

THE CONTRIBUTION OF DISPOSITION AND INFERENCE SKILLS TO CRITICAL THINKING MATHEMATICS ABILITY OF STUDENTS AT SENIOR HIGH SCHOOL JAKARTA

Desi Valindra, S.Pd.
Indonesian University of Education,
valindra08@gmail.com

Abstract

Critical thinking mathematics ability is one of the high order mathematical thinking that is used to solve mathematical problems systematically and to make a responsible decision for the solution that already has been chosen. Critical thinking mathematics ability includes remember, apply, analyze, evaluate, and create. However, the fact is, students only remember and apply. The others are not applied by the students properly, so that students may just memorize without understanding the concept of the subject. The aim of this research is provide information about significance contribution between disposition and inference skills to critical thinking mathematics ability, then how much these contributions attributed to critical thinking mathematics ability, in class XI IPA SMA 44 Jakarta among 50 students randomly selected who have passed the several concepts of subjects in this research. The several concepts tested in this research are about circle, sequences and series, and curved side. The research method used is survey where data are collected, processed by using double linear regression, and organized in such away that can be used to answer the problem in this research. The results showed that disposition and inference skills have shown significance contribution to critical thinking mathematics ability, especially on the subject that was chosen.

Keywords : contribution, disposition, inference skills, critical thinking mathematics ability

INTRODUCTION

Mathematics plays an important role in various disciplines and in improving of human thought. Beside that, mathematics is one of the lessons that learned from primary school level until university. However, the emphasis of the learning process of mathematics in schools is still too focused on aspects of doing, but lacking in aspects of thinking. Students are accustomed to working on the problems that can be directly solved by using formulas and algorithms as given by the teacher or questions in procedural way. Therefore, a basic understanding of students' thinking skills become less well developed.

One of the thinking skills that should be possessed by the student in the learning of mathematics is critical thinking mathematics ability. Through critical thinking mathematics ability, students can easily process and use information to solve problems that are found, even able to improve student skills and understanding. Critical thinking mathematics ability includes remember, apply, analyze, evaluate, and create. However, the fact is, students only remember and apply. The others are not applied by the students properly, so that students may just memorize without understanding the

concept of the subject. As a result, students' critical thinking mathematics ability is said to be likely low.

The low critical mathematics ability have seen by the results of mathematical study of Trends in International Mathematics and Science Study (TIMSS) in 2007 that Indonesia was ranked 36 out of 49 countries participating in the field of mathematics and Survey Programme for International Student Assessment (PISA) in 2009 also showed that the quality of mathematics teaching in Indonesia was ranked 61 out of 65 countries.

The results of studies such as TIMSS and PISA surveys indicate that students tend to be weak in solving non-routine problems, ie problems that require thinking skills such as critical thinking mathematics ability. These conditions need to be improved, remembered the development of critical thinking skills is one of the mathematical curriculum development of Kurikulum Satuan Tingkat Pendidikan (KTSP) which refers to Standar Kompetensi Lulusan (SKL) in the learning of mathematics, namely that students have the ability to think logical, analytical, systematic, critical, and creative, and have the ability to work together. Therefore, the development of today's mathematics learning should be relevant to the tendency of the mathematics curriculum at the unit level of education, in particular especially in the critical thinking mathematics ability.

Critical thinking mathematics ability presented by Ennis (2011) is the ability to think rationally and reflective which are focused on what is believed and done, which is divided into two aspects, namely general aspects and particular aspects. General aspects include abilities and tendencies (dispositions). Furthermore, aspects of abilities includes basic clarification, basic decisions, inference, advanced clarification, supposition and integration, and auxiliary abilities. Then, Ennis (Innabi, 2003) said that this particular aspect is related to the mathematical material, such as concept, generalizations, algorithms and skills, and problem solving.

Somakim (2010) also describes some of the indicators of critical thinking mathematics ability that are identify and justify the concept, generalize, analyze the algorithms, and solve problems. Identify and justify the concept is the ability to compare or connect a concept with other concepts, and provide a reason to use the concept. Generalize is the ability to complete the data or information that supports and determine general rules based on the observed data. Analyzing the algorithm is the ability to evaluate or inspect the algorithms, and clarify the conceptual basic used in each step of solving. Problem solving is the ability to identify the elements that are known, asked, and examine the adequacy of the required elements in the question, formulate and solve mathematical models, and verify the results or answers.

Critical thinking mathematics ability of students should be able to develop optimally if the student has a disposition. Kilpatrick, Swafford, and Fuindell (2011) stated that the disposition refers to see sense in mathematics, to perceive it as both useful and worthwhile, to believe that steady effort in learning mathematics pays off, and to see oneself as an effective learner and doer of mathematics. Meanwhile, Wardani (Permana, 2010) revealed several indicators of disposition, as follows:

- a. Confidence: confidence of the ability/ belief.
- b. Curiosity: asked questions frequently, enthusiasm/ passion in learning, a lot of reading and searching for other sources.

