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**LEVELING OF STUDENTS' CRITICAL ABILITY IN SOLVING MATHEMATICS
PROBLEM BASED ON GENDER DIFFERENCES**

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Abstract

This qualitative research aimed to formulize the levelling of students' critical ability in solving mathematics problem based on gender. The data collection was gathered by interview based task. The research subjects were the eleventh grader students of SMA Islam Sultan Agung Semarang. This research revealed that (1) the more critical students': (a) the female was able to solve a problem correctly and carefully. Besides, she looking back her works, (b) the male was able to solve a problem correctly but he did not careful and did not looking back his works, (2) the critical students, (a) while planning the problem they tend to be trial and error, (b) the female student looking back her works, but the male student did not, and (3) the less critical students, they were able to create the plan by writing the formula several times but they were not able to solve the problem correctly.

Keywords: *critical thinking ability, mathematics problem, gender*

I. Introduction

1.1 Background

In Mathematics Standard Competence which is published by Depdiknas (2006), mathematics learning aimed to prepare students to solve the routine problems, involve the students in data collection activity, exploration, interpretation, reasoning, designing model, analysing, hypothesis formulation, generalization, and checking outcome. Thereby, in learning mathematics, except for achieving the exist purpose on each mathematics topic, students need to be equipped with certain thinking ability such that able to evolve and evaluate the argument in solving a certain problem. One of the thinking abilities that must be developed to achieve these aims is critical

thinking ability.

Critical thinking is indicated by the abilities: (1) identify the facts that given clearly and logically; (2) formulate the main problem precisely; (3) apply the method that has already learned accurately, (4) reveal the data/ definition/ theorem in solving the problem correctly, (5) decide and carry out the plan correctly, (6) evaluate the argument in solving a problem carefully, and (7) differentiate between conclusion which is based on valid logic/not valid (Ennis. 1995).

Based on Polya (1973), mathematics problem is distinguished into two types namely problem to find and problem to prove. In problem to find, the point is the students are expected to determine the solution or answer from the problem. Meanwhile, in problem to prove, the students are expected to show the rightness of a theorem or statement. However, in the learning mathematics at senior high school (SMA), solving the mathematics problem cannot be done quickly and easily. The students need an algorithm of thinking with critical thinking ability to solve the problem.

The ability to solve mathematics problem is influenced by several factors, both intern and extern factors. The intern factors consist of the intelligence, motivation, interest, talent and mathematics ability as well as gender differences. Meanwhile, the external factors consist of facilities, infrastructure, media, curriculum, teachers, learning facilities, and so on. Arends (2008) explained that there are differences of cognitive ability between male and female. The males are more rational, has enthusiasm directed to the things that intellect, abstract, such that they are better in logical thinking and more critical. Meanwhile, the females are more accurate and detail in making decisions, her memory is better, more emotional, and interested more in verbal skills.

The consideration of choosing the senior high school (SMA) students as the research subjects are as follows: the first, the age of senior high school students based on the Piaget's stages of intellectual development lie on formal operations stage. At this stage if the students are faced with the things, then the students can formulate conjectures or hypotheses and then deduction the

consequences based on those conjectures or hypotheses.

1.2 Research Problem

Based on the background, then the research problem that will be posed in this research is how is the levelling of senior high school students' critical ability in solving mathematics problem based on the gender differences?

1.3 Research Objective

The aim of this research is to describe the critical thinking process of senior high school (SMA) students' in solving mathematics problem based on the gender differences.

1.4 Significance of Research

To classify the process of students' critical thinking in mathematics learning, in particular solving mathematics problem in senior high school (SMA) based on the gender differences.

2. Theoretical Framework

2.1 Critical Thinking

The critical and creative thinking are realization of the higher order thinking. The critical thinking seen as personal thinking ability to compare two or more information, such as the received information from outside and the exist information. If there are the similarities or the differences, then he/she will pose a question or comment in order to obtain an explanation.

