

Identification Critical Thinking Stages Of Students' Mathematics Education Study Program FMIPA UNNES For Solving Mathematics Problems

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Abstract

This research is qualitative research that purpose to describe critical thinking stages of college students for each level of critical thinking skills in Mathematics Education Study Program FMIPA UNNES for solving mathematics problems. In the clarification, a subject in critical thinking level 0 until level 3 showed the same characteristic that is getting the information in the picture, and be able to create images to get additional information. In the assessment, subjects in critical thinking level 0 just dig a small portion of relevant information, the subject in critical thinking level 1 until level 3 dig most of the information. In the inference stage, a subject in critical thinking level 0 to level 2 only using inductive thinking, subject in critical thinking level 3 using deductive thinking. In the strategy stage, a subject in critical thinking 0 using the analogy or not can come up with strategies employed, subject in critical thinking level 1 and level 2 using the analogy, subject level 3 using his own ideas by looking for relationships in solving problems.

Keywords: critical thinking, the stages of critical thinking, clarification, assessment, inference, strategies , and solving mathematics problem.

I. INTRODUCTION

1. Background

Critical thinking is a mental process that is well organized and play a role in the process of making decisions for solving the problem by analyzing and interpreting data in the activities of scientific inquiry. According to the Association of American Colleges and Universities (in the Office of Outcomes Assessment University of Maryland University College, 2006) there are 6 of intellectual standards that students must possess ie critical thinking, communication skills, quantitative and qualitative literacy, information literacy, cooperation, and integrated learning. Therefore, universities should facilitate critical thinking development because universities graduates must contribute their specific disciplined mastery to society. Institutions are also asked produce graduates who are able to demonstrate or apply high-level cognitive skills for solving problems that are not limited to a particular discipline.

College student of mathematics education study program of Natural Science and Mathematics Faculty of UNNES as a pre-service teacher expected became

mathematician who enjoys math and enjoys teaching math. Therefore, college students need to be equipped with competencies in science, technology, oral communication, working independently, working in teams, think logically, and think analytically. College students should be participate in learning, reasoning, comparing on what is learned with what is already known, completed between what is already known with what is required, and must have the skills. Such skills include problem-solving skills, decision making skills, critical thinking skills, and creative thinking skills. The important thing for solving mathematical problems are process, understanding, reasoning, and methods until produces the correct answer so that students can use critical and creative thinking skills.

The research about the quality of critical thinking skills have been widely applied. McLean (2005) states that the quality of college students critical thinking are low and medium. These results are consistent with research conducted by Bullen, 1998; Kanuka & Anderson, 1998; Hara et al, 2000; and Rose, 2004 (McLean, 2005). Gibson (McLean, 2005) provides clues why research on college students do not show a high critical thinking. The quality of critical thinking will evolve over time ranging from content-based skills toward critical thinking skills and complex, researchers should not apply a high standard, and 4 weeks for researcch so it is not allow the quality of critical thinking of students moving towards a high level. Kurniasih (2009) found that the critical thinking quality of college student in Mathematics Education FMIPA UNNES for solving mathematical problem are not critical and less critical. The research also found that the arrangement of the level of critical thinking skills consists of critical thinking skills level 3 (critical), critical thinking skills level 2 (quite critical), critical thinking skills level 1 (less critical), and critical thinking skills level 0 (not critical).

College student critical thinking stage investigation in online asynchronous discussion have been widely applied e.g Norris & Ennis, 1989; Henri, 1992; Clulow & Brace- Anderson, Govan, 2001; Garrison, Anderson & Archer, 2001; Newman, Webb & Cochrane,1995; Bullen, 1997 (Perkins & Murphy, 2006). But, college student critical thinking stage investigation for each critical thinking level never yet. Whereas, that investigation result can be used for increasing the quality of critical thinking. Therefore, research for identifying characteristic of critical thinking stage for each level of critical thinking must be done. This research try to identify critical thinking stage of college

student of Mathematics Education of Natural Science and Mathematics of Semarang State University for solving mathematical problems as a advanced research of the arrangement of the level of critical thinking skills.

