Critical Thinking Skills of an Eighth Grade Male Student with High Mathematical Ability in Solving Problem

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Abstract. This study aims to describe student’s critical thinking skill of grade VIII in solving mathematical problem. A qualitative research was conducted to a male student with high mathematical ability. Student’s critical thinking skill was obtained from a depth task-based interview. The result show that male student’s critical thinking skill of the student as follows. In understanding the problem, the student did categorization, significance decoding, and meaning clarification. In devising a plan he examined his ideas, detected his argument, analyzed his argument and evaluated his argument. During the implementation phase, the skill that appeared were analyzing of the argument and inference skill such as drawing conclusion, deliver alternative thinking, and problem solving skills. At last, in rechecking all the measures, they did self-correcting and self-examination.

1. Introduction
Mathematics needs to be given to all of students ranging from elementary school to equip students with the ability to think logically, analytical, systematic, critical, and creative as well as the ability to cooperate. The competencies are required, so that learners can have the ability to acquire, manage, and use information to survive in ever-changing, uncertain, and competitive state. Critical thinking skills involve the integration of several capabilities, they are: the ability of observation, analysis, reasoning, judgment, and decision making [1].

Critical thinking is a skill that is very important in the 21st century besides the other skills such as creative thinking, communication skills and collaboration skills [2]. Those skills are recognized as an integral part of students who are prepared to stock the more complex life and in the environment work on the 21st century. Critical thinking is a skill that is needed by everyone. Why is critical thinking important that need to be learned? There are several reasons, among others: Critical thinking is a skill that is required in any job, when studying any field of science, to solve any problems, and is a valuable asset to one's career. Critical thinking is very important in the 21st century, because this is an era of information and technology [3]. One must respond to changes quickly and effectively, thus require a flexible intellectual skills, the ability to analyze information, and integrate multiple sources of knowledge to solve problems. Critical thinking is analytic and reflective [4].

Based on the limited test results showed that the students' ability to provide the correct arguments related to the question of critical thinking in schools is still low. This is indicated by the many students who can provide the argument correctly to the question, but the question asked students to give arguments.
Critical thinking skills can be developed through the study of mathematics. The problem, as long as teachers in the class did not develop critical thinking skills optimally through learning. Based on observations limited to the teacher in the classroom and review of lesson plans Ismail shows that teachers are more oriented to the contents of the subject matter [5]. Teaching the teachers are still lacking in the development of students' critical thinking skills.

Critical thinking is thinking that involve testing, connecting, and evaluate all aspects of the problem. Creative thinking is the thinking that is the authenticity and reflective and produce something as complex and “new.” Facione identified 6 main critical thinking skills, the interpretation, analysis, evaluation, inference, explanation and self-regulation [6].

To be able to develop critical thinking skills of students, teachers need to find the right strategy in learning accomplishments [4]. Questions that can be asked of teachers are critical to the students. There are various examples of critical questions for example, Is there another way? What if ...? What is wrong? Problems that develop critical thinking skills students have different characteristics compared with ordinary matter. A matter of critical thinking is a matter that involves the analysis, synthesis, and evaluation of a concept.

Based on this background the authors formulate the following research questions: How critical thinking skills of male students of eighth grade of junior high school ability in solving mathematical problems? Based on the research questions, the general purpose of this study is to describe the critical thinking skills of male students of eighth grade junior high math ability in solving mathematical problems.

2. Review of literature

2.1 Thinking
Thinking is an internal mental processes that build and operate the mental representation of information. This is in line with the statement Solso, thinking is defined as the process of generating a new mental representation, through the transformation of information that involve complex interactions between mental attributes such as ratings, abstraction, reasoning, imagination, and problem resolution. Based on some of the above opinion, thinking is required in decision making and problem solving[7]. Thus, in this study is meant to think is all mental activity can be observed from the behavior that appears in the form of statements and results of problem resolution.

