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Algebraic thinking ability of VIIth grade students in mathematics using SAVI learning model

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Abstract

Algebraic Thinking has become a research trend to be developed in secondary and elementary schools. Algebraic Thinking, according to Kieran (2004), includes generational ability, transformational ability, and global meta ability. Permendikbud No. 58 of 2014 indirectly states mathematics is being taught to hone the algebraic thinking ability. The SAVI learning model (Somatic, Auditory, Visual, Intellectual) combines physical movement, five senses, intellectual activity. The purpose of this study was to analyze the classical mastery of algebraic thinking ability of VIIth grade students, one of junior high school in Ungaran in the SAVI learning model, to analyze the algebraic thinking ability of VIIth grade students in the SAVI learning model and PBL (Problem Based Learning), to describe the algebraic thinking ability of VIIth Grade students in the SAVI learning model. The results showed that (1) Algebraic thinking ability of VIIth Grade students in SAVI learning did not achieve classical mastery; (2) The algebraic thinking ability in SAVI learning was better than in PBL; (3) Algebraic thinking ability of VIIth in SAVI learning showed that generational ability reached 47.84%; transformational ability reached 51%, and global meta ability reached 33.8%.

1. Introduction

Mashuri et al. (2018) stated abstract algebra is one of the fields of study in mathematics. The algebraic relation is not just about numbers but is related to daily life and can be expanded in geometry (NCTM, 2000: 3). Suhaedi (2013) stated algebra is very important for students to learn both implicitly and explicitly for daily activities. As an example of the problem revealed by Warsitasari (2015: 1), if the entrepreneur wants to estimate the maximum profit of a company, the variables that affect profits can be simplified into a symbolic language so that it is easy to do calculations. Lew (2004) states Algebra is a subject dealing with a statement with symbols and numbers up to variables (unknown numbers) to solve a mathematical problem. Also, Katz (2007) also revealed the role of algebra as a gateway to the future of technology.

Algebraic Thinking has become a trend to be developed not only in secondary schools but also in elementary school students who are introduced through arithmetic. Many related studies develop algebraic thinking skills for students as early as possible such as Kieran (2004), Lew (2004), Radford (2013). Algebraic Thinking is presenting algebra learning activities. Algebra thinking does not only carried out in algebra topics. Mason et al., quoted by Becker & Rivera (2007: 1), stated that if each student has demonstrated the ability to generalize and certain abstract things, he has done the algebraic Thinking since it is the root of algebra.

According to Lew (2004), indicators of algebraic thinking ability includes Generalization, Abstraction, Analysis of Thinking, Dynamic Thinking, Modeling, Organization. Algebraic thinking ability, according to Kieran (2004), includes generational ability, transformational ability, meta global ability. Generational ability includes the formation of algebraic expressions and equations of the objects, as well as presenting problems in relations between variables, using patterns as guesses in problem-

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solving, and being able to make generalizations. Transformational ability involves changing the transformation of an expression or equation based on rules. Meta global's ability includes the use of algebra to solve other problems.

Permendikbud No. 58/2014 stated that mathematics is intended to develop participants' algebraic thinking ability. Understanding mathematical concepts in problem-solving is a transformational activity. Using patterns as conjectures in problem-solving and being able to make generalizations is a generational ability. While solving problems, designing mathematical models is a global meta ability.

Indicators of algebraic thinking ability in this study were adopting the Kieran algebraic thinking ability indicators, as shown in the following table:

Table 1. Table 1.Indicator of Algebraic Thinking

Activity	Code	Indicator
Generational	G1	Students can determine the meaning of variables from a problem.
	G2	Students are able to represent problems in an algebraic equation.
Transformational	T1	Students can do algebraic operations.
	T2	Students can determine the completion of an equation in algebra.
Meta Global	M1	Students can use algebra to analyze changes, associations, and predict problems in mathematics.
	M2	Students can model problems and solve them.

One of the learning models based on activities that are interactive, fun, motivating students to participate actively, providing space for creativity, adjusting the development of talents, interests and physical development of students is the SAVI learning model. SAVI stands for Somatic, Auditory, Visual, Intellectual. SAVI learning model is learning that combines physical movement, involving all five senses and intellectual activity (Meier: 2002).

Radford's research (2013) showed students' algebraic thinking ability could be improved as early as possible with learning that optimizes the whole body, language, gestures, and all five senses to understand symbolization in algebraic Thinking. Elementary school students can generalize number patterns with the help of certain gesture number patterns to show a variable. Radford's learning is following SAVI learning, which optimizes the whole body for learning.

SAVI learning model stages, including (1) Preparation, to prepare students for the learning; (2) Submission, to find learning topic which is fun and involves the five senses; (3) Training, to perceive new knowledge and skills in various ways; (3) Results, to apply new knowledge and skills.

The formulation of the problems in this study was (1) Does the algebraic thinking ability of VIIth grade students in the SAVI learning model meet the classical mastery criteria; (2) Is the algebraic thinking ability of VIIth grade students in the SAVI learning model better than in the Problem Based Learning model; (3) What is the description of algebraic thinking ability of VIIth grade students in the SAVI learning model.

