The ability of multi-representation of junior high school students in solving algebra problem in the TIMSS model

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Abstract. Algebra is one of mathematical topics that’s difficult to understand by students. Many symbols in algebra make students difficult, so multi-representation can help any student to understand. This study is to describe students ability of multi-representation in solving algebra problems. The sample of this qualitative study is the 8th grade students of SMPN 2 Waru Sidoarjo, East Java, there are eight class from A to G, we choose class VIII B was purposively chosen from eight classes and contains 20 girls and 18 boys. All students were given both maths ability test and problem solving test. There were 10 students with the high ability in algebra, 25 students with medium ability in algebra and 3 students with low ability in algebra. Two volunteer students with high ability in algebra who had interesting representations were chosen as our respondents. The semi-structured interview was utilized to investigate the process, representations and students conceptual of algebra. The representation use by the first student is symbolic representation and visual representation. The representation use by the second student is symbolic representation and verbal representation.

Keywords: Multi-representation, Algebraic Problem

1. Introduction
The result of the TIMSS (Trends in International Mathematics and Science Study) in 2011, Indonesia in 30 out of 42 countries possessed an average science achievement score, which was lower than the international average one [12]. This mean that Indonesia have still possessed some problem in mathematical learning. TIMSS

Multi-representation in writing to learn activities improved the students critical thingking skills. Students are able to form representation to show their tought by writing and using different modes, diagram, picture, and image [8]. Representation contain the interpretation and explanation of a concept by using such modes as analogies, verbal statements, written texts, diagram, graphics and simulation. Using multi-representation to display the concepts will make them more comprehensible. Algebra have been used not only in mathematics but also in everyday, algebra is one of mathematical topics that is difficult to understand by students. Many symbols in algebra make students difficult, so multi-representation can help any student to understand. The resulted representation is strongly influenced by the one’s learning experience [5], so if some people are faced the same problem then it is possible to obtain several different representation. NCTM principle and standards not only concern for students ability to work with multile representation but also their interpretations of the meaning and value of what they are doing when they use multi-representation.
Classroom practice, it is possible to distinguish two main tendencies concerning multi-representation. One point towards students constructing their own representation, both in pure mathematical context and in situation where mathematics applied to non-mathematical or real life situation. The other points towards students using or adapting standard representations, particularly, algebraic, graphic, tabular, and verbal representations [6].

This study will be studied multi-representation used by students in algebra that is doing algebra thinking with multi-representation based on conceptual and procedural capability and provide teacher with a better knowledge about how students are able or unable to solve algebra problems. Students with the high score will be chosen based on the interesting and different representations used.

Algebra Problems
Algebra is a branch of mathematics in which letter and symbols for operations are used to represent basic arithmetic. As in arithmetic, the basic operations of algebra are addition, subtraction, multiplication, division, and the extraction of roots. Arithmetic, however, cannot generalize mathematical relationships such as the Pythagorean theorem, which states that the sum of the squares of the sides of any right triangle is also a square. Arithmetic can only produce specific instances of these relationships (for example, 6, 2, and 7, where $6^2 + 2^2 = 7^2$). But algebra can make a purely general statement that fulfills the conditions of the theorem: $a^2 + b^2 = c^2$ for any right triangle and $c$ is the hypotenuse. Any number multiplied by itself is termed squared and is indicated by a superscript number 2 [2,5].

In the case of an algebra problem, a student is required to write an algebraic equation in terms of a set of variables, which are related to one another in a fixed (or fixable) relationship that can be stated in terms of an equality or inequality. Difficulties with algebra problems had been found in the past several years and had been studied extensively in many articles and research studies. In order to understand why algebra word problems are difficult, we will look at students’ mental models of algebra problems [4,12].

One general definition is that mathematical thinking is the cognitive process of figuring out how to solve a mathematics problem that one does not already know how to solve [2]. Alternatively, this process can be defined as when a problem solver solves the problem by moving from the given state to the goal state, from a state of not knowing how to solve the problem to knowing how to solve it. Definition of a problem is a situation that has a goal where one does not know how that goal is to be reached. With this non-specificity, the operationalization of problem solving has taken widely different approaches [2,4,9].