- c. Persistence: persistent/ seriousness.
- d. Flexibility: cooperation/ sharing of knowledge, respect from different opinions, trying to find a solution/ other strategies.
- e. Reflective consists of two indicators, namely: act and relate to mathematics, loved/ pleasure to mathematics.

In addition, critical thinking mathematics ability of students should be able to develop optimally if students can understand the problem and then connect various data, instructions, or facts by utilizing existing knowledge so can make the solution in solving the problems. In other words, students should have the skills of inference. According Sutrisno (Rachmawati, 2012), inference skills is defined as one that should be owned by the ability of the student in terms of connecting the various clues, facts, or information that is available by utilizing the knowledges that can make a final result.

The existence of this inference skills will improve and aid the students' thinking in terms of explaining the information submitted because students are try to use the whole capacity to think to be able to understand the core of the problem so that obtain an answer of the problem. Meanwhile, the existence of dispositions will lead the students to be sensitive to their environment and tend to regard the whole situation carefully and thoroughly, and also motivated to solve challenging problems.

Based on those, further research will be done to find out about the information in how much the contribution between dispositions and inference skills to critical thinking mathematics ability.

THEORETICAL FRAMEWORK

Critical thinking mathematics ability

Critical thinking mathematics ability presented by Ennis (2011) is the ability to think rationally and reflective which are focused on what is believed and done, which is divided into two aspects, namely general aspects and particular aspects. General aspects include abilities and tendencies (dispositions). Furthermore, aspects of abilities includes basic clarification, basic decisions, inference, advanced clarification, supposition and integration, and auxiliary abilities. Then, Ennis (Innabi, 2003) said that this particular aspect is related to the mathematical material, such as concept, generalizations, algorithms and skills, and problem solving.

As for the aspects of critical thinking mathematics ability presented by Facione (2011) consists of cognitive skills that include interpretation, analysis, evaluation, inference, explanation, and self-regulation; and disposition. The explanation as follows.

- a. Interpretation is the ability to understand and explain the meaning of the situation, experiences, events, data, decisions, rules, and procedures.
- b. Analysis is the ability to identify the relationship between several statements, questions, concepts, descriptions, and various forms that are used to reflect the thoughts, ideas, decisions, and rationale.
- c. Evaluation is the ability to test the credibility of statements or other forms used for perception, judgment, reason, and opinions.
- d. Inference is the ability to identify and select the elements required to formulate a logical conclusion; consider the information needed; and decide the consequences to

- be drawn from the information, statements, events, principles, opinions, and concepts.
- e. Explanation is the ability to declare the result of thought, explains the reasoning based on evidence and concepts, and presenting arguments.
 - f. Self-regulation is the ability to review and re- formulate explanations that have been given to the decision ever taken or to reconsider their opinions and views are never taken.
 - g. Disposition is willing to be open-minded attitude in evaluating, prudent in making judgments, used to want to know, tell us why that is trustworthy, and flexible in considering alternatives and opinions.

Critical thinking mathematics ability that will be assessed in this study is about the disposition, the attitude would be open-minded and thoughtful in evaluating, giving reasons trustworthy, and flexible in considering alternatives and opinions; and inference skills, ie the ability to identify and select the information needed to formulate a reasoned conclusion.

Critical thinking mathematics ability can be seen through the mathematical characteristics that may indicate the presence of critical thinking mathematics ability indicators contained in critical thinking mathematics ability. As revealed by Ennis (Innabi, 2003), ie mastery of concepts (concept), making generalizations (generalizations), algorithms and skills (algorithms and skills), and problem solving (problem solving) as follows:

- a. Aspects related to the concept, includes:
 - 1) Identify the characteristics of the concept.
 - 2) Comparing the concept with other concepts.
 - 3) Identify examples of the concept to justify.
 - 4) Identify the concept of counter- examples to justify.
- b. Aspects relating to generalization, includes:
 - 1) Determine the concepts contained in the generalization and association.
 - 2) Determine the conditions for applying generalizations.
 - 3) Determine the formulas are different generalizations (special situation).
 - 4) Provide supporting evidence for generalization.
- c. Aspects related to the skills and algorithms, includes:
 - 1) Clarify the conceptual basis of skills.
 - 2) Comparing the performance of students with exemplary performance.
- d. Aspects related to problem solving , includes:
 - 1) Provide a general form for the purpose of settlement.
 - 2) Determine the information provided.
 - 3) Determine relevance and unrelevance of information.
 - 4) Choose and justify a strategy to resolve the problem.
 - 5) Determine and deduce sub goals that lead to the goal.
 - 6) Suggest an alternative method to solve the problem.
 - 7) Determine the similarities and differences between the given problem and other problems.

