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## THE PROFILE OF CRITICAL THINKING OF SENIOR HIGH SCHOOL STUDENTS IN MATHEMATICS PROBLEMS SOLVING: INTERMEDIATE MATHEMATICS SKILLS

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### ABSTRACT

The aim of this research was to describe the profile of critical thinking at Senior high school students in mathematics problems solving with intermediate Mathematics skills. This is a qualitative-exploratory research conducted at SMA Negeri 1 Semarang by using one student as a subject, with intermediate mathematics skills. The profile of critical thinking research subjects with intermediate mathematics skills was conducted through steps as follows: (i) *understanding the problem*, at determination step the subject can mention all data, the subject has been expressed clearly and in detail. In the decisive step in question is using the right information, so that the subject can mention the subject matter thoroughly and carefully, (ii) *the plan of problem solving*, the first subject can reveal the facts of the matter are provided with appropriate and justify appropriate capabilities previously. Second, in planning the steps that will be used to resolve the issue, the subject of research suggests gradual steps, but not yet detailed and accurate. Third, in revealing the definition or rules in order to solve the problem has been done properly and systematically, yet not exhaustive and detailed, (iii) *carrying out the solution*, the first step of selecting the method or steps that had to do with precisely known. Second, when revealing the definition or rules to resolve the problem, the subject and do not have trouble remembering the rules of trigonometry known before. Third, in carrying out the calculation profile, the subject can work correctly after doing the calculations made outside the plan, (iv) *re-examine profile*, first the subject has not been an evaluation of the steps that have been made carefully, because the subject just re-read the steps one by one. Second, the study subjects believed that the final answer is correct, for rereading, although the subject of count back at simplifying the comparison of two numbers. Third, the study subjects were not able to draw conclusions based on reason.

**Keywords:** critical thinking, mathematics problems, mathematics skills

### Introduction

The mathematics learning at school, is expected to provide structuring reasoning, critical thinking, the formation of students' attitudes and able to apply in his daily life or to study the other multi-knowledge (Depdiknas, 2006). Thus, the profile of learning mathematics at school has objectives to develop certain thinking skills so as to develop and evaluate information in a mathematics problem solving. One of the thinking skills that must be developed is the ability to think critically. Therefore, the profile of students' critical thinking became interesting part to be known early.

A student is said to have the ability to think critically, if he has a systematic way to think, consciousness in thinking, and has the ability to distinguish whether something is true and false. However, the profile of the critical thinking, is not easily known only by result in answering the teacher questions either written and oral.

Critical thinking skills is one of the authorized capital or intellectual capital which is very important for everyone and its become a fundamental part of human maturity (Depdiknas, 2006). Therefore, the development of critical thinking skills is very important for students at every education level and this ability is one of thinking skills that can be developed through the profile of learning mathematics at school. Andrew P. Johnson (2002), gives an example of critical thinking and its mind frame as a representation of a specific cognitive profile that is created in specific steps and used to support the thinking profile. This mind frame is used as a thinking guide for the students when they learn a thinking skill.

According to Nickerson. 2002, Ennis. 1995, Gokhale, 1995, the profile of critical thinking is characterized by ability to: (1) identify the facts clearly and in detail; (2) formulate the problem issues thoroughly and carefully; (3) implement a method that had been studied in detail and systematically, (4) reveal the definition or formula to resolve the problem in detail and precisely; (5) decide and do the plan correctly, (6) evaluate the solution of a problem thoroughly, and (7) draw conclusion based on the right reasons. If that profile is associated with solution of mathematical problems at school, then the profile (1) and (2) can be used to determine a question (to be searched). Profile (1), (3), and (4) is used to plan the completion of a problem and implement a plan. While the profile (6) and (7) is used to check the results that have been obtained.

Associated with math problems, Marpaung (2006) said that generally, the mathematical problem can be divided into three kinds, namely the problem of searching, the problem to prove, and problem to asses and find the mistake. Their differences are very clear. The problem of searching is the type of problem that the purpose will be searched and require a profile. The problem to prove is a problem with determined purpose but still requires a profile. While the problem of assessing or finding fault is a problem that purpose and profile have been determined. In this research, we focus at problem to find in the material trigonometry. This is in accordance with the opinion of Polya (1973) who said that, there are two kinds of problems, namely the problem of finding (problem to find) and problems to prove (problem to PROVE). In this research, we focus at the first type namely problem to find.



