Analysis of Students’ Error in Algebraic Thinking Test

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Abstract. This research aims to know students’ mistakes and lackness in solving the test of algebraic thinking. This research uses a descriptive qualitative method, and involve 33 students of 8th grade in a junior high school. The results of this study showed that students got a lack of interpreting, comprehending, and combining logic and concept in solving the problems.

1. Introduction
Algebraic thinking plays an important role in mathematics. Algebraic thinking skill is a fundamental element that needed in mathematical reasoning and mathematical thinking [1]. The importance of algebra was admitted by the world, because algebra is a tool that used further in mathematics, science, business, economy, finance, accounting, computation, and so on [2]. Beside that, algebra also the key of success in mathematics. Algebra is an academic passport for students to be success in mathematics.

According to Windsor that said the development of algebra in the middle school oftenly marked as one of lackness in mathematics. One of students difficulties in algebra is in understanding the meaning of variable, especially in students at 7th grade which still in transition from aritmethic thinking to algebraic thinking [3]. Algebraic thinking is a unit of understanding which have to be interpret by translating information or phenomenon to describe and predict a phenomenon [4]. Algebraic thinking devided into two major components, they are the development of mathematical thinking tools and the study of fundamental algebraic ideas [5]. The development of mathematical thinking tools organized into three topics, they are problem solving skills, representation skills, and quantitative reasoning skills. The study of fundamental algebraic ideas explored through three lenses, they are algebra as generalized arithmetic, algebra as language and algebra as as a tool for function and mathematical modeling. Each topics of the development mathematical thinking tools and lenses of the fundamental algebraic ideas have their own indicators. Table 1 shows the components of algebraic thinking.

Table 1. Components of Algebraic Thinking

| Mathematical Thinking Tools | Fundamental Algebraic Ideas |
|-----------------------------|-----------------------------|
| Problem solving skills      | Algebra as generalized mathematics |
| - Using problem solving strategies | - Conceptually based computational strategies |
| - Exploring multiple approaches/multiple solutions | - Ratio and proportion |
| | - Estimation |
| Representation skills       | Algebra as the language of mathematics |
| - Displaying relationships visually, symbolically, numerically, verbally | - Meaning of variables and variable expressions |
| - Translating among different representations | - Meaning of solutions |
Interpreting information within representations

- Understanding and using properties of the number system
- Reading, writing, manipulating numbers and symbols using algebraic conventions
- Using equivalent symbolic representations to manipulate formulas, expressions, equations, inequalities

Quantitative reasoning skills
- Analyzing problems to extract and quantify essential features
- Inductive and deductive reasoning

Algebra as a tool for functions and mathematical modelling
- Seeking, expressing, generalizing patterns and rules in real-world contexts
- Representing mathematical ideas using equations, tables, graphs, or words
- Working with input/output patterns
- Developing coordinate graphing skills

Table 1 shows the indicators of each component of algebraic thinking. The indicators that used in this research are (1) conceptually based computational strategies, (2) ratio and proportion, (3) using equivalent symbolic representations to manipulate formulas, expressions, equations, inequalities, (4) seeking, expressing, generalizing patterns and rules in real-world contexts. This research is aimed to know students’ difficulties and lackness in solving the test of algebraic thinking based on those indicators.

2. Experimental Method
This research is a descriptive qualitative research to describe students’ difficulties and lackness in solving the test of algebraic thinking. Subjects of this research are 33 students on 8th grade at one of junior high school. The data obtained by the test of students’ algebraic thinking.

3. Result and Discussion
Based on the result of data analyss, obtained that the average score of algebraic thinking test is 12.94 with the maximum ideal score is 47. It shows that students’ algebraic thinking skills is on the low level.

3.1. Analysis Problem 1 (Indicator 1)
Problem 1 for indicator conceptually based computational strategies is “Mr. Ahmad bought some woods by the length 3 meters of each wood. Mr. Ahmad is going to make 8 window frames shaped like a rectangle that measures of 6 window frames are 50 cm by 75 cm and 2 windows frame are 50 cm by 120 cm. How many woods that Mr. Ahmad bought? How long the residual woods which unused for the window frames?"

From 33 students, there were 8 students answered correctly, 25 students gave wrong answers with varying error. One of student’s answer shown on figure 1.
Figure 1 show that student didn’t understand the way to solve the problem. He/she didn’t understand that to find the length of the needed wood for the window frame is by using the concept of perimeter. It show the lackness of students’ in interpreting the problem into mathematical language.

3.2. Analysis Problem 2 (Indicator 2)

Problem 2 for indicator ratio and proportion is “the ratio of parallel side of an isosceles trapezoid is 1 : 2. If the ratio of the shorters parallel side and the opposite sides is 6 : 5 and the perimeter is 56 cm, how to find the area of trapezoid?”

From 33 students, there were 17 students answered correctly even without any written arguments and 16 students gave wrong answers with varying error. One of student’s answer shown on figure 2.

Figure 2 shows that student exactly determine the length side of trapezoid without any written arguments because they use logic on it. Although the student answer correctly, but the student will get an obstacle when the problem ask the vice versa.

3.3. Analysis Problem 3 (Indicator 3)

Problem 3 for using equivalent symbolic representations to manipulate formulas, expressions, equations, inequalities is “Naura and Hasbi had bedroom with the same floor area. Naura’s bedroom floor area shaped like square and Hasbi’s shaped like rectangle. Hasbi’s bedroom floor area that measures 1 meter longer than the length side of Naura’s bedroom floor and the width is 0.8 m shorter than the length side of Naura’s bedroom floor. Determine the area of their bedrooms floor!”

From 33 students, there were 3 students answered correctly and 30 students gave wrong answers with varying error. Based on analysis of students’ answer, they didn’t read the question comprehensively. One of student’s answer shown on figure 3.
Figure 3 shows that student did the multiplication of numbers shown on problem without comprehend the given information in the problem.

3.4. Analysis Problem 4 (Indicator 4)
Problem 4 for seeking, expressing, generalizing patterns and rules in real-world context is “look at the picture!

The frame for 1 glass block window uses 4 log of woods, for 2 glass block windows use 7 log of woods, and for 3 glass block windows use 10 log of woods. If this pattern continues, how many log of woods to frame 8 glass block windows? Find the perimeter!”

From 33 students, there were 15 students answered correctly and 18 students gave wrong answers with varying error. One of student’s answer shown on figure 3.

Figure 4 shows that student didn’t finish his answer and he didn’t make a pattern in solving this problem. Although he has a logic argument, but when the problem ask for 50 blocks of glasses, students will get an obstacle in solving it.
4. Conclusion
Based on the result and discussion as described on the previous section, we conclude that students’ mistakes and lackness in solving algebraic thinking test are on (1) interpreting information from the problem to mathematical language, (2) comprehending the given information and the question in the problem, (3) solving problem with combination of logic and concept they have learnt. Therefore, for the learning process teacher should plan a learning approach that could minimize those mistakes and optimize students’ algebraic thinking skills.

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