2.2 Critical Thinking
Critical thinking is no cynical skepticism [6]. Critical thinking is an open-minded without vacillating. Critical thinking is analytical thinking. Critical thinking is judging without judgment and strong without dogmatic. Critical thinking skills is the main interpretation (interpretation), analysis (analysis), evaluation (evaluation), inference (inference), explanation (explanation), and self-regulation (self-regulation). Interpretation means to understand and express the meaning of a variety of experiences, situations, data, events, assessments, conventions, beliefs, rules, procedures, or criteria. Analysis of means to identify the purpose and the true relationship between statements, questions, concepts, description, or other forms of representation of the other, is intended to express the conviction, judgment, experience, reason, information, or opinions. Including checking ideas, detecting arguments, and analyzing arguments as a sub-analysis skills. Evaluation means assessing the credibility of statements or other representations, intended to reveal the perception, experience, situation, judgment, belief, or
opinion of someone, to assess the strength of logic, purpose and the true relationship between the statements, descriptions, questions or other forms of representation. Inference means to identify and secure elements needed to withdrawal reasonable conclusion; to form conjectures and hypotheses; to consider the relevant information and the consequent data, statements, principles, evidence, judgments, beliefs, opinions, concepts, descriptions, questions, or other forms of representation to another. Explanation (explanation) means capable of reassuring things and the way that is coherent with the results of reasoning. This means to express and justify reasoning in terms of evidence, the conceptual, methodological, criteria, and contextual based on the consideration, and to present one's reasoning in the form of a convincing argument. Self-regulation means self-awareness to monitor the activities of a person's cognitive, elements that are used in these activities and the results, particularly by applying skills in analysis and evaluation of the self-assessment with a view to asking, confirm, validate, or correct any of the results or reasoning someone.

2.3 Problem Solving and Critical Thinking Skills
Problem solving is an attempt to find a way out of the difficulties in order to achieve a goal that is not so easy to be reached soon. Polya (1985) proposed four steps to resolve the problem, which is to understand the problem, problem-solving strategies to plan, the implementation of problem-solving strategies, and check back all the steps that have been undertaken [8]. Phase understand the problem, without any understanding of the given problem, students may not solve the problem correctly, then the students should be able to plan problem-solving strategies. Completion of the problem, in this phase is very dependent on the student experience more creative in preparing the resolution of a problem, if the plan for settlement of the problems has been made either in writing or not. The next step is the student is able to solve the problem, in accordance with the plans that have been prepared and considered appropriate. The final step of the process of resolving the problem by Polya is checked back all the steps that have been done starting from the first phase up to the third phase. With this model it is unnecessary errors occur can be corrected so that students can find answers that really correspond to a given problem.

Relationship between problem solving and critical thinking skills can be presented with the table 1.

| No. | problem-solving steps          | Critical Thinking Skills                        |
|-----|--------------------------------|-------------------------------------------------|
| 1   | Understanding the problem      | Interpretation:                                  |
|     |                                | - categorization                                 |
|     |                                | - decode                                         |
|     |                                | - clarification of meaning                       |
| 2   | Devising a plan                | Analysis:                                        |
|     |                                | - Examination of ideas                           |
|     |                                | - Identification of the argument                |
|     |                                | - Analysis of arguments                          |
|     |                                | Evaluation:                                      |
|     |                                | - Assessment of the claim (statement)            |
|     |                                | - Evaluation arguments                          |
| 3   | Carrying out the plan          | Inference:                                       |
|     |                                | - Questioning the claims                         |
|     |                                | - alternative thinking                          |
|     |                                | - drawing conclusions                           |
|     |                                | - problem solving                               |
|     |                                | - decision making                               |
Relations troubleshooting steps with critical thinking skills in Table is a reference to see the critical thinking skills of students in solving problems of critical thinking math problems. The components contained in the table is used to assess students’ critical thinking skills in mathematics.

3. Research Methods

The purpose of this study was to describe the critical thinking skills of male students in class VIII SMP in solving mathematical problems. Based on the object of obtaining a description of the critical thinking skills of male students of class VIII junior high math ability in solving mathematical problems. To accomplish this use of qualitative research. Qualitative research approach used in order to understand the phenomenon of what is experienced research subjects holistically at a special natural context and look at what is behind the symptoms that occur.

