Proving indirectly, directly, or using mathematical induction.
   e. Making counter example.
   f. Formulating and validating generalization.
   g. Criticizing proof by adding, reducing, or rearranging mathematical proving.

Mathematical justification skills to be strengthened in this research are: (a) Skill of making conclusion, (b) Skill of arranging proof, (c) Skill of making proof for solution, (d) Skill of making decision.
1.1. Problem Statements
Problem statement proposed in this research is “Is students’ mathematical justification developed through experiential learning?”

1.2. Research Purpose
Based on the background and problem statements that have been explained, the purpose of this research is to study the effect of experiential learning toward students’ justification skill.

1.3. Research Benefits
This research is expected to give positive benefits, namely:
1. Experiential learning is able to be alternative to develop mathematical justification skill.
2. As one of the efforts to develop mathematical thinking.

2. Research Methods
2.1. Method and Design
Research method used is quasi experiment consisting of one group. Design of this research is experiment of one group pretest posttest.

\[
\begin{align*}
\text{Experiment:} & \quad O & \chi & O \\
\text{Description:} & \\
O & : \text{Pretest and posttest} \\
\chi & : \text{Experiential learning}
\end{align*}
\]

2.2. Research Subject
Samples of this research are Junior High School students of Grade VIII. Population of this research is one of Junior High Schools with materials about line, angle, triangle, and rectangle.

2.3. Research Instrument
Data is collected using description text of mathematical justification skill on materials of line, angle, triangle, and rectangle that have been adjusted to the condition of the research samples. Indicators of mathematical justification skill developed in this research are as follow: (a) Skill of making conclusion, (b) Skill of arranging proof, (c) Skill of making proof toward solution, and (d) Skill of making decision.

2.4. Data Analysis
Data obtained is then examined using quantitative analysis. The following steps are used to process data quantitatively:
1. Prerequisite normality test
2. T-test using Kolmogorov Smirnov
3. T-test for initial and final ability using parametrical test.

3. Results and Discussion
Based on the data obtained, students’ mathematical justification skill through experiential learning is described in Table 1.1 below.

| Score         | \( \bar{x} \) | SD  |
|---------------|---------------|-----|
| Initial ability| 32.45         | 7.504|
| Final ability  | 42.31         | 8.893|

\[\text{Table 1. Description of Mathematical Justification Skill}\]
Details for the comparison of scores between initial ability and final ability are described the following bar chart:

![Mathematical Justification Skill](image)

**Figure 1.** The Average Score of Mathematical Justification Skill

On Figure 1.1, it is seen that there is the different average of initial ability and final ability before and after experiential learning. It is shown that before experiential learning, the average score of students’ justification skill is 32.45, but it is increased into 42.31 after experiential learning. Based on the result of descriptive statistical analysis, it can be concluded that experiential learning is able to give positive contribution to students’ mathematical justification skill.

To strengthen the result of descriptive statistical analysis, it needs hypothesis. Thus, the initial step in hypothesis test is by conducting prerequisite test of normality test. The result of normality test is described in the following Table.

| Table 2. | Normality Test |
|----------|----------------|
| Statistic | df | Sig. | Conclusion |
| Initial Ability | .256 | 26 | .000 Data is not distributed normally |
| Final Ability | .191 | 26 | .925 Data is not distributed normally |
| a. Lilliefors Significance Correction |

Prerequisite test shows that the comparison of the average of students’ mathematical justification is tested using non parametrical statistical test. Thus, hypothesis test uses *wilcoxon* test. The result of hypothesis test of mathematical justification skill is described in the following Table 1.3.

| Table 3. | Wilcoxon Test Result |
|----------|----------------------|
| Z       | -3.857<sup>b</sup> |
| Asymp. Sig. (2-tailed) | .000 |
| a. Wilcoxon Signed Ranks Test |
| b. Based on negative ranks. |
The result of statistical hypothesis uses Wilcoxon test with p-value $0.000 < \alpha = 0.05$, then hypothesis is accepted, meaning that there is an increase of students’ mathematical justification through experiential learning. Thus, it can be concluded that the effect of experiential learning can increase students’ mathematical justification skill.

After conducting analysis descriptively and inferentially, it can be concluded that there is difference in the increase of students’ mathematical justification skill which is an effect of experiential learning. The result of the analysis shows that the difference of the increase of mathematical justification skill is the effect of experiential learning in which there are some steps in that learning style, namely: (a) Teacher formulates open plan of learning experience (open minded), (b) Teacher gives motivation, (c) Students work individually or work in group in experience-based learning, (d) Students are brought to the real situations, (e) Students participate actively in the provided experience, make their own decision, and accept consequences of their decision, (f) Overall, students retell what have been experienced. Thus, during the steps of experiential learning, students’ justification skill increases significantly.

Experiential learning gives effect in the increase of students’ mathematical justification skill, which is in line with Vygotsky using Zone Proximal Development (ZPD) and scaffolding, in which there are steps of formulation and students’ knowledge, and during the learning process, scaffolding is really important in learning process.

4. Conclusion and Suggestion
Result and problem statements of this research obtain some conclusions and suggestion stated below:

4.1. Conclusion
Through experiential learning, students’ mathematical justification skill is better.

4.2. Suggestion
1. Experiential learning is suggested to give positive effects for justification skill.
2. Experiential learning will be more effective if the time for the implementation is used properly.

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