At the time think critically, someone is going through a stage of thinking. Many researcher have theory about critical thinking stage e.g Garrison, Anderson & Archer, 2001; Newman, Webb & Cochrane, 1995; Bullen, 1997, (Perkins & Murphy, 2006). According to Perkins & Murphy (2006) critical thinking through four important stages of thinking ie clarification, assessment, inference and strategy/tactics. Critical thinking stage in this study were the steps of critical thinking that includes the ability for clarification, assessment, inference, and strategies/tactics. Clarification stage includes identify and analyze problems activities. Assessment stage includes choose and connect relevant information/ideas/concepts, connect the information/ideas/concepts of the problems with relevant information/ideas/concepts, connect the problems with previous problems, and assess the reasoning. Inference stage includes develop hypotheses and make conclusions. Strategy/tactics stage includes the use of thinking strategies. Identification critical thinking stage in this study refer to Perkins & Murphy Critical Thinking Stage.

2. Need for the Study

The thinking process of college student for solving mathematical problem was important thing to be analyzed. College student critical thinking can be analyzed by investigation critical thinking stage ie clarification, assessment, inference, and strategies/tactics. The thinking process especially critical thinking can be used for knowing their thinking right or not, and logic or not. The characteristic of each critical thinking stage can be used for knowing what kind of mathematics representation they used to understand and solve mathematics problem, contribute to the knowledge base of teaching and learning as a process in education in general and specifically in the field of mathematics education. Furthermore, findings from this research will inform practicing lecturers of alternative strategies that can be used in the classroom, and help inform lecturer preparation programs as to what instructional strategies should be.

3. Research Question

The research question was how are critical thinking stages of college students in mathematics education study program of Natural Science and Mathematic Faculty of Semarang State University for solving mathematics problems.

4. Purpose of the Study

The purpose of the research was to describe critical thinking stage of college students for each level of critical thinking skills (the result of previous research) in Mathematics Education Study Program of Natural Science and Mathematic Faculty Semarang State University for solving mathematics problems.

5. Benefit of the Study

The benefit of the research are the characteristic of critical thinking stage can used for completely the mathematics learning theory especially the theory that related with development mathematics critical thinking ability, and as consideration for the lecturer to design a model or a learning strategy that can enhance critical thinking skills of college students.

II. RESEARCH METHOD

1. Research Design

The research is a qualitative research that studies about characteristics of critical thinking stage with the main data in written and spoken words. The research tried to reveal the substance of the symptoms that arise from the research subjects. That substance is used to identify critical thinking stage of college students for each level of critical thinking skills. That substance is traced using qualitative methods ie interview-based tasks to each subject. When interviewing, researchers acted as neutral observer, in order that the subject can reveal characteristics of critical thinking stages naturally, clear and minimize the contamination of the mind or the influence of the interviewer.

Data taken in accordance with the reality that occurred in the study (natural background). Researchers involved and interact with students who become research subjects when learning in the classroom directly.

The collected data is descriptive, ie the actual explanation about characteristics of critical thinking stage college students. The form of resulting data are words or

utterances obtained from interviews and written or number obtained from interviews. This is similar to what is expressed Moleong (Moleong, 2009), qualitative research produce descriptive data in the form of written or spoken words and the observed behavior of a person.

The research is a descriptive-qualitative, means describe the events that became the center of attention (characteristic of critical thinking stages) qualitatively and based on qualitative data. Characteristic of critical thinking stages is assessed the activities of college student thinking in the clarification stage, assessment, inference and strategy/tactics. Based on the qualitative approach in this study, all the facts either written or oral from human data sources that have been observed and other relevant documents that described what it is then assessed as possible to answer the problem.

The data in this study are the identification of critical thinking stage of college students at each level of critical thinking skills (critical thinking level 3, 2, 1, and 0 obtained in the previous research). This data are the characteristic of the thinking process of college students who performed at the clarification stage, assessment stage, inference stage, and strategies/tactics stage.