The problem solving, either to find and to prove is very important thing and needs to be studied. Through problem solving, students become expert to identify, to select the relevant knowledge, to organize skills already possessed, to plan, and make generalizations. However, in mathematics learning at high school, solve mathematics problems can not be done quickly and easily. Students need thought line of critical thinking skills.

The ability to solve mathematics problems influenced by several factors, either internal and external factors. Internal factors include: intelligence, motivation, interests, talents, and math skills as well as differences in gender. External factors, among others: facilities, infrastructure, media, curriculum, teachers, learning facilities, and so on. Siswono (2008) says that students who have different backgrounds and mathematical abilities, also has different ability to solve mathematics problems. The students ability especially related to math skills in a class usually divided into three groups, namely high, medium, and low ability.

The research results Nurman (2008), found that the ability of a student's math affect to mathematics problem solving abilities. Students with high ability have high ability in solving mathematics problems, the ability in solving mathematics problems is quite good for students with medium ability, and the students with low ability have less ability in solving mathematics problem.

The profile of critical thinking can provide accurate guidance in thinking and solving a problem, and also help to determine relation each other more accurately. Therefore, the profile of critical thinking is needed in solving the problem or search problem solution (Siswono, 2007). In addition, the profile of critical thinking is an integrated mental activity of some components, such as the observation (observation), analysis, reasoning, judgment, decision making, and persuasion. If someone has a good ability to integrate these components, then he has a better ability to cope problems that are more complex and with satisfactory results. In accordance with the purpose of mathematics learning at high school, namely as a means to train students to think logically and based on mathematical characteristics, which are closely related to the definition-theorem with strict axiomatic deductive structure, then high school students are expected to have a logical reasoning ability to be used as a preparation to answer questions or solve mathematics problem.

Consideration to select high school students as research subjects are as follows: First, the age of high school students if it is associated with the stage of intellectual development in the view of Jean Piaget (Nur, 1991: 3) has been on formal operation stage. Second, formal reasoning characterized by thinking about abstract ideas, organize ideas,

reason about what will happen. At this stage if the students are exposed to problem, then <sup>1</sup> students can formulate conjectures or hypotheses and then deduce consequences based on the allegations or the hypotheses.

Based on explanation above, it can be said that theoretically, child at formal operation stage have the reasoning ability to learn high school math materials, include solving mathematics problems. And focus of this study is to investigate the profile of students' critical thinking in solving mathematics problems. A statement in elementary mathematics and further mathematics must be shown a coincidence (verification), and requires an explanation of why the statement was true (explanation). Thus, in mathematics learning, solve mathematics problem is very necessary at every education level, especially for high school students.

Based on the high school math learning goals mentioned above, one of them is expected that students have the ability to think critically and creatively, so we need study deeper on the profile of critical thinking for students with medium mathematics skill.

Based on explanation above, question <sup>1</sup> in this research is how the profile of high school student critical thinking in solving math problems with medium mathematics skill?

Based on the question above, <sup>1</sup> the purpose of this research is to describe the profile of high school student critical thinking in solving math problems with medium mathematics skill.

## Method

<sup>3</sup> This research is explorative research with qualitative approach which tried to look for the essence behind the happened symptoms at research subject. It means that the purpose of this research is to reveal profile of students thinking namely profile of critical thinking in solving math problems with medium mathematics skill.

This research was conducted at high school for level XI students, by the reason : (1) they are on medium stage so they can solve mathematics problems, (2) they have enough knowledge and experience before, because they had passed elementary and junior high school. So this research can be used as a guidance to next stage.

The selection methods of research subject by tiered method based on mathematics ability with essay test on mathematics national examination of the material that has been studied by research subjects. Subjects was searched according to determined criteria and





satisfy criteria of critical thinking profile in solving mathematical problems. Subjects were selected based on a student with medium mathematics abilities.

