



## ANALYSIS OF TRANSFORMATIONAL CAPABILITIES FOR JUNIOR HIGH SCHOOL STUDENTS BASED ON CRITICAL THINKING ABILITY

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### ABSTRACT

The purpose of this research was to determine the ability of transformational junior high school students in terms of critical thinking skills. Source of data in this research were students in grade VIII SMP Negeri 2 Ambarawa. The research method uses descriptive qualitative approach, the collection of data used tests methods and interviews. Critical thinking skills measured by the test refers to Watson-Glaser Critical Thinking Appraisal (WGCTA). Result of the test of critical thinking refers to Watson-Glaser quantitatively was analyzed descriptively, then selected eight subjects for interviewed. Based on the analysis of the results of the interview, obtained 6 subjects were divided into three category of thinking skills; each two subjects of upper, middle, and lower group. These results indicated that the ability of transformational: (1) The upper group is high, the subject is able to carry out operations, factoring, expansion, substitution, addition of two or more polynomial, multiplication of two polynomials, determine the completion of an equation, simplifying expressions, change the expression to expression equivalent, (2) the middle group is high, the subject is able to define a concept/term, expanding, substitution, addition of two or more polynomials, multiplication of two polynomials, determine the completion of an equation, simplifying expressions, change the expression to expression equivalent, (3) The lower group is moderate to high, the subject is able to perform operations, factoring, expansion, addition of two or more polynomials, multiplication of two polynomials, simplify the expression, make changes expression equivalent to the expression.

Keywords: critical thinking, transformational, capabilities.

### INTRODUCTION

Mathematics is a subject that is given to students who are useful to increase the ability of logical thinking, analytical, systematic, critical, and creative, as well as the ability to cooperate (Depdiknas, 2007). Based on Permendiknas No. 22 of 2006 on the Content Standard for Primary and Secondary Education, the purpose given mathematics courses for SMP/MTs such that the students have the ability to use reasoning on the pattern and nature, do mathematical manipulation in making generalizations, compile evidence, or explain ideas and a mathematical statement. Another purpose give the materials of mathematics have respect for the usefulness of mathematics in life, which has the

curiosity, attention and interest in studying mathematics, as well as a tenacious attitude and confidence in solving problems.

While the purpose of learning mathematics in the curriculum 2013 is summarized in four core competencies (KI) is the competence of the attitude of spiritual and social, knowledge, and skills developed through the basic competency (KD). One of the basic competencies that develop the competencies of social attitudes is to show the attitude of the logical, critical, analytical, consistent and conscientious, responsible, responsive, and does not easily give in problem solving. Thus, competence is embedded in the materials of

mathematics, and not only useful for solving mathematical problems but also to solve problems in everyday life. For learning mathematics at school students can reach competencies in the curriculum 2013.

On the other hand, the facts about education in Indonesia has not shown the maximum results. Based on the results of TIMSS in 2011 (Mullis et al., 2012), Indonesia was ranked 38th out of 42 countries, with an average score of 386 and math achievement is still below the international average score is 500. The first rank is occupied by Korea states with achieving a score of 613. Then the second rank occupied by Singapore with achieving a score of 611. Several countries under Indonesia is Arab, Morocco, Oman, and Ghana. The results showed that the standard of progress and improvement of Indonesia's achievements in the field of mathematics has not been satisfactory at the international level.

Achievement of average scores Indonesian students on the TIMSS 2011 decreased from the average achievement scores on the TIMSS 2007 is 397, although the framework for TIMSS 2011 is equal to 2007. TIMSS 2011 Assessment frame work consists of two dimensions, namely the content and cognitive dimensions. Dimensions of contents determine the subject matter and cognitive dimensions that determine the process of thinking that students use when related to the content. Based on the results of TIMSS 2011, the average achievement of the lowest percentage by Indonesian students are in the cognitive domain. This indicates that the learning process has been used in schools have not accustom students to develop higher-level thinking skills, which is one aspect is the ability to think critically.