2. Research Subject

Research subject in this study are first year college student (first semester) of Mathematics Education Study Program of Mathematics Department of Natural Science and Mathematic Faculty of Semarang State University academic year 2009/2010 as many as 8 subjects. Research subjects is the informant to get any characteristic of critical thinking stage of each critical thinking level. The subject is reviewed their critical thinking activity deeply. Research subjects are those who follow courses of calculus. Besides college students, this study involves 2 lecturers of calculus courses. Lecturers are those who make the validation of the problems used at the written test and interview guides.

The research was conducted in calculus class of first year college students of Mathematics Education Study Program. Problem Based Learning with problem solving activities carried on in the classroom. At the end of the course college students are given problems to be solved within a certain time. After that, the research choose 8 subject that represent each critical thinking level.

In previous studies, researcher have obtained four levels of critical thinking skills ie critical thinking skills level 3 (critical), critical thinking skills level 2 (quite critical), critical thinking skills level 1 (less critical), and critical thinking skills level 0 (not critical). Researcher choose the right subject to determine the characteristic of critical thinking stage for each level of critical thinking abilities. Each level of critical thinking selected 2 subjects who can communicate ideas clearly and based on the uniqueness of the answers given by college students at every level of critical thinking skills. Specified two subjects, with the consideration that the method of data analysis used the constant comparative method.

3. Research Procedur

The procedure used to collect data are (a) validation of the mathematical problems and validation of the interview guides, (b) Problem-Based Learning as a means for identification of critical thinking stage every critical thinking level of college students in solving mathematical problems, (c) written test (essay test) to identify critical thinking stage of college students when solve mathematical problems, (d) task-based interviews to obtain in-depth information and support what has been obtained from the written test. Interviews were conducted around the answer of written test done by college student. Researcher used a tape recorder to record all information during the interview, (e) Field notes to complement the data that does not recorded in the written test and interview.

4. Research Instrument

The research instrument are validation guides of mathematical problems and interview, research lesson plan, written test, and interview guides.

5. Data Analysis

Analysis is done for problem solving written tasks and result of interview. Analysis of problem-solving written tasks based on solutions that do by the college students and guided solution. The steps of data analysis results of the interviews are data reduction, data display, drawing conclusions from the data collected and verification of conclusion. Results of interviews analysis will be used as a triangulation on the analysis of the task and used to identify critical thinking stage of each level critical thinking college

students. Data analysis was done using The Constant Comparative Method. This analysis involves the comparison of one segment data with other segments to determine the similarity and difference. Data are grouped together in the same dimension. This dimension tentatively given a name, which became a category.

The data in qualitative research required the credibility, transferability, dependability, and confirmabilitas (Siswono, 2007). Credibility refers to the question of whether the data obtained in accordance with what exists in reality. In this research, the credibility of the data done by persistent observation, that is the researchers interviewed the subject thoroughly, in detail and hold a repetition of questions at different times if the information that is unclear or different. Researchers also conducted triangulation to validate data. Triangulation in this study done to compare data of students work (in problem solving written tasks) with data from interviews, compare and examine data from different subjects in one level of critical thinking. Additionally, validation of the mathematical problems used to identify mathematical critical thinking stages.

Transferability is an attempt to build generalizations as in quantitative research. In this research, transferability done by describe each aspect of critical thinking component of every subject in detail. Dependability is a term that is equated with reliability in quantitative research, ie can not be made replication or retest research results. In this research, dependability done by techniques as described to maintain credibility and audit techniques that maintain the honesty and accuracy of the observer perspective. Confirmability replaces the term objectivity in quantitative research. In this study, confirmability filled with certainty because it is based on data extracted with the truth.