2. Methods
This study is conducted on 8th grade students of SMPN 2 Waru, selected students of VIII B class. This class consists of 20 girls and 18 boys, chosen purposively from eight available classes. All Students have completed math ability test and problem solving test. There were three quations including unit algebra. The results of ability test were catagorized into high ability, medium ability and low ability. The results of problem solving test were catagorized into verbal, visual, and symbolic representation. The semi structured interview was conducted on two subjects for 30 minutes to examine students’ conceptual understanding deeply, process and representation used. Table 1 show the indicators of representation used in algebra problem.

3. Results
The ability test based on procedural and conceptual understanding then catagorized into high, medium, and low ability. Based on the analysis results there were 10 students with the high ability, 25 students with medium ability, and 3 students with low ability. The problem solving test was analized based on representation catagorized into verbal, visual, and symbolic representation. From 10 students with the high ability in algebra problems, there were two students who had the different and interesting strategy in solve the algebra problems and will be chosen as subjects.
Table 1. Indicators of representation used in algebra problem

|                                      | Verbal Representation | Visual Representation | Symbolic Representation |
|--------------------------------------|-----------------------|-----------------------|-------------------------|
| **Understanding the problem**        | Mention the information in the problem (use sentences) | Mention the information in the problem (use a pictures) | Mention the information in the problem (use symbols) |
| **Devising a plan**                  | Determine the procedure and strategy used to solve the problem (use sentences) | Determine the procedure and strategy used to answer the problem (use pictures) | Determine the procedure and strategy used to solve the problem (use symbols) |
| **Carrying out the plan**            | Carry out the procedure and representation that has been determined to solve the problem (use sentences) | Carry out the procedure and representation that has been determined to solve the problem (use pictures) | Carry out the procedure and representation that has been determined to solve the problem (use symbols) |
| **Looking back**                     | Recheck the consistency of the representation used | Recheck the consistency of the representation used | Recheck the consistency of the representation used |

3.1 The Representation used by student 1

Student 1 estimated and checked correctly all of the numbers, he used visual and symbolic representation. Figure 1 shows the resulting test of student 1.

number 2 he used the number line to solve the problem. It means he used visual and symbolic representation to solve that problems. But for making sure, the above answer was justified with the result of the interview as follows.

Q : Could you tell me what is the information on the problem as you know?
S1: There are a variable that we can used to solve that problem.
Q: What did you do with these variable?
S1: I used that variable to solve that problem with elimination strategi to find the result.
Q: What happen with number 2?
S1: I used the number line to representation the question.

From the result of the interview, student 1 be able to mention and explain the information in the problem. He used visual and symbolic representation to answer the problems.

3.2 The Representation used by student 2
Student 1 estimated and checked correctly all aof the number, he used visual, verbal and symbolic representation. Figure 2 show the resulting test of student 2.

![Figure 2. The answer of student 2 in problem solving test.](image)

From the resulting test, he used picture to answer the question number 2, for question number 3 he used verbal representation to solve the problem. It means he used visual and verbal representation to solve that problems. But for making sure, the above answer was justified with the result of the interview as follows.

Q: Could you tell me what is the information on the problem as you know?
S1: There are a variable that we can used to make picture.
Q: What did you do with these variable?
S1: I used that variable to make a picture for solve the problem.
Q: What happen with number 3?
S1: I used a sentences to representation the question.

From the result of the interview, student 2 be able to mention and explain the information in the problem. She used visual and verbal representation to answer the problems.

4. Discussion
Students use different representation to solve algebra problem. The first student has a good procedural and conceptual understanding, he can used visual and symbolic representation. Students are said to understand the problems. The second student has a good procedural and conceptual understanding, she can used visual and verbal representation. The second student uses a more efficient strategy than the first student.

Acknowledgments
This research reported here in was supported by SMPN 2 Waru. The opinions expressed herein do not necessarily reflect the position, policy, or endorsement of the supporting agency.

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