Somakim (2010) also explain some of the indicators of critical thinking mathematics ability, such as identify and justify the concept, generalize, analyze the algorithms, and solve problems. Identify and justify the concept is the ability to compare or connect a

concept with other concepts, and provide a reason to use the concept. Generalize is the ability to complete the data or information that supports and determine general rules based on the observed data. Analyzing the algorithm is the ability to evaluate or inspect the algorithms, and clarify the conceptual basis used in each step of solving. Solving problems is the ability to identify the elements that are known, asked, and examine the adequacy of the required elements in the matter, formulate and solve mathematical models, and verify the results or answers.

Based on the above, the next critical thinking mathematics ability indicators referred to in this study is in accordance with the opinion of Somakim.

Inference Skills

According Sutrisno (Rachmawati, 2012), inference skills is defined as one that should be owned by the ability of the student in terms of connecting the various clues, facts, or information that is available by utilizing the knowledges that can make a final result.

This inference skills will facilitate students in doing mathematics learning because students are able to draw conclusions if the student is able to understand the essence of the problem is presented. This is because students use the entire capacity to think to do inference to obtain answers to these problems. Although it is not easy to perform inference for each student, but by inference one can know the level of students' reasoning.

Besides that, the existence of this inference skills will improve and aid the students' thinking in terms of explaining the information submitted because students are try to use the whole capacity to think to be able to understand the core of the problem so that obtain an answer of the problem. Meanwhile, the existence of dispositions will lead the students to be sensitive to their environment and tend to regard the whole situation carefully and thoroughly, and also motivated to solve challenging problems.

Based on the above, further inference skills referred to in this research is the ability to make general conclusions based on data or information available through a thought process either inductive or deductive. This means reviewing the premises given to acquire a perception of the rule, nature, patterns, characteristics, or mathematical logic in order to obtain a conclusion.

Disposition

Kilpatrick, Swafford, and Fuindell (2011) stated that the disposition refers to see sense in mathematics, to perceive it as both useful and worthwhile, to believe that steady effort in learning mathematics pays off, and to see oneself as an effective learner and doer of mathematics.

Disposition of students said to be good if the students interested in challenging problem and directly involved in finding and solving problem. In other words, students are able to feel the emergence of self-confidence, hope, persistence in the face of challenging issues, and awareness to look back at the results of the thinking and responsible for their own learning outcomes. The existence of this disposition can be said to help and determine the success of students in the learning process because when students feel confident in solving a problem and were able to see it as something that can be learned

or found a solution so the student can simultaneously develop the ability to understand a concept .

Disposition in the learning process of mathematics will appear when students complete a math problem, for example, the desire that arise in students to change the strategy that has been selected, evaluation, and analysis to be able to obtain a solution to the problems faced. Disposition can also be observed in a classroom discussion, such as how big the desire of students to be able to explain the solutions that have been obtained in solving mathematical problems and be able to defend the reason.

Meanwhile, Disposition can be measured by several indicators. The disposition indicators according to Shaban (Permana, 2010), as follows:

- a. Demonstrate passion/ enthusiasm in learning mathematics.
- b. Shows serious concern in learning mathematics.
- c. Shows persistence in the face of problems.
- d. Demonstrate confidence in learning and completing problem.
- e. Shows a high curiosity.
- f. Demonstrate the ability to share with others.

Wardani (Permana, 2010) also revealed several indicators of disposition, as follows:

- a. Confidence: confidence of the ability/ belief.
- b. Curiosity: asked questions frequently, enthusiasm/ passion in learning, a lot of reading and searching for other sources.
- c. Persistence: persistent/ seriousness.
- d. Flexibility: cooperation/ sharing of knowledge, respect from different opinions, trying to find a solution/ other strategies.
- e. Reflective consists of two indicators, namely: act and relate to mathematics, loved/ pleasure to mathematics.

Based on the above , the indicators disposition referred to in this study is in accordance with the opinion of the Permana Wardani .

METHOD

The method used in this research is survey where data are collected, processed by using double linear regression, and organized in such away that can be used to answer the problem in this research.

The procedure of this study includes problem analysis, problem formulation, design question framework, design questions, expert validation and revision, observation field trials and revision, and final draft.