This research was conducted in the Luqman Al Hakim Junior High School of Surabaya. Selected junior high school students of eight grade to this consideration, the first based on the age of students is currently on a formal level, so being able to think more abstractly to produce answers that are critical, both students at this level have sufficient knowledge and experience in the materials basic math, because it has been past the primary school level in which there are materials, such as numbers, shapes geometry or other forms of algebra, and three students at this level is still the basic education level, so that the results of the exploration level of critical thinking this could be the foundation or guidelines for the next education level.

Based on the opinions expressed previously, that the cognitive abilities influential in the way of thinking to solve mathematical problems, researchers found critical thinking skills in mathematical problem solving was also influenced by the mathematical skills of students. With this study, researchers wanted to know how critical thinking skills in male students with high math skills. Thus, in this study the researchers classify subjects into three groups: subjects with mathematical ability is high, medium, and low.

Techniques used in the selection of subjects is sought subjects who meet the criteria based on the results of mathematical ability Mathematical Ability Test (SMEs) and subjects that can communicate the idea clearly and allow the (potential) explore critical thinking skills. Selection of subjects starting from the highest level and then the lower level. Subjects selected based on the ability of mathematics math skills test results compiled by the researchers themselves. The questions were given to the test, the matters relating some of the material has been obtained prior to the study testing. For your consideration, note also the result of the average daily in learning mathematics in the classroom according to information (information / data) math teachers concerned. Based on test results obtained mathematical skills and a few other considerations that have been mentioned above, students were grouped into three groups: high, medium, and low.

Subjects were eight grade junior high school. Selection of research subjects is done by selecting a male subject with high math skills by comprehension mathematical abilities test.

Data collection instrument in this study is the researchers themselves, while supporting instruments are (1) Tests of mathematical ability (2) issues critical thinking math problem and (3) Guidelines for interviews: interviews conducted in this research is interview-based problems, which do by means of subjects given the task of writing and given time to finish it. Afterwards, subjects were interviewed
based on the work already done. During the interview conducted with the assistance handycam observation. Purpose of the interview is to investigate the process of critical thinking of students who do research subjects in solving critical thinking mathematical problems. Through interviews are expected to explore and reveal the students' critical thinking skills. Methods of data collection in this study is Critical Thinking Problems Math (CTPM) and in-depth interviews (in-depth interviews) based CTPM. After the data collected is then performed checking the validity of the data with (1) a test of credibility, that is the truth test data obtained or known as the internal validity, (2) the reliability test, the test of consistency or constancy of data obtained using triangulation of time, (3) transferability test or external validity testing is not done, since the research findings are not generalizable, and (4) confirmability test or test of objectivity will be fulfilled by itself, when the internal validity of the study are met.

Furthermore, after the data is valid, then the data analysis that includes categorization / classification of data, data reduction, data interpretation, and conclusion.

4. Conclusion and Discussion

4.1 Conclusion

The results showed that the critical thinking skills of eighth grade students of junior high math ability in solving mathematical problems are as follows:

Phase 1: Understanding the problem

At this stage used interpretation skills characterized by the presence of sub-sub-indicators: categorization, decode, and clarify the meaning. Categorization: disclose information, description, statement, or the required data related to the problem posed. Decode: read the statement, information or data are required and can express what they know and ask related problems presented. Clarification of meaning: expressing or clarifying statements, information or data related to the problem posed.

Phase 2: Planning Problem Solving Strategies

At this stage of Strategic Planning Problem Solving use skills of analysis: examination of ideas, arguments identification and analysis of the arguments and skills evaluation: assessing arguments. Examination of ideas: expressing arguments and descriptions that will be used to make a claim concerning the issues raised, only on the problem with a critical question: "What's wrong?", And the problem with a critical question: "Assess whether the statement ... What do you think about ... ? ", while the problems with critical questions" that meet certain conditions "does not appear. Identification arguments: declare the arguments or the basics need making a conclusion concerning the issues raised, only on the problem with a critical question: "What's wrong?", And the problem with a critical question: "Assess whether the statement ... What do you think about ... ? ", while the problems with critical questions" that meet certain conditions "does not appear. Analysis arguments: declare the arguments or the basics of calculations related to the problems posed needed in making a conclusion on the next step is implementation-related problem-solving strategies. Assessing argument: states convinced of the veracity arguments concerning the issues raised and expressed confidence once with the conclusions made, after some time the calculation process.