John J. Patrick (1986) summarized some definitions of critical thinking based on Richard Paul, Barry Beyer, Stepahan Norris, and Robert H. Ennis. Paul defined critical thinking as the ability to make inferences based on observation and information. Beyer described critical thinking as an activity to assess the authenticity, accuracy, and the value of a claim, belief, and argument, or shortly he stated that critical thinking is the act of making a reasonable assessment. Norris stated

that critical thinking is the application all of knowledge and feelings to evaluate their own thoughts, in particular to change the behaviour.

Paul Ernest (1991) defined critical thinking as an ability to make conclusion based on observation and information. According to Beyer (1987), he described the critical thinking as an activity to assess accurately, trust, and by using argument, or briefly he stated that critical thinking is an act committed by a person in making judgments with good reasoning.

Further, Inch (2006), stated that critical thinking has eight interrelated components namely: (1) question at issue (2) purpose (3) information (the existence of the data and facts), (4) concepts (theories, definitions, axioms, propositions), (5) assumptions (6) points of view (frame of completion), (7) interpretation and inference, and (8) implications and consequences.

Based on the opinions above, it can be concluded that the main characteristics of a critical thinking are: (1) solving a problem with a certain purpose, (2) analyse, generalize, and organize the ideas based on the exist facts / information, and (3) draw conclusions in solving the problem systematically with correct argument.

Critical thinking that is intended in this research are marked with the ability to: (1) identify the given facts clearly and logically, (2) to formulate the main problem carefully, (3) apply the methods that have learned accurately, (4) reveal the data / definition / theorem in solving the problem precisely, (5) decide and execute correctly, (6) evaluate the argument that is relevant in solving a problem carefully, and (7) distinguish between conclusions which is based on logic that is valid / not valid.

2.2 Mathematics Problem

Bell (1978) proposed the definition of the problem as follows: “a situation is a problem for person if he or she is aware of its existence, recognizes that it requires action, wants or needs to act and does so, and is not immediately able to resolve the situation”.

Problems in mathematics generally formed as a mathematics questions, but not all the mathematics question is a problem. A mathematics question called as a problem when the students do not have a method to solve it, but willing to solve that question. Thus, in order to mathematics question become a problem for the students, it is needed two conditions: (1) students did not immediately know the method to answer question and (2) students willing or desire to solve the question.

Mathematics question is called as not mathematics problems, when the students can quickly find out the method/procedure to answer the question or the students do not willing to solve the question. To solve a mathematics problem the students need to perform more and complex a mental activity (thinking) than when they solve the not mathematic problem.

In this research, the Polya's step (1973) are chosen to solve mathematics problem, it offers a strategy to solve the problem which consists of four steps, namely: (1) understand the problem, (2) plan for solving the problem, (3) carry out the plan, and (4) looking back.

2.3 Critical Thinking Process in Solving Mathematics Problem

Solving mathematics problem explicitly become a mathematics learning objectives and set out in the mathematics curriculum, particularly for high school or university. There are four reasons why the mathematics problem should be given to senior high school students, the four reasons are: (1) improving cognitive skills in general, (2) encourage creativity and critical attitude, (3) as a part of the mathematics applications, and (4) motivate the students to learn mathematics.

