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## STAGE OF CRITICAL THINKING ABILITIES IN SOLVING MATHEMATICAL PROBLEMS FOR PROSPECTIVE TEACHERS DEPARTEMEN OF MATHEMATICS FMIPA UM MALANG

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### Abstract

Critical thinking is a way for someone to improve the quality of the ideas using techniques systematization way of thinking and intellectual thinking in generating ideas initiated. The level of critical thinking abilities of each person is different and the differences in learning mathematics can be seen as a level that starts from the lowest level to the highest level. But in reality, research related to stage of critical thinking for assessment in mathematics instruction are valid and reliable, has not been developed by mathematics education experts. Thus, this research seeks to formulate stage of critical thinking abilities in solving mathematical problems. Stages of development of critical thinking start from the lowest are: unreflective thinking, challenged thinking, beginning thinking, practicing thinking, advanced thinking and master thinking. Critical thinking which will be observed and studied are the elements of reasoning: purpose, questions, assumptions, point of view, information, concepts and ideas, interpretations and implications by using a standard of intellectual reasoning which include: clarity, accuracy, precision, relevance, consistency, significance, logicalness, depth, breadth and fairness. This stage, that related with critical thinking abilities, describes thinking strategies generally, not only in mathematics. The developed level provide evidence of the degree of hierarchical (sequential) in critical thinking. This research is a qualitative research aimed to formulate stage of critical thinking abilities in solving mathematical problems are valid and reliable, find and identify the characteristics of students' critical thinking stage for each of these levels. The research's subjects were prospective teachers of Mathematics Department, State University of Malang, using the snowball method. Steps of research stage of critical thinking abilities, the steps as follows: formulate initial theory about the level of critical thinking abilities based on the study of theory supported by empirical data, draft Validating theories about the level of critical thinking abilities in an expert to determine the validity and construct a theory developed, doing pre-research to prove the existence of the level of critical thinking abilities, revise draft theory about the level of critical thinking abilities, Perform data collection to determine the existence of the level of critical thinking abilities, Perform data analysis. Researchers initially formulating the criteria of critical thinking abilities are theoretically that consists of 5 levels starting from the lowest levels: level 0 (not critical), level 1 (less critical), level 2 (critical enough), level 3 (critical) and level 4 (very critical). For the lowest level, which is unreflective thinking (thinking that is not reflected) can be compared with the level 0 (not critical), challenged thinking (thinking that challenged) can be compared with the level 1 (less critical), beginning thinking (thinking starters) can be compared with level 2 (critical enough), practicing thinking (thinking exercises) and advanced thinking can be compared with the level 3 (critical), as well as a master's thinking can be compared with the level 4 (very critical).

**Key words:** stage of critical thinking, critical thinking criteria, elements of reasoning, intellectual standards of reasoning, and mathematical problem solving.

### INTRODUCTION

Critical thinking skills are essential skills for life, work, and function effectively in all other aspects of life. Critical thinking skills are important because they allow students to deal effectively with the problems of social, scientific, and practical. Simply put, students are able to think critically

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*This paper has been presented at Sriwijaya University Learning and Education-International Conference 2014. Faculty of Teacher Training and Education, Sriwijaya University, Palembang, May 16—18, 2014.*



are able to solve problems effectively. Just have not sufficient knowledge or information. To be effective in the workplace (and in their personal lives), students should be able to solve the problem to make effective decisions, they must be able to think critically. Critical thinking is a complex concept that involves cognitive skills and affective dispositions, and this has affected the way some teachers give concepts to students.

Critical thinking takes effort for someone to gather, interpret, analyze and evaluate information for the purpose of arriving at the conclusion that reliable and valid. In Mathematics learning in schools, critical thinking needs to be integrated and emphasized in the curriculum so that students can learn the skills and apply them to improve their performance and reasoning abilities. In this context, if the teacher is supposed to instill critical thinking skills for learning mathematics in their classroom, the teacher education programs should also allocate more to critical thinking exercises so that prospective teachers will be the model of strategic thinking which in turn will make it easier for subjects the students.

The ability to think critically is a competency that must be trained to the students, because these skills are necessary in life. Besides the ability to think critically is a thought process that is acceptable sense reflective directed to decide what is done or believed. With the students' critical thinking can also make the best conclusion. The importance of critical thinking skills for students are often not empowered by teachers in exploring the cognitive abilities of students, the teacher should help students to develop critical thinking skills in solving mathematical problems.