Chukwuyenum (2013) claimed critical thinking has become one of the tools used in everyday life to deal with the problems. Critical thinking is one of the tools used in everyday life to solve some problems because it involves logical reasoning, interpret, evaluate and evaluate information to enable decision-making that is reliable and valid. While based on mathematical learning objectives as expected in Curriculum 2006 or Curriculum 2013, one of which students have the ability to think critically. Therefore, mathematics is taught in schools can not be separated from the importance of the students have the critical thinking skills to solve mathematical problems and face the problems of everyday life. It is also in line with the opinion of Chukwuyenum (2013) in teaching mathematics in schools, need to be integrated and critical thinking are emphasized in the curriculum so

that students can learn the skills and apply them to improve the performance and capabilities of reasoning.

Competencies that must be mastered in mathematics based curriculum in 2013, one of which is capable of completing the algebra operations. A good understanding of algebra will help in the control of other material. Rochmad (2014) stated at the time of study materials function, equation, quadratic equations and inequalities, circle equations, trigonometric equations, and other materials requiring algebra operations.

Algebra is one-dimensional domain content within the implementation of the Trends in International Mathematics and Science Study (TIMSS) (Research and Development, 2011). Based on the survey results of the TIMSS 2011, which has been explained earlier that the average achievement of the lowest percentage by Indonesian students are in the cognitive domain. Factors causing weakness of Indonesian students in algebra material is expected because of the lack of ability to apply knowledge in linking the concept of numbers and algebra, lack the ability to make a mathematical model generalization algebraically. Moreover, in the process of learning mathematics, reading, thinking and solving problems to be able to understand the essential and strategic information become toward students skill (Tjalla, 2009). In addition, the ability to think critically and creatively less also cause weakness of students in understanding the concepts of algebra (Rochmad et al., 2014).

According to Piaget's theory, junior high school age students are at the stage of formal operations (11-15 years old) who is able to think abstractly including algebraic thinking. According to Kieran (2004) thinks this algebra include meta-global, generational and transformational thinking. Transformational capability is indicated if the student is able to manipulate and determine the form of algebraic equivalents, surgery algebraic form, specify the settlement equations in algebra. Some researchers who have conducted research among other transformational capabilities Panasuk (2010) examined the manipulation of symbols in the form of algebra, Vance (1998), Blanton and Kaput (2011) about the similarities and abstraction arithmetic. From the research that there is no research linking transformational ability to think critically.

SMP Negeri 2 Ambarawa as one of the favorite public school in Ambarawa, Semarang regency. From the results of the pre-study conducted by researchers in class VIII SMP Negeri 2 Ambarawa, students still make mistakes in algebra proficiency test. At one indicator transformational capabilities, sub-indicators of change

equation equivalent to the equation, there are many pre-research graders made a mistake in completing the equation. Manipulation of the student is not true that the settlement is not appropriate.

Based on the background described, it will be investigated transformational capability analysis based on critical thinking skills in grade VIII SMP Negeri 2 Ambarawa. Critical thinking skills of students can be seen from the results of tests critical thinking refers to Watson-Glaser, while algebra is devoted to transformational capabilities. From the information on the results of research on transformational thinking skills and critical thinking of students can be used as input for the teacher in the classroom to improve learning outcomes of algebra and critical thinking of students, especially in algebra.

Problems in this study how the transformational ability of junior high school students in terms of critical thinking skills? Complete figures are presented in the following research questions. (1) how the transformational ability of students in junior high school students relating critical thinking? (2) how the transformational ability of students in junior high school students in lower, middle, and upper group?

Panasuk (2010) describes the process of understanding in algebra include an understanding of algebra as a generalization of arithmetic, in which the operating processes and rules used in algebra is essentially a continuation of arithmetic. While conceptual understanding in algebra is the ability to recognize the functional relationship between variables, independent and dependent variables, and interpret and distinguish between different representations of the concepts of algebra. It is manifested with competence in reading, writing and manipulating numbers and symbols algebraic symbols used in formulas, expressions, equations and inequalities. Another explanation about the ability of algebra is also expressed by Driscoll (1999) which defines the ability of algebra as the ability to represent the situation so that the quantitative relationship between variables become clear.

Usiskin (2010) describes four common conception of algebra is arithmetic, a collection of procedures used to solve specific problems, studying the relationship between quantity and learning structures. Blanton and Kaput (2011) mentions some understanding of algebraic form categories that directly or planned in the classroom, among others: the generalization arithmetic, functional relationships, properties of numbers and operations, and the treatment of algebraic numbers. Kieran (2004) categorize the school algebra

student activities undertaken by that activity generational, transformational, and meta-global. Generational activities involving shapes and algebraic equations. Transformational activities related to the idea of changing the shape or the equation does not change the value to maintain equivalence. While the meta-global activity using algebra as evidence, mathematical modelling, and problem solving. An explanation of the algebraic ability covered in three ability algebra proposed by Kieran (2004).