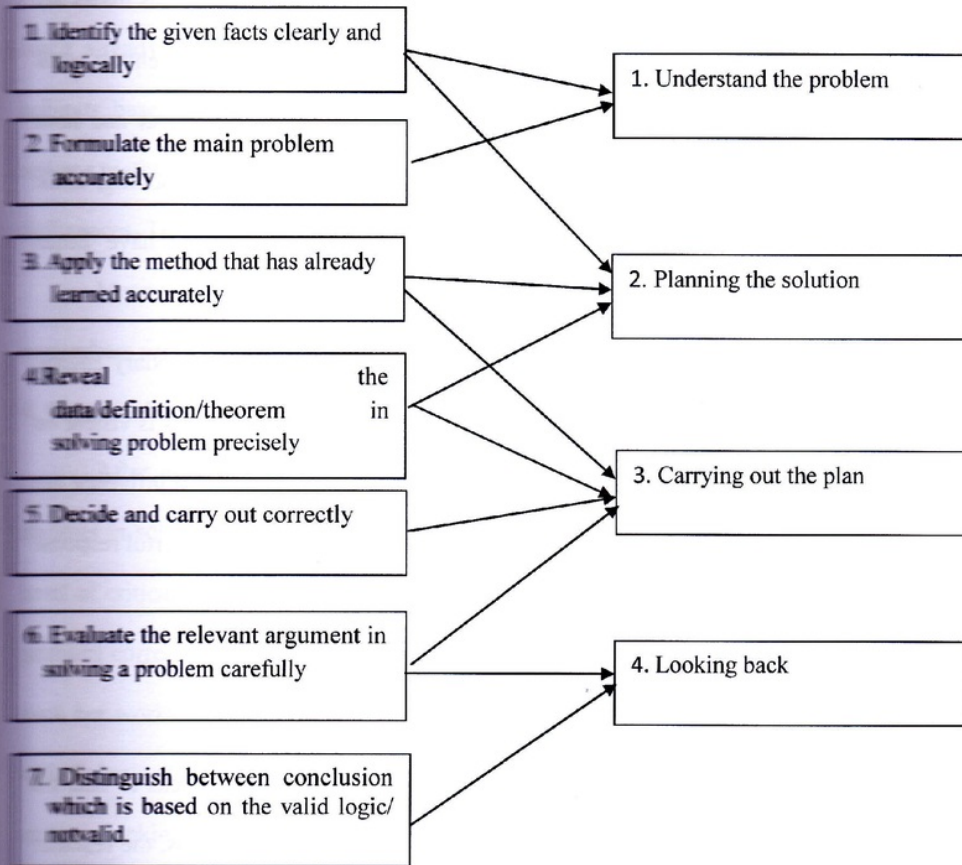
Based on that category, then in mathematics learning, particularly related to the mathematics problem solving needs to be investigated about the process of students' critical thinking and it can be seen based on students' critical thinking in mathematics learning through mathematics problem based on the gender differences. Tracing the students' critical thinking process in mathematics learning by giving the students mathematics problem is not the only way to know the process of critical thinking students.

In this research, the analysis of students' critical thinking process was conducted by tracking the students' critical thinking abilities. It was integrated in the solving mathematics problem at senior high school that involves the students actively and linked with the indicators of critical thinking ability. The indicators of each component of critical thinking and the steps of solving mathematics problem will be displayed in the following diagram.

Diagram: The indicators of critical thinking and the steps to solve mathematics problem.

Indicators of Critical Thinking

The steps of solving problem



In this research, to analyse and know the process of students' critical thinking can be traced through the students' critical thinking abilities. It was integrated in the process of mathematics learning in senior high school which involves the students actively and associated with solving mathematics problems by creating the indicators.

2.4 Gender

Gender is the natural concept, social, and culture that distinguish between male and female. These concepts are a nature which embeds on male and female. It is formed by social and

culture factors that exist around them.

According to Arends (2008), females are slightly better at verbal ability, whereas males are better at visual ability. Females are generally more concerned about performance at school; work harder, but less courageous to take the risks. Meanwhile, the males mobilize his power and have greater effort. Moss & Koziol (1991), stated that: (1) males are superior in logical reasoning, while women are superior in precision, accuracy, and thinking accuracy, (2) males have better mathematics ability than females.

¹ The differences between the males and the females are visible on the secondary nature, emotional, and activity of psychological function. The secondary nature in the females is visible on the feeling not in the intellectual, such that the value of feeling and experience more influence her personality than male's feeling. The females make realization of work with more powerful response and more emotional than males, but she more accurate and detail.

3. Methodology of Research

This research is an explorative research with qualitative approach, which seeks to find the meaning or essence behind the symptoms that occur in research subjects. That means, the research that conducted aimed to reveal the levelling of students' thinking that is the levelling of critical thinking in solving mathematics problems (problems of proof) based on gender differences. Regarding to the students' answer, it was used as a base in investigating of the levelling of students' critical thinking with the interview. The interviews in this study aimed to reveal a picture of students thinking processes associated with the hierarchy of critical thinking students. Interviews in this research aimed to reveal descriptions of students' thinking processes related to the levelling of students' critical thinking.