The main instrument in this study is the researcher himself, because at the time of data collection in the field a researcher act as data collectors during the research profile. Then proceed with depth interview by using an interview guide. In addition, there is a task sheet instruments in this study in the form of a mathematical problem namely a set of mathematics test in a form of mathematics problem.. The test instrument which is used to determine the mathematical ability is a test that had already standard, and interview guides which is used to guide the interview.

Research data collection was conducted by giving students math problems related to high school math material. The results are used as the basic of interview which is used to obtain description of the students critical thinking profile. Furthermore, the collected written and verbal data result (data from interview) was examined its provisions or its consistency. If there is inconsistent data, then we repeat interview again so we obtain data which appropriate with research question.

Qualitative data analysis carried out at the time of collection profiles, this means the data analysis can be done since the first moment of data collection in the field and ends at the time of preparation of research reports. This is in accordance with the opinion of Muhajir (2002) suggested that data analysis is an attempt to locate and organize systematically record of observation results, interviews, and other research to improve understanding about the studied cases and serve as an useful innovation for others. In this study, data analysis performed during and after data collection profiles, with the intention that the obtained data can be systematically arranged and easier to interpret. Analysis of qualitative data is divided into three stages of activities, namely: data reduction, data presentation, and conclusion.

## Result and Discussion

*Result.* The exposure and analysis of high school students critical thinking profile in solving mathematics problems for medium mathematics ability subject are presented from understanding the problem, problem-solving plan, the implementation of problem solving and check back.

Based on the interview transcript result, that the subject of research in understanding the problem can be summarized as follows: (a) after reading the issue, the subject declare carefully and precisely overall, and (b) the subject proposed subject matter (what is being asked) carefully and precisely

Excerpts of the interview with the research subject is presented as follows:

- 1 P1 Have you read this problem carefully?
- 2 J1 Yes sir. I have
- 3 P2 Lets explain, what are you thinking after you read it?
- J3 Yes sir, According to my opinion, from this problem we get :
- three numbers direction  $A-B = 40^\circ$
- three numbers direction  $B-C = 160^\circ$ .
- Velocity  $A-B = v$  km/jam
- Velocity  $B-C = 2v$  km/jam;
- Distance  $A-B = 100$  km
- Distance  $A-C = 150$  km
- The question is comparison between time  $A-B$  dan  $B-C$ .
- $D_1 : A \rightarrow B : 40^\circ, v \text{ km/jam}$   
 $B \rightarrow C : 160^\circ, 2v \text{ km/jam}$
- $S_{AB} : 100 \text{ km}$   
 $S_{AC} : 150 \text{ km}$
- $D_2 : t_{AB} : t_{BC} ?$

The results of interview transcript in problem solving plan can be summarized as follows: (a) subject had not been complete to propose used steps to solve the problem, there are still some steps that have not been proposed and (b) subject proposed definition or used formula to solve the problem precisely, but uncomplete. Nevertheless, subject can complete it back after getting a stimulus in the form of questions from researcher.

From the work result of the research subjects, it can be summarized that the subject in executing the settlement of the problem as follows: (a) the first step is creating the image, (b) a second step is determining the value of  $\sin C$  with a sine rule and determine the value of  $\cos C$  by comparison of triangle side, (c) the third step is determining the angle  $A$  and





proceed to determine the value of  $\sin A$  by sinus summation formula, and (d) fourth step is determining the length of BC with a sine rule.

Based on a interview transcript with related subjects related by re-examining, it can be concluded as the following: (a) the subject had not been evaluated about the undertaken steps in solution using the right reasons, because the subject just re-read the steps that had been undertaken and (b ) the subject believe that the answer is correct by reason of the used formula had been correct and arithmetic operations are performed well too.

*Discussion.* Discussion of high school students critical thinking profile with medium mathematics ability in solving math problems being guided by critical thinking indicators and associated by using problem solving steps based on Polya namely: the first phase is understanding the problem, the second phase is planing mathematics problem solving, the third phase is implementing the solving plan , and the fourth phase is re-examining the profiles and results of problem solution.