The purpose of this study was to (1) Test the classical mastery of VIIth grade students' algebraic thinking ability in the SAVI learning model; (2) Knowing the comparison of VIIth grade students' algebraic thinking ability in the SAVI learning model and in the PBL model; (3) Describe the VIIth grade students' algebraic thinking ability in the SAVI learning model.

The hypotheses proposed in this study were (1) the algebraic thinking ability of students taught with the SAVI learning model meet 75% of the classical mastery; (2) The average score of the algebraic thinking ability test in SAVI learning is better than in PBL; (3) The proportion of algebraic-thinking-ability mastery test scores in SAVI learning is more than in PBL.

2. Method

The research method used in this study was quantitative. This study compared students' algebraic thinking ability in the control class with PBL learning and with SAVI learning. The quantitative research designs used were shown in the following table.

Table 2. Table 2. Posttest-Only Control Design Research Design

Class	Treatment	Posttest
A	X	O_1
B		O_2

Source: Sugiyono, 2013
Information:
A: Experimental Class
B: Control Class
X: Applying SAVI Model
O_1 O_2: Posttest of algebraic thinking ability

The population in this study was VIIth grade students. There was no special class there. This study used a random sampling technique, resulting in class VII B was chosen as an experimental class with SAVI learning models. As for class VII C as a control class using PBL model learning. Class VII A was chosen as a test class for the algebraic thinking ability test instrument.

First, the initial data test was carried out on the normality test, the homogeneity test, and the average similarity test using the score-data of VII B and VII C in the 1st-semester term test.

The study was conducted during four meetings in each class on SAVI model learning and PBL model learning. At the end of the meeting, an algebraic thinking ability test was held. From the results of the algebraic thinking ability test, hypothesis testing and analysis of the algebraic thinking ability was done in the SAVI learning model.

3. Results & Discussions

3.1. Data Analysis of Algebraic Thinking Ability Test

Hypothesis I was conducted to test the actual mastery limit in proportion to the algebraic thinking ability in SAVI learning using the z test. Obtained that $z_{score} = -7.47$while $z_{table} = 1.64$ for $\alpha = 5\%$. The test criteria are rejected H_0 if $z_{score} > z_{table}$. Thus, H_0 was accepted, which means the algebraic thinking ability in SAVI learning did not meet the actual mastery criteria in proportion.

Hypothesis II test was made to test the difference in the mastery proportion of the algebraic thinking ability test scores in the SAVI learning model and the PBL model. The test criteria are rejected H_0 if $z_{score} \leq z_{0.5-\alpha}$ with a significance level of 5%. Obtained that $z_{score} = 1.923$ while $z_{table} = 0.36$. This means that the mastery proportion of the algebraic thinking ability test scores on the SAVI learning model is better than the PBL model.

Hypothesis III testing was done by using a difference in the two-means test. The mean result of algebraic thinking ability in SAVI learning was 44.33, while in PBL was 36.07. Hypothesis III was conducted to find out whether the algebraic thinking ability in SAVI learning and PBL learning models was significantly different. The test criterion is rejected H_0 if $\boldsymbol{t'} \geq \frac{w_1 t_1 - w_2 t_2}{w_1 + w_2}$. Obtained the calculation $t' = 1.6$ and $\frac{w_1 t_1 - w_2 t_2}{w_1 + w_2} = 1.173$. Thus, H_0 is rejected, which means the mean score of algebraic thinking ability in SAVI learning was more than in PBL.

3.2. The algebraic thinking ability in SAVI learning on meeting the classical mastery

The classical mastery criteria set in this study are at least 75% of students participating in learning reach Minimum Mastery Criteria (MMC) (Masrukan, 2014: 18). Based on hypothesis testing, algebraic thinking ability in SAVI learning did not meet the minimum criteria of classical mastery; this also occurred in classes with the PBL model.

The number of students in SAVI learning who met the MMC (score ≥80) was only three students. While in PBL, there were no students who met the MMC. The mean test score on algebraic thinking ability in SAVI learning was 44.33, while in the PBL model, a mean of 36.07 was obtained. The cause of failed in meeting the classical mastery in SAVI learning classes and PBL learning classes was the quality of the algebraic thinking ability test.

In the test, it was found that from 8 questions, there were seven valid questions and one invalid question. The difficulty level of questions consists of 1 easy problem, four medium questions, and three difficult questions. The distinguishing power of questions consists of 1 question with fewer criteria, two questions with medium criteria, two questions with good criteria, three questions with excellent criteria. So for the test of algebraic thinking ability taken seven questions with valid criteria, the level of difficulty consists of 4 medium questions and three difficult questions, and the distinguishing power of questions with moderate, good, and very good criteria.

From the test problems in class VII A, it was found that the mean score of the algebraic thinking ability was 35.87, with one student achieving the MMC. While the reliability obtained was 0.73. According to Yusuf (2015: 74), the measuring instrument is said to be reliable if the measuring instrument is tested on the same subject repeatedly, the results will remain the same, consistent, stable, or relatively the same (not statistically different). Meanwhile, according to Rusman (2013: 57), reliability ranged between 0.6 - 0.79, categorized as high-level reliability, which means that the algebraic thinking ability test includes high reliability. So if the algebraic thinking ability test is used again in the same population conditions, it will get relatively the same results.