III. RESULT AND DISCUSSION

Critical thinking stage are the steps of critical thinking include clarification, assessment, inference, strategies/tactics abilities. Clarification stage includes identify and analyze the problems activities ie define the problem, define the detailed problems, identify information of the problem, and explore the relationships between information. Assessment stage includes select relevant information/ideas/concepts, connect relevant information/ideas/concepts, connect the information/ideas/concepts of the problems with relevant information/ideas/concepts, connect problem with previous problems, and assess the reasoning activities. Inference stage includes develop hypotheses and make

conclusions activities through deductive thinking and thinking induction. Deduction thinking and induction thinking refers to Gubbin (Sternberg, 1986). Deduction thinking consist of the use of logic, observe contradictive statements, analyze silogism, solve spatial problems. Induction thinking consist of determine the cause and effect, analyze open-ended problems, reasoning using analogy, make a conclusion, determine relevan informations, recoqnize the existence of a relationships, solve problems of insight deeply. Strategy/tactics stage includes activities use of thinking strategies ie use of algorithms of thinking embodied in the action resolves the problem.

The results of this research are characteristic of college student critical thinking stage. The results based on results of written test and interview-based tasks are as follows.

1. The identification results of college student who are at critical thinking level 0 (not critical) for solving mathematical problems.

Characteristics of thinking in the clarification stage are obtaining information based on the image, identifying problems (questions) based on what is written and incomplete, interpreting questions based on existing knowledge and do not see what is implicit in the question, and able make an image to obtain additional information. Characteristics of thinking in the assessment stage are just digging some relevant information, do not have any idea to solve the problem or idea is analogous to a problem that has been done previously in class and using the knowledge already known or memorized. Characteristics of thinking in the inference stage is induction thinking ie determine the relevant information even if only partially, recognize the existence of a relationship, and use analogous to the previous problem that has been done in the classroom. Characteristics of thinking in the strategy/tactic stage is using an analogy or unable bring the strategy used because the college student still searching for relevant information.

2. The identification results of college student who are at critical thinking level 1 (less critical) for solving mathematical problems.

Characteristics of thinking in the clarification stage are identifying problems based on a statement (written) on the problem as a whole (the question sentence is read), knowing the meaning of question implicitly, knowing that the questions related to the derivatives, utilizing an existing information on the image, creating images for

obtaining additional information that can be dug up, and using knowledge to get the information. Characteristics of thinking in the assessment stage are defining the concept directly, digging most of the relevant information to the problem, making the connection between existing information and information is dug, digging the knowledge that has been recognized, the idea of working on using the analogy and based on interpretation of the questions which accompanied the previous knowledge. Characteristics thinking in the inference stage is induction thinking ie determine the relevant information, identify relationships, use the analogy, and determine the cause and effect. Characteristics of thinking in the strategy/tactic stage are using an analogy, their thinking can not be followed and illogical, and using the knowledge that has been recognized.

3. The identification results of college student who are at critical thinking level 2 (quite critical) for solving mathematical problems.

Characteristics of thinking in the clarification stage are identifying problems based on a statement (written) on the problem as a whole (the question sentence is read), knowing the meaning question implicitly, utilizing an existing information on the image, knowing the questions relating to derivatives, making the image to get additional information can be extracted and use of knowledge to get the information. Characteristics of thinking in the assessment stage are defining the concept precisely, digging most of the relevant information and concepts to the problem, can make the connection between the information/concepts that exist and the information/concepts that were dug, digging the knowledge that has been recognized, and still can not come up ideas of their thinking because their ideas analogous to the idea of doing what's already been done or is based on knowledge that has been recognized. Characteristics of thinking in the inference stage is induction thinking ie determine the relevant information, identify relationships, using analogies, and determine cause and effect. Characteristics of thinking in the strategy/tactic stage are using an analogy, some of their thinking can not be followed and illogical, and using the knowledge that has been recognized.

4. The identification results of college student who are at critical thinking level 3 (critical) for solving mathematical problems.