There are many researcher in algebra, for example: understanding the variables and the equal sign (Knuth et al., 2005), the functional relationship between variables (Panasuk, 2010; Blanton and Kaput, 2011), the representation of the situation quantitatively involving variable (Driscoll, 1999), the types of such understanding including the ability generational. Furthermore, an understanding of the manipulation of symbols in the form of algebraic equations (Panasuk, 2010) and the arithmetic algebraic abstractions (Vance, 1998; Blanton and Kaput, 2011) are included in the transformational capabilities.

Based on the explanation, in this study will adopt algebra capabilities presented by Kieran (2004) in particular transformational capabilities that the student is able to manipulate and determine the form of algebraic equivalent, algebraic form, and solving some equations in algebra.

Ennis (2011) defines critical thinking is thinking that is reasonable and reflective with consideration and focus on making decisions about what to believe or do. In critical thinking, decision taken must be based on accurate information and a clear understanding of the situation at hand. Because if the decision is not based on information and assumptions are true, then the conclusion has no basis of truth.

Glaser (Fisher, 2007) defines critical thinking as (1) an attitude would think deeply about the issues and matters that are within the reach of one's experience, (2) knowledge of the methods of inspection and logical reasoning, and (3) some kind of a skill to apply these methods. Based on this definition, critical thinking requires effort to examine any belief or knowledge assumptive based on supporting evidence and conclusions resulting continued. That is, a person can be said to have the critical thinking skills when reasoning and argument abilities involves three things that disclosed Glaser. This is in line with that expressed Lamb (2003) that involve critical thinking logical thinking and reasoning with more use of the left brain. Therefore, critical thinking mathematically included in higher-level thinking.

Watson-Glaser (2002) suggests that critical thinking as a combination of attitudes, knowledge and skills. Competence in critical thinking represented by the skills of critical thinking as follows: (1) inference, namely the ability to distinguish between degrees of truth and falsehood. Inference is a conclusion that is produced by a person of observation suit certain facts, (2) the introduction of assumptions, namely the ability to recognize those assumptions. The assumption is something that is considered correct, (3) deduction, namely the ability to determine the conclusions of particular need to follow the information in the questions provided, (4) interpretation, ie skills to weigh the facts and make conclusions based on the data provided. Interpretation is the ability to assess whether a logical conclusion based on the information provided, and (5) evaluation, namely the skills to distinguish between a strong or relevant argument and the argument is weak or irrelevant. Based on the above, it can be concluded that critical thinking is a thought process in trying to acquire knowledge or information by considerations which focuses on decision-making believed.

According Bessick (2008) are some of the measuring instruments used to assess critical thinking that Academic Profile (A. Profile), the Collegiate Assessment of Academic Proficiency (CAAP), California Critical Thinking dispositions Inventory (CCTDI), Critical Thinking Assessment Inventory (CTAI), California Critical Thinking Skills Test (CCTST), Cornell Critical Thinking Test (CCTT), College Outcomes Measures Program - Objective Test (COMP), ETS Tasks in Critical Thinking (ETS TASKS), Measure of Intellectual Development (MID), Problem Solving Inventory (PSI), Reflective Judgment Inventory (RJI), Watson-Glaser Critical Thinking Appraisal (WGCTA).

In this study, to measure critical thinking ability of students to use critical thinking test, which refers Watson-Glaser Critical Thinking Appraisal (WGCTA). WGCTA is an assessment tool designed to measure a person's ability to think critically containing an array of problems, statements, arguments, and interpretation. According Husband (2006) This instrument is a written test and are widely used by educational and professional occupations.