3.3. Comparison of Algebraic Thinking Ability in SAVI Learning and Algebraic Thinking Ability in PBL

The algebraic thinking ability in SAVI learning is better than the algebraic thinking ability. This is supported by the evidence of statistical tests about the difference of proportion test and the difference of mean test.

Supporting factors that cause the algebraic thinking ability in SAVI learning better, among other things such as:

1. The learning process is fun caused by students excite while engaging in the new activities in learning each meeting.
2. The learning process involves the entire physical and senses, causing the brain and body to be fresh.

In the process of mathematics learning using the SAVI model (Somatic, Auditory, Visual, Intellectual), students show enthusiasm in each stage of SAVI learning. This is following the three main principles of Piaget's Learning Theory (Rifa'i, 2011: 225) about active learning, learning through social interaction, learning from experience. Students were active in learning in each introductory activity; for example, in the first meeting, students were excited about the question and answer apperception topic. In the second meeting, by emphasizing the auditory, students were asked to stand up, then two students in the same group whispered to each other about the topic of the previous meeting. At the third meeting, the students asked questions actively.

The core activity of learning, for example, students were actively engaged in the adventure of looking for objects that have a square shape and then calculate the size and the problem according to Student worksheet (LKPD) 1. The adventure itself is an activity of measuring the surface lengths of an object and calculating the circumference. It is a form of active learning and learning from experience. The second meeting took the form of making an illustration of a rectangular garden with the help of stationery stating the size of a pen is a certain variable a meter, and the size of an eraser is 1 meter, then calculating area and circumference. The third meeting is learning while playing with a snowball game. The snowball contains one question of algebraic thinking ability to solve. Snowballs are thrown upwards; then, after the snowballs fall, students take the snowballs to finish. Then back in the group to share what questions were obtained, how to work, is there a correction. In this core activity, students naturally learn through social interaction and active learning.

SAVI learning is also following Bruner's learning theory. Bruner's learning theory (Asikin, 2004: 15) states that there are three stages of learning, namely the Active Learning Stage, the Iconic Learning Stage, and the Symbolic Learning Stage. Enactive Stage students learn through pictures or visuals, learning with the help of media quadrilateral models. At the iconic stage, the activities carried out by children relate to mental, which is a picture of objects that are manipulated. Then the last stage is the symbolic learning stage where students learn by notation. This activity is seen in changing a rectangular side size into a certain variable. It does not only involve calculations with numbers but also involves variables.

SAVI learning is better than PBL learning. SAVI learning with somatic, auditory, visual, intellectual characteristics optimizes all five senses, gestures for learning. According to Radford's (2013) research, learning that involves the whole body (motion), emotions, gestures, and all five senses can facilitate

students in developing students' algebraic thinking ability as early as possible. During the study, students with SAVI learning were more active and did not feel bored during learning.

The results of research that show SAVI learning has advantages over PBL are also in line with research by Matthews (2007). More specifically, in Matthews's research using the subject of indigenous students. The learning used is MAST learning to improve algebraic thinking skills. MAST learning emphasizes the semiotic process to improve generalization thinking skills.

3.4. Description of Algebraic Thinking Ability in SAVI Learning

Generational ability consists of indicators (G1) determining the meaning of variables and (G2) forming equations. Questions containing generational ability are 1,2,4,5, and 6. The maximum score for generational ability is 12 with 6 scores for (G1) and 6 scores for (G2). The percentage of generational ability in SAVI learning is 47.84%.

Transformational ability consists of indicators (T1) performing algebraic operations and (T2) determining the completion of an equation. The questions that contain transformational ability are 1,2,4,6, and 7. The percentage of the transformational ability of VIIth grade students in SAVI learning is 51%.

The meta global ability consists of indicators (M1) using algebra to analyze changes and (M2) modeling problems and solving them. The questions that contain meta global ability are 3,5 and 7. The global meta ability of VIIth grade students in SAVI learning is 33.8%.

4. Conclusion

Based on the research results and discussion, the following conclusions are obtained: (1) Algebraic thinking ability of VIIth grade students in the SAVI learning model did not meet the classical mastery criteria. The causal factor of not achieving classical mastery criteria is the algebraic thinking ability test used has moderate-difficult criteria. The test of algebraic thinking ability obtained a mean of 35.87 with a reliability of 0.73 and a validity of 7 questions out of 8 questions; (2) The algebraic Thinking in SAVI learning is better than in PBL. The difference between the two-means test shows that the algebraic thinking ability test in SAVI learning is better than in the PBL model. The proportion test of students who met the MMC showed that the proportion of students' algebraic thinking ability tests who met the MMC in SAVI model learning was more than the proportion of students' algebraic thinking ability tests who met the MMC in PBL model; (3) Algebraic thinking ability of VIIth grade students in SAVI learning showed that generational ability reached 47.84%, transformational ability reached 51%, and meta global ability reached 33.8%.

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