### **Theoretical Background**

Critical thinking is a form of high-level thinking is widely used in daily life. Learn about the critical thinking skills of students, the teacher is very important, because the activity of critical thinking is to evaluate the conclusions based on the testing of an issue, event or solving problems logically and systematically. The importance of critical thinking skills can not be separated from the expectations of Curriculum K-13, that wants students to have a power capable of critical thinking skills, so that the output will be generated will really be able to develop soft skill. However, often there are critical thinking skills in students often are not empowered by the teachers in exploring the cognitive abilities of students.

According Halpen (2007), is to empower critical thinking skills or cognitive strategies for goal setting. The process through which after setting goals, consider, and refer directly to the target-is a form of thinking that needs to be developed in order to solve the problem, formulate a conclusion, collect a variety of possibilities, and make a decision when to use all these skills effectively in the context and the appropriate type. Critical thinking is also an activity-evaluate the conclusions that will be taken into account when determining several contributing factors to make a decision. Critical thinking is also commonly called directed thinking because thinking directly to the focus that will be addressed.

According to Johnson (2002), defines critical thinking is a focused and clear process used in mental activities such as solving problems, making decisions, analyzing assumptions and conduct scientific research. Similar opinion was also expressed by Anggelo (1995), applying critical thinking is a rational activity, high thinking activities that include analyzing, synthesizing, and solutions know the problems, deduce and evaluate. According to Mason (2008), critical thinking associated with the thinking that is based on specific skills, such as the ability to judge right or reason to consider relevant evidence or to identify a false statement. According to Paul and Elder (2005), critical thinking is a way



for someone to improve the quality of the ideas using techniques systematization way of thinking and intellectual thinking in generating ideas initiated.

Scriven (1996) Critical thinking is an active process and full intellectual skills in making definitions, concepts, application analysis, synthesis and evaluation made. According to Cottrell (2005), critical thinking is a cognitive activity associated with the use of the mind. Learning to think in an analytical and evaluative means using mental processes such as attention, categorization, selection and assessment.

According, Krulik, Rudnick. (1995) Critical thinking is the inspection / testing, relating, and evaluating all aspects of a situation or problem, focusing on the parts of a situation or problem, collect and organize information, validate and analyze information, and associate recall previously learned information , determine the reasonableness of answers, draw conclusions valid, analytical and reflective. Furthermore, Krulik, Rudick, Milou, (2003), critical thinking is the ability to analyze a problem, check the completeness of the data to resolve the problem, decide whether there is any additional information on the problem and analyze the situation. Ennis (1996), there are 12 identified indicators may help to think of a critical analysis of ideas, namely: meaningful, clear, consistent, logical, meticulous, follow the rules, careful, thoughtful, relevant, produce, well defined and correctly. Of the 12 indicators grouped into 5 groups, are:

- a. Provide a simple explanation contains: focus question, analyze and ask and answer questions.
- b. Build basic skills consisting of: consider whether the source is reliable or not, and observe, consider an outcome.
- c. Summing comprising: activities considering the results and make a value judgment. d. Provide further explanation.
- e. Set up strategies and techniques.

Based on the above description, the critical thinking that is intended in this study, is cognitive empowerment in achieving goals which include activities to identify problems and solutions, analyzing which includes (observe, test, associate, decided wisely), synthesize, summarize and evaluate.

A student will be able to answer the critical thinking problems in learning well, will think clearly and precisely. Also, it can use an abstract idea to be able to create a model of effective problem solving. Some of the things that is characteristic of critical thinking itself are:

- (1) Being able to make conclusions and solutions that are accurate, clear, and relevant to existing conditions.
- (2) Open Thinking systematically and have assumptions, implications, and consequences are logical.
- (3) Communicate effectively in solving a complex problem.

From some of these opinions, it appears the equation in terms of systematic thinking that turned out to proceed. Critical thinking must go through several stages to arrive at a conclusion or judgment. Emphasis on the process and stages of thought expressed also by Scriven, critical thinking is an active process of intellectual and full of skill in making sense or concept, applying, analyzing, making synthesis, and evaluation. All of these activities is based on observation, experience, reasoning, judgment, and communication, which will guide in determining the attitudes and actions.

Critical thinking is critical thinking mathematically in the field of mathematics that involves the knowledge of mathematics , mathematical reasoning , mathematical proof and mathematical

problem solving. Based on the definitions of critical thinking are presented by experts in the above, in this study, the researcher will classify indicators of critical thinking mathematically classified into three indicators of critical thinking, namely :

- (1) Analysis includes: identifying the facts given clearly, formulate problem issues carefully, exposing the data / definitions / theorems to solve problems correctly.
- (2) Set strategies and techniques include: determining , implementing methods / ways been studied accurately in order to resolve the problem.
- (3) Evaluation includes: evaluating the arguments that are relevant in the resolution of a problem thoroughly, giving logical reasons, make conclusions and distinguish between logical conclusions based on valid or invalid.