## METHODS

This study used a qualitative descriptive approach that will analyze the ability of transformational algebra class VIII SMPN 2 Ambarawa based on critical thinking skills. The data in this study were (1) the ability of transformational algebra junior high school students

(2) junior high school students' critical thinking skills. Data taken with the test method and interview, which test the ability of transformational thinking algebra and junior high school students' critical thinking test according to the theory of Watson-Glaser. The interview is required to obtain in-depth information and support what has been obtained from the tests. Selection is based on the subject of critical thinking test results refers to Watson-Glaser and interviews. The data source is divided into 3 groups critical thinking namely the upper, middle, and lower groups. For each group selected two students as research subjects. Based on the results of the test and the interview can be identified transformational thinking of algebra.

## RESULTS AND DISCUSSION

### 1. Subject of Upper Group

Algebraic ability of junior high school students in transformational capabilities indicated by a written test. Based on the results of written tests, obtained by the fact that the average ability level algebra transformational upper group is 89.41. For an indicator to define a concept / term gained an average of 75 for the indicators perform factoring operations gained an average of 100 for the indicator to substitute gained an average of 77.5. Score of determine solution of equation reach an average of 100. Results transformational ability to think critically the upper group are presented in the Figure 1.

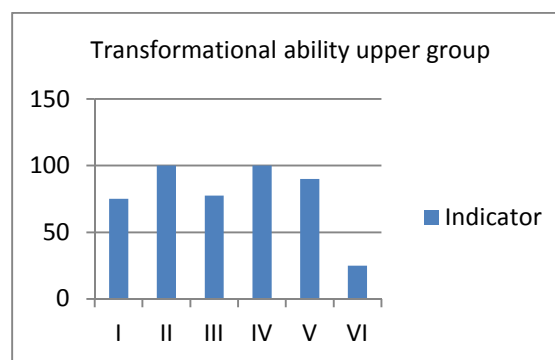


Figure 1: Transformational ability upper group

### 2. Subject of Middle Group

Transformational capability for students with critical thinking skills middle group obtained by the fact that the average ability level algebra transformational middle group is 77.35. The result of the transformational ability of students to think algebraic of middle group are presented in Figure 2.

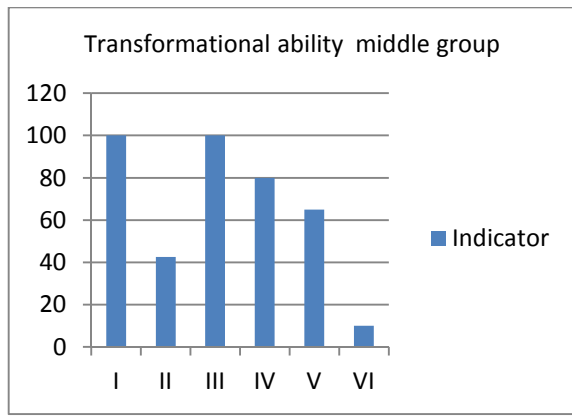


Figure 2: Transformational ability middle group

### 3. Subject of Lower Group

The ability of junior high school students in algebra transformational capability is indicated by a written test. Based on the results of written tests, obtained by the fact that the average ability level algebra transformational lower group is 64.71. The result of the transformational ability of students to think algebraic of lower group are presented in Figure 3.

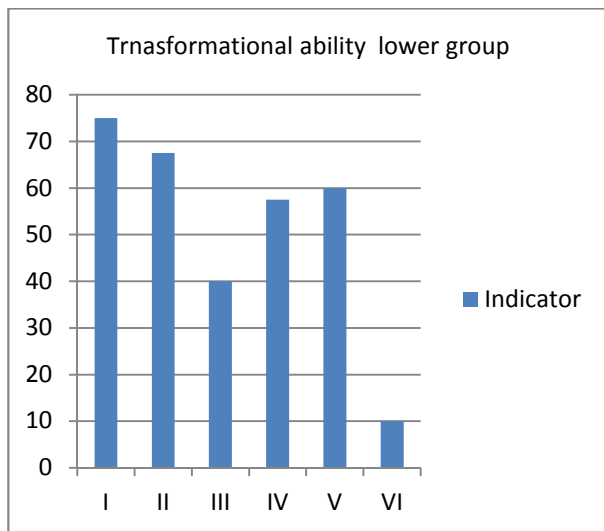


Figure 3: Transformational ability lower group

### 4. All of subjects (upper, middle and lower group)

Transformational ability for students with critical thinking skills (upper, middle, and lower) group for each of the indicators presented in Figure 4.