Characteristics of thinking in the clarification stage are identifying problems based

on a statement (written) on the problem as a whole (the question sentence is read), knowing the meaning of question implicitly, utilizing an existing information on the image, knowing the questions relating to derivatives, making the image to get additional information can be extracted and using knowledge to get the information. Characteristics of thinking in the assessment stage are defining the concept precisely, digging most of the relevant information and concepts to the problem, gaining knowledge that has been identified, making relations between information/concepts that exist and the information/concepts are explored, using own ideas with look for relationships that can be used to solve the problem, can form a thought to solve problems and be able to assess the reasoning is done. Characteristics of thinking in the inference stage are induction thinking and deduction thinking. They are determining the relevant information and identifying relationships as a induction thinking. They using logic as a deduction thinking. Characteristics of thinking in the strategy/tactic stage are using their own ideas to seek a relationship, their thinking clear and logic.

Critical thinking stage in this study consist of clarification stage, assessment stage, inference stage and strateg/tactics stage. At this critical thinking process, the subject tried to solve the problem with logical reasoning. However, due to the ability of each subject is different so not all subjects can solve problems with logical reasoning. Characteristics of critical thinking stage subject is a combination of characteristics that raised two research subjects. The constant comparative method used for getting characteristic of critical thinking stage for each critical thinking level of 2 subject research.

IV. CONCLUSSION AND RECOMMENDATION

Based on the results of data analysis, the conclusion of this study are as follows.

1. In the clarification stage, subject from critical thinking level 0 until 3 shows the same characteristics ie obtain information on the image, and able to make the image to get additional information. In critical thinking level 0, subjects identified the problem (question) based on what is explicit and not exhaustive. Subjects in critical thinking level 0 also interpret the questions based on existing knowledge and do not see what is implied in the question. While on the subject from critical thinking level 1 until 3 are able to identify problems based on existing statements (written) on the

problems as a whole (the question sentence is read), knowing the meaning of the question implicitly, knowing that the question related to the derivative and using the knowledge to get the information.

2. In the assessment stage, subjects in critical thinking level 0 only dig some relevant information while subject in critical thinking level 1 to 3 dig most of the relevant information to the problem. In critical thinking level 0, the subject does not have any idea to solve the problem and if any idea then the idea is analogous to a problem that has been done previously in class. In critical thinking level 1, the idea of working on using the analogy and based on interpretation of the questions which accompanied the previous knowledge. In critical thinking level 2, the ideas based on the use of an analogy to what's already been done or is based on knowledge that has been recognized. While the idea of doing a subject on critical thinking level 3 is their own idea by looking for relationships that can be used to solve the problem. In critical thinking level 0 to 3, the subject has used the knowledge that has been recognized. In critical thinking level 1, the subject defines the concept directly while the subject in critical thinking level 2 and 3 define the concept precisely. Subjects in critical thinking level 1 to 3 able to make connections between existing information with the information extracted. Subjects in critical thinking level 3 able to form ideas to solve problems and assess the reasoning performed.
3. In the inference stage, subject from critical thinking level 0 until 2 only using induction thinking while subject on critical thinking level 3 uses induction and deduction thinking. In critical thinking level 0, induction think that subject use are determine the relevant information, recognize the existence of a relationship, and using analogies. In critical thinking level 1 and 2, induction thinking that subject use is same with induction thinking on critical thinking level 0 plus determine the cause and effect. Induction thinking of the subject on critical thinking level 3 are determining relevant information and identifying relationships while the deduction thinking is done by using logic.
4. In the strategy/tactics stage, subject on critical thinking level 0 using an analogy or unable make strategy used for because still searching for relevant information. Subjects critical thinking level 1 and 2 use an analogy, thinking (reasoning) can not be followed and not logical, and using existing knowledge. Subjects in critical

thinking level 3 using his own ideas by finding relationships in solving problems, and their thinking (reasoning) is clear and logical.

Based on the conclusions of the research results, it is recommended the further research in the Mathematics Department of Natural Sciences and Mathematics Faculty of Semarang State University to solidify the identification stage of critical thinking college students for solving mathematical problems. However, further research should use variety measuring tool of critical thinking and research time long enough. In addition, based on the characteristics of critical thinking stage of each critical thinking level can be enhanced critical thinking skills of college students.

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