The profile of students critical thinking for the subject to understand the problem as follows: identify the facts that are given clearly and in detail, and formulate problem issues thoroughly and carefully. This means that the subject has been able to linking the available information with previous knowledge which had been possessed by research.. The subject's response to this aspect in accordance with the opinion of Hergenhahn and Olson (2009), which said that a person responds to the world based on previous experience, but every experience includes different aspects of the experience that before. By assimilation allows one to respond to the present situation in accordance with previous knowledge. Similarly profile of students' critical thinking is a mental experience that connects between one object with another object.

The initial step of the subject makes picture gives reason to determine the elements of the triangle so he can determine the trigonometry rules that will be used. Thereby indicating that the subject is able to give reasons according to ability has ever had before. This is in accordance with the opinion of Piaget (Brooks & Brooks, 1993) which said that: in the assimilation, the stimulus is interpreted based on a scheme that is owned by someone. If the stimulus is entered suitable with the existing scheme, then one can respond to the stimulus directly. Thus the subject is able to plan the used steps to solve mathematics problems in detail, systematic, and accurate. The used steps by the subject of this study suitable with the opinion of Bakley (1990), which said that , (1) in solving the problem someone connecting existing information in question with previous knowledge, and (2) one can choose the right strategy. If it is associated with critical thinking indicators, then we obtained a description as



follows: (1) the subject can reveal the facts of a given problem correctly and can provide reasons appropriate with previous ability, (2) in planning the steps that will be used to solve the issue, the subject propose his steps systematically and in detail, but it has not been complete, and (3) in revealing the definition or rules in order to solve the problem have been done correctly.

In carrying out the math problem solving, the subject did not find any difficulties. This is due to the subject already has knowledge of a concept or knowledge required in mathematics. From the calculations, there is one interesting point, which is when determining the value of  $\sin A$  by using the formula the sum of two angles and begins by searching the angles  $A$ . If we associated with critical thinking profile, it can be concluded that the subject in selecting methods ever known can be done properly. In revealing used concepts or rules to solve the issue, by considering rules that have been previously known. Thus the students critical thinking profile stage in implementing the problem solution plan as following: (1) at the stage of completion of the implementing solution steps detailed and systematic, but incomplete, (2) in applying the definition or formula in accordance with the made plans, there is only one unplanned formula, (3) at the stage of deciding and carrying out, the order process is systematic, and (4) the obtained final results is true.

The subject profile in Re-examine have not been implemented in full and detailed, this indicates that the profile of students critical thinking in re examining still steady. In re examining the steps of completion, subject only re-read by remembering used rule. Likewise in re-examining the results of the calculation only done by recalculating. Although the subject states that it is done at every step, but only read it without linking with the owned knowledge. So understanding the subject to examine steps just means re-read, and the subject said that the work is believed to have been correct. If the above description is associated with students critical thinking profile namely evaluate steps of problem solution with a detailed and thoroughly, then the subject has not been evaluate both the steps and the completion of the final calculation result thoroughly. The subject has believed the steps of completion and the final answer simply because it has been re-read. Likewise, the subject had not taken conclusions based on valid reasons. This can be seen in the interview that the subject was believed the happened answer without giving clear reasons.

### Conclusion

Critical thinking process for medium mathematics ability subject can be summarized as follows :



<sup>3</sup>  
*Understanding the problem:* (1) identify the facts that are given clearly and in detail, (2) formulate the problem issues thoroughly and carefully.

*Planning Problem solution:* (1) identify the facts that are given clearly and in detail, (2) planning steps that are used to complete a detailed, systematic, accurately, and (3) reveal a plan definitions or formulas in solving mathematics problems in detailed, systematically, and precisely.

*Implementing problem solution:* (1) implement steps to solve the problems in detail, systematically, accurately, (2) apply the definitions or formulas in solving mathematics problems in detail, systematically, precisely, (3) determine and implement correctly, and (4) determine the final outcome in solving a problem precisely

*Re examining:* (1) evaluate the steps in solving a math problem in detail and carefully, and (2) take the conclusion had not been based on the right reasons.

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