Phase 3: Implementation Strategies Problem Solving

In this stage used the skills of inference: inference, and problem solving skills and an explanation: the presentation of the problem, justification of procedures, and the articulation of the argument. Conclusion: propose drawing conclusions based on the analysis of available information on the problem and based on the results of calculations related to the problems posed. Problem Solving: mention the additional information needed to resolve the problems.
Presentation of the problem: explain the relationship between the information contained on the issue and the interpretation on the matter referred to convincing arguments used in the conclusion.

Justification procedure: explain the steps taken to find solutions to the problems posed answer.

Articulation argument: explain arguments or reasons answers used in drawing conclusions related to the problems posed.

Phase 4: Looking Back All Steps Have Done

In this stage the use of self-regulation skills characterized by the presence of sub-sub-indicators: self-correcting and self-study.

Proofreading yourself: revisiting the calculation and the results of analysis that has been done before taking a final decision. At problems with a critical question: "What's wrong?" The students aware of miscalculation, and can fix it up properly.

Research myself: On the issue of "who meet certain conditions with a solution of more than one" describes how well the method used, but on three other issues critical thinking skills that do not appear.

4.2 Discussion

Based on the conclusions of this research there are several suggestions submitted:

1. Based on the results of critical thinking skills "alternative thinking" appears on male students with high math skills. Based on this, the teacher in the classroom needs to develop in solving mathematical problems allow students to use the skills "alternative thinking". Thus the critical thinking skills "alternative thinking" can develop better in all students.

2. Based on the research skills of analysis with sub indicators argument analysis and identification of optimal arguments appear in male students with high math skills. Based on the researchers gave suggestions for teachers in the classroom in order to provide more opportunities for students to put forward an argument either orally or in writing. For example in learning more discussions about mathematical problems in it requires a lot of arguments in solving the problem.

3. Problem of critical thinking with critical questions that "meets certain conditions" and likely to bring a lot more than one correct answer, provide opportunities for students raises critical thinking skills optimally. Based on the research of male students with high math skills can be optimally achieve it. With that researchers gave suggestions for teachers in the classroom to give students the chance to get more variations of critical thinking math problems, so that all critical thinking skills can be achieved optimally.

5. References

[1] Ennis R 1992 Critical thinking: What is it? Proceedings of the Forty-Eighth Annual Meeting of the Philosophy of Education Society Denver, Colorado, March 27-30. Retrieved from http://www.ed.uiuc.edu/PES/92_docs/Ennis.HTM.

[2] The Partnership for 21st Century Skills 2009 P21 Framework Definitions Retrieved from http://www.21stcenturyskills.org.

[3] Huit W 1998 Critical thinking: An overview. Edu Psy Int. Valdosta, GA: Valdosta State University. Retrieved from, http://www.edpsycinteractive.org/topics/cogsys/critthink.html.

[4] Krulik S and Rudnick J A 1999 Innovative Tasks to Improve Critical and Creative Thinking Skills. In Stiff L V and Curcio F R (eds) Developing Mathematical reasoning in Grades K-12. 1999 Year book (Reston: The National Council of teachers of Mathematics, Inc.) pp.138-145

[5] Ismail 2012 Laporan Pelaksanaan Kegiatan In-House Training Peningkatan Mutu Pembelajaran SMP Mata Pelajaran Matematika Di Kab. Ponorogo 2012. Surabaya: Jurusan Matematika FMIPA Universitas Negeri Surabaya

[6] Facione PA 2011 Critical thinking: What It Is and Why It Counts. Retrieved from http://www.insightassessment.com/padaf files/what & why98.padaf.

[7] Solso R L 1995 Cognitive Psychology (Boston: Allyn and Bacon)

[8] Polya G 1985 How To Solve It 2nd ed (New Jersey: Princeton University Press)