- a. Preliminary research in the form of problem analysis is the first step that conducted by collecting information, it is intended to find out what problems that occur in the field and then find appropriate solutions to resolve the issue. After that, the problem is formulated.
- b. Design question framework
This step is done by looking at the basic competencies, indicators, issues raised in the questions and structure of sentences. The several concepts tested in this research are about circle, sequences and series, and curved side. Then, do the design of questions.
- c. Expert validation and revision

Before the draft is use to measure the ability, the first draft should be examined by experts in in accordance with it as a lecturers and teachers. At this stage, the experts were asked to examine the suitability of the question that has been made with structure of sentences and the subject matter, then asked to provide feedback about the draft. Based on input from experts, the revised draft.

d. Observation field trials and revision

This step is question's trial. Respondents were comprised of 20 students at class XI IPA SMA 59 Jakarta are asked to do on the problems that have been made to determine the accuracy of the questions. Based on input from them, then the revised draft.

e. Final draft

This step is widely draft trials. Trials at this stage is given to a number of respondents more numerous. Input from the results of field trials are the basis to see the contributions of the abilities. After the data is processed, it can be made a conclusion about that the contribution given to the abilities.

The research was conducted at class XI IPA 1 and XI IPA 2 SMA 44 Jakarta with 50 students were randomly selected, on August until September of 2012.

The data in this study is a score derived from the results of tests and non-test. Scores obtained in the form of the test consisted of a set of questions to measure a critical thinking mathematics ability the ability by the form of essays and inference skills such as drawing conclusions by the form of multiple choice, then scores obtained in the form of non-tests include the disposition by the form of check list. And technical analysis of the data used in this study involves several points as follows.

1. Suspect double linear regression model
2. Analysis of test requirements:
 - a. Normality test error
 - b. Homogeneity test error
 - c. Multicollinearity test
3. Significance test of double linear regression model
4. Linearity test of double linear regression model
5. Double linear regression coefficients Test
6. Hypothesis testing:
 - a. Multiple correlation coefficient test
 - b. Correlation coefficient test parsil
7. Coefficient of Determination

RESULT AND DISCUSSION

Based on the analysis of data obtained regression model $\hat{Y} = -37,511 + 0,676X_1 + 0,364X_2$. The regression model showed that each increase of one score of disposition will improve critical thinking skills mathematical scores of 0.676 and for every increase of one score inference skills will improve critical thinking skills of mathematical score of 0.364.

The results of this study indicate that the disposition and inference skills together make a significant contribution to the mathematical ability of critical thinking that is equal to 40.07% where the contribution disposition toward critical thinking ability that is equal

to 35.40% mathematical and inference skills contribute to the ability to think critical mathematical is equal to 13.84%

Based on the results of this study can be said that disposition of which is the tendency to act or think in a positive manner toward mathematics such as the presence of self-confidence, hope, and perseverance in the face of problems; the desire to be able to explain the solutions that have been obtained and maintains the reason; as well as awareness to look back at the results of his thinking and responsible for their own learning outcomes, contribute significantly to critical thinking mathematics ability. Similarly, inference skills which is the ability to discover, connect, and identify a variety of information by utilizing the knowledge to make a final result or conclusion in general, contribute significantly to critical thinking mathematics ability.

The existence of a significant contribution between disposition to critical thinking mathematics ability showed that the development of critical thinking mathematics ability can be reached by developing disposition. The development of disposition in mathematics learning can be done by looking at the students' tendency to act or think in the face and solve a mathematical problem, so there is a desire in the student to modify the strategies, to evaluate, and perform analysis to obtain solutions to these problems. In addition, it also can be done by holding a class discussion so that it can be seen how much the desire of students to be able to explain the solutions that have been obtained in the completion of a math problem and maintains the reason.

Furthermore, the existence of a significant contribution of inference skills to critical thinking mathematics ability showed that the application of inference skills need to be considered as an attempt to improve critical thinking mathematics ability. Application of inference skills can be done through a learning process that is able to activate students' thinking by presenting problems that are challenging for students that require students to be able to understand the ability to provide solutions to these problems. Thus, students can easily process the math concepts being able to understand the essence of problem and achieve a good learning outcomes such as critical thinking mathematics ability.

CONCLUSION

Based on the research results, it can be concluded as follows:

1. There is a significant contribution between disposition and inference skills together to on critical thinking mathematics ability, especially on the subject that was chosen.
2. There is a significant contribution between disposition to critical thinking mathematics ability, especially on the subject that was chosen.
3. There is a significant contribution of inference skills to to critical thinking mathematics ability, especially on the subject that was chosen.
4. The contribution of disposition to critical thinking mathematics ability is equal to 35.40%, the contribution of inference skills to critical thinking mathematics ability is equal to 13.84% , and the contribution of the dispositions and skills of inference together to on critical thinking mathematics ability is equal to 40.07% .

Based on the conclusion of the study that has been done, it can be revealed that the dispositions and inference skills provide a significant contribution to critical thinking

mathematics ability, especially on the subject of circles, sequences and series, and a curved side.

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