Furthermore, to assess whether a person is a critical thinker students including a good or a less critical thinkers, then according to Facione (2013) can be seen from the skills to interpret, analyze, evaluate and conclude, explain what he was thinking and making decisions, applying the power of critical thinking to myself and improve critical thinking skills to the opinions he made. Levels of critical thinking skills of each person is different and these differences can be seen as a Leveling starting from the lowest level to the highest level. Paul, Elder (2008), developed a model of critical thinking that includes standards of intellectual reasoning, elements of reasoning and intellectual character reasoning. Further elements of reasoning and intellectual standards of reasoning to assess and measure the level of critical thinking skills in solving mathematical problems, while the intellectual standards used are clarity, accuracy, precision, relevancy, the logic, the depth and breadth. While the elements of reasoning used is information, concepts and ideas, inference and viewpoints.

Elder and Paul ( 2008 ) , states are 6 stages of critical thinking that includes:

1. Unreflective thinking is not aware of the role of thinkers think in life, are less able to judge the thoughts and develop a variety of thinking without realizing it.
2. Challenged thinking is conscious critical thinkers role in life, realizing thinking, quality reflective thinking requires deliberate thought and realize that do often lack but can not identify where deficiencies.
3. Beginning thinking are thinkers began to identify some of the capacity to think, but have limited insight.
4. Practicing thinking is analyzed thinkers thinking actively in a number of areas, but still have limited insight into the level of deep thinking.
5. Advance thinking are active thinkers analyze his thoughts , has an important knowledge on the subject at the level of deep thinking.
6. Masters thinking is a thinker internalize the basic ability to think deeply , think critically and consciously performed using high intuition.

For the lowest level, which is unreflective thinking can be compared with the level 0 (not critical), challenged thinking can be compared with the level 1 (less critical), beginning thinking can be compared with level 2 (critical enough), practicing thinking and advanced thinking can be compared with the level 3 (critical), as well as a master's thinking can be compared with the level 4 (very critical).

.Based on the brief description above, the research questions are:

1. Leveling How critical thinking skills to solve problems math?
2. How does the identification of critical thinking for each level of critical thinking skills?

## **METHOD**

### **The Research classified**

This research is a descriptive qualitative research-which describes events that become the center of attention characteristic levels of critical thinking based on qualitative and qualitative data. This means that this study illustrate or describe events that become the center of attention (characteristic level of critical thinking) based on qualitative and qualitative data. The data generated in the form of words obtained from interviews and writing or numbers obtained from interviews.

### **Subjects Research**

The study subjects were students of prospective teachers Department of Mathematics FMIPA UM Malang. Subject selection techniques with the snowball method (snowball method) is the subject of the next election conducted after analysis of the results obtained from the subjects before. If none of the subjects who met the criteria related to the critical thinking process in accordance with the expected level of ability, then be repeated until the subject obtained. Characteristics of assessing levels of critical thinking skills about the intellectual standards of reasoning against reasoning element in the activity of the teacher candidates completing mathematical problems. Furthermore, to determine the critical thinking leveling selection techniques used by the study subjects using the snowball method (snowball methods), which is the subject of research is sought in accordance with the criteria and be able to communicate ideas clearly and lets meet the level of critical thinking skills. If none of the subjects who met the criteria related to the critical thinking process according to the level of critical thinking skills, it is done repeatedly to get the research subjects.

### **Research Instruments**

The main instrument in this study is the researchers themselves and equipped with instruments math problem and guide the interview. Researcher as the main instrument, so that by the time of data collection in the field researchers participating during the research process and actively follow research activities related to the subject of data collection. Before the interviews were conducted, students were given the instrument a matter of proof. In order sheet instruments math function optimally begins with the first validation by experts, with 2 mathematics education expert.

Stages Leveling critical thinking abilities to follow the steps as follows:

1. Formulate initial theory about the level of critical thinking skills based on the study of theory supported by empirical data. In this step, the researcher examines the theories related to critical thinking, critical thinking measurement standards, establish the initial theory that will be implemented in the classroom to indicate the level of critical thinking skills .
2. Validating draft theory of critical thinking skills at the level of experts to determine the content validity, construct validity of the theory developed and empirically.
3. Conduct research to prove the existence of pre level critical thinking skills.
4. Revise draft theory about the level of critical thinking skills. If the results of the pre- study levels of critical thinking skills prospective teacher are not in accordance with the draft level critical thinking skills, the draft was revised in accordance with the results of pre-research. The formulation of a new theory is called the degree of improvement of critical thinking. The theory is a hypothetical theory developed in this study. .
5. Perform data collection to determine the existence of the level of critical thinking skills. .
6. Data analysis.





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