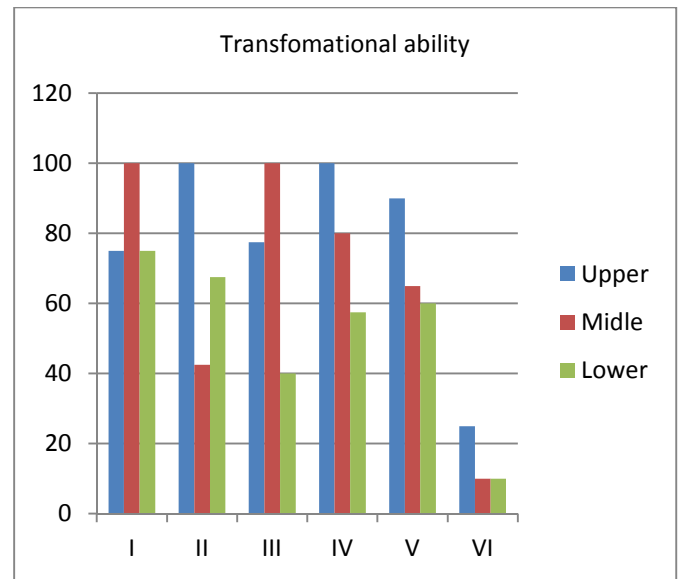


Figure 4. Transformational ability all subjects

While transformational capability for students with critical thinking skills upper, middle and lower to the overall presented in the Figure 5.

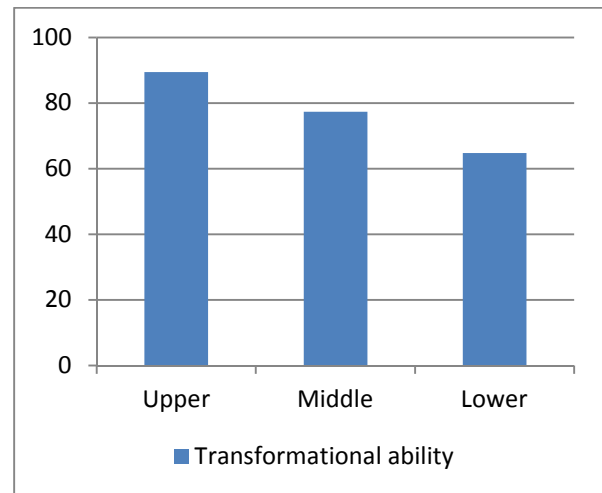


Figure 5. Transformational ability each group

This study has been obtained by the fact that the transformational capabilities of students with critical thinking skills upper group higher than the transformational ability of students with critical thinking skills in lower and middle group. For a group of high critical thinking has a high transformational ability (the rate is 89.41), Middle group of critical thinking in the high category (the rate is 77.35) and a lower group of critical thinking in medium category (the rate is 64.73). there is relationship: it shows that higher level of critical

thinking of students, then in higher level of transformational thinking.

Transformational algebraic thinking is thinking that requires logical algebra thinking, while logical thinking is needed in critical thinking. Vance (1998) explained that the understanding of algebra is a form of reasoning that involves variables, generalization, representation of different forms of relationships, and abstraction of shape calculation. So students with critical thinking skills that will either have a transformational algebraic thinking skills are good. Glaser (Fisher, 2007) described one of the indicators of critical thinking is to know about the methods of examination and logical reasoning that it is also a capability that is needed in transformational algebraic thinking.

Ghadi (2013) explained that students must learn critical thinking skills for reasoning and understanding; so that they know: students with high critical thinking skills have higher reasoning and understanding, this ability is needed in transformational thinking. Similarly, the research Chukwuyenum (2013) critical thinking is effective in improving students' mathematics performance, think algebra is one to think mathematically. McMahon (2009) states the ability to think critically correlated with skills in information technology and computer, which is also close to mathematical ability and the ability of transformational algebra.

## CONCLUSION

We conclude several important results: (1) the ability of algebraic-transformational thinking of junior high school students in the high category; (2) students that have high ability of critical thinking also have high ability in algebraic-transformational thinking; (3) students that have medium ability of critical thinking have the high ability to think algebraic-transformational; (4) students in lowest level of critical thinking have medium ability of algebraic-transformational thinking; and (5) the highest level of critical thinking is the highest level in algebraic-transformational thinking skills.

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