The subjects of this research were senior high school students in grade XI, they are chosen

by reason of: (1) students are at a formal level, thus being able to think more abstract to produce critical answer, (2) students have enough knowledge and experience about mathematics beforehand, since already finished elementary school and junior high school. The method of selection the subjects based on the established criteria and fulfil the criteria of levelling critical thinking in solving mathematics problems. The research subjects were chosen two students based on the gender differences. There were two students, the male and female students.

Meanwhile, the main instrument in this research was the researcher itself, because the researchers serve as data collector during the research process and continued by in-depth interviews.

4 Results of Research

After analysed the data, then obtained the result of levelling students' critical thinking abilities in solving mathematics problems based on the gender differences as follows: (1) the fourth level of critical thinking ability (more critical): (a) for the female student, she was able to solve a problem correctly and carefully that appropriate with Polya's step. Besides, she willing to looking back her works, (b) for the male student, he was able to solve a problem correctly that appropriate with Polya's step but he did not careful and did not looking back his works, (2) the third level of critical thinking ability (critical), (a) both female and male students while planning the problem need to be trial and error with several formulas that have already known, (b) the female student willing to looking back her works, but the male student did not do it, and (3) the second level of critical thinking ability (less critical), both female and male students were able to create the plan by writing the formula several times. At the end, they were not able to solve the problem correctly.

Based on the results, the levelling of students' critical thinking abilities learning can be applied in mathematics learning particularly in solving mathematics problem by considering the gender differences, and also to enhance the students' critical thinking abilities. Besides, it can be used as a foundation for further research that has characteristics verification and modification.

5. Discussion

Based on the research finding, the research subjects for the fourth level of critical thinking ability choosing the method that has been known, the subject choose precisely and using the logical consideration. While expressing the formula that was used to solve the problem, the subject did not need more time since they remembered the rules that have been already known beforehand. Likewise, while process of counting, the subjects were able to do correctly and relatively fast. It showed that the procedure of thinking has already well enough. This fact in line with Hergenhahn and Olson's opinion (2009) that told someone response the world based on the previous experience, yet each experience loaded aspects which were different with experience that had been around in the previous time.

The research subjects for the third level of critical thinking ability, in term of the method that was used to reveal the paces of solving the problem either or find the concept or the rule by using the reasonable consideration. It can be seen that there was relevance between the given information and the subject's knowledge. The knowledge which attributed to the research subjects were good enough and also they did not experience difficulty in connecting several information that exist in the problem, such that they were able to find the appropriate relationship between the had known and the had asked. This fact in line with Piaget (Brooks & Brooks, 1993) that told, in assimilation, stimulus was interpreted based on the scheme that was possessed by people. If the stimulus that go into appropriate with the exist scheme, then someone directly response those stimulus.

The research subjects for the second level of critical thinking ability, they have not yet identify the given facts and detail of a problem. Likewise, in planning the solving steps, the subjects have not revealed yet completely and detail. While finding the concept or the rule for solving the problem, the subjects have not mentioned yet completely. It showed that the knowledge that exist

on the research subjects were limited, such that they have not find yet the appropriate relationship between the had been known and the had asked.

6. Conclusions

The research finding about the levelling ¹ of students' critical thinking ability in solving the mathematics problem based on the gender can be concluded as follows:

- I. *The forth level of critical thinking ability (more critical)*: (a) for the female student, she was able to solve a problem correctly and carefully that appropriate with Polya's steps. Besides, she willing to looking back her works, (b) for the male student, he was able to solve a problem correctly that appropriate with Polya's steps but he did not careful and did not looking back his works.
- II. *The third level of critical thinking ability (critical)*: (a) both female and male students while planning the problem still trial and error with several formulas that have already known, (b) the female student willing to looking back her works, but the male student did not do it.
- III. *The second level of critical thinking ability (less critical)*: both female and male students were able to create the plan by writing the formula several times. At the end, they were not able to solve the problem correctly.

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PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6

PAGE 7

PAGE 8

PAGE 9

PAGE 10

PAGE 11

PAGE 12
