Analyzing Students’ Decision-Making Style in Prior Knowledge of Mathematical Critical Thinking Skill

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ABSTRACT

Critical thinking is a higher-order thinking skill which is believed to be able to enhance students’ ability in facing academic as well as real life challenges and problems. Student’s thinking skill is affected by their prior knowledge and experience, which play an important part in the decision-making process, a crucial phase and a compound process taking a principal role in all thinking levels. The purpose of this research is to find out students’ critical thinking skill in order to recognize the characteristics of students' thinking based on decision-making style. This research is a case study adopting a qualitative approach, using descriptive analysis. The data are collected using test, observation and interview. The results show that more than half students’ critical thinking skill is still on the lower cognitive complexity based on the decision-making style.

INTRODUCTION

The aim of education is to develop the students’ potential in order to help them face problems in real life. It is similar to the Law Number 20 of 2003 on National Education system, which states:

“Education means conscious and well-planned effort in creating a learning environment and learning process so that learners will be able to develop their full potential for acquiring spiritual and religious strengths, develop self-control, personality, intelligence, morals and noble character and skills that one needs for him/herself, for the community, for the nation, and for the State”.

To achieve this goal, the government has conducted a variety education programs, which can be categorized into formal and non-formal education. Formal...
education offers subjects that can develop students’ abilities in various aspects. Mathematics is one of the subjects studied in all level of education and can be applied in other fields of science. Prihandoko (2006) states that mathematics is the basis of knowledge that has been a tool to learn different fields of science [1]. Mathematics is the main lesson that should be taught to students in order to they have the thinking skills logically, analytically, systematically, critically, and creatively. The prominent purpose of mathematics lesson is enhancing prior knowledge of students. According to Svinicki, “Prior knowledge affects how learner perceives new information, how a student organizes new information, and how easily students make connections for new information” [2]. To enhance the students’ prior knowledge, they should be trained to do observing, predicting, assuming, analysing, and reasoning in learning activities so that their thinking skills will be developed. In learning critical thinking, students will be lead to improve their skills such as a higher level of concentration, more in-depth analytical abilities, and improved thought processing [3]. Because of these opportunities, they will know how to use their knowledge and skills by thinking critically.

The term ‘critical thinking’ means making reasoned judgements. Beyer (1995) viewed critical thinking as a disciplined manner of thought in which a person can use it to evaluate the validity of something (statement, news, ideas, arguments, research, etc.). Some writers like Glaser (1985), Primack (1986), and Wilson (1988) believed that critical thinking ability would directly influence the capacity of individuals to advance in applying information effectively so they can decide the best alternative solution of any problems [4]. Decision making is considered as a crucial phase in thinking level process because, in Bloom’s Taxonomy, decision making is not a one-step process, but a compound process. It takes part in all thinking levels, namely comprehension, application, analysis, synthesis, and evaluation. According to Al Shra’ah (2015), decision-making process consists of seven steps, which are appreciating the problem, gathering the information and data, analysing the data and information, developing the alternatives, evaluating these alternatives, and finally choosing the appropriate alternative solution. The importance of decision-making process is also stated by Rowe and Bougarrides (1992), that is by knowing an individual’s decision-making style, we can predict how he or she will react to various situations [5]. The classification of decision-making style will aid to look for the characteristic of students’ thinking so every student can change and train their thinking to have a high complexity cognitive ability.

METHODS
The study adopted qualitative research approach. More specifically, it was a case study conducted at a junior high school in Cicalengka, West Java. The subjects were students in grade IX at the school. The instrument used was a test including indicators of mathematical critical thinking, observation and interview. The data were analyzed using descriptive analysis method to look into the decision-making style of students’ prior knowledge.

The table below shows the indicators of students’ mathematical critical thinking.

| Indicators | Explanation |
|------------|-------------|
| Interpretation | Understanding problem by writing what |
Next, the result of students’ answer sheet will be analyzed based on the rubric score of mathematical critical thinking skill. The rubric score of mathematical critical thinking was adopted and then modified according to Facione and Ismailmuza [11].

**Table 2.** Rubric Score of Mathematical Critical Thinking Skill.

| Indicators | Explanation | Score |
|------------|-------------|-------|
| **Interpretation** | Student did not write what known and asked the question | 0 |
| | Student wrote what known and asked the question, but their answer is not correct | 1 |
| | Student wrote what known and asked the question correctly, but their answer is not complete | 2 |
| | Students wrote what known and asked the question correctly and completely | 3 |
| **Analysis** | Student did not make the mathematical model of the question | 0 |
| | Student made the mathematical model, but their answer is not correct | 1 |
| | Student made the mathematical model correctly, but their answer is not complete | 2 |
| | Student made the mathematical model and completely | 3 |
| **Evaluation** | Student did not use the strategy in solving question | 0 |
| | Student used the strategy, but their strategy is not correct | 1 |
| | Student used the strategy correctly, but their strategy is not complete | 2 |
| | Student used the strategy correctly and completely | 3 |
| **Inference** | Student did not make a conclusion | 0 |
| | Student made a conclusion, but their conclusion is not correct | 1 |
| | Student made a conclusion correctly, but their conclusion is not complete | 2 |
Student made a conclusion correctly and completely.

The way of the calculation of percentage values is as follows: the value of the percentage of the students’ critical thinking skill obtained from the calculation above will be categorized based on the table below:

**Table 3. Category of Percentage of Mathematical Critical Thinking Skill**

| Interpretation (%) | Category    |
|--------------------|-------------|
| 81.25 < X ≤ 100    | Very High   |
| 71.5 < X ≤ 81.25   | High        |
| 62.5 < X ≤ 71.5    | Moderate    |
| 43.75 < X ≤ 62.5   | Low         |
| 0 < X ≤ 43.75      | Very Low    |

After examining the students’ answer sheet according to indicators of critical thinking, the students’ answer sheets were analyzed based on the types of decision-making style. The kinds of the decision-making style are:

**Table 4. Types of Decision-making style.**

| Types       | Explanation                                      |
|-------------|--------------------------------------------------|
| Analytic    | Over-analyze. It means that more accurate and more detail, well structured |
| Directive   | Structured. It means that data presented based on facts and its form is structured |
| Conceptual  | Its characteristics are creative and broad outlook |
| Behavioral  | It tends to give an opinion and unstructured     |

**RESULTS AND DISCUSSION**

The research was conducted in class IX in one of junior high school in Cicalengka. The material was the congruent and congruous with mathematical critical thinking indicators used in the prior knowledge test. The result of the scoring of critical thinking skill showed that the mean score of students’ critical thinking skill were very low.

**Table 5. The Percentage of Mean Score of Student’s Mathematical Critical Thinking Skill**

| Indicators | Mean Score |
|------------|------------|
| Interpretation | 0          |
| Analysis    | 1.83       |
| Evaluation  | 2.5        |
| Inference   | 0          |
| Total       | 4.33       |
| Percentage  | 36.1%      |

Note: Maximal score = 12

Consequently, based on the results, it was found that more than half the
students’ critical thinking skill is still on the lower cognitive complexity based on the decision-making style, in which more than half of them have the behavioral style of decision making.

From all students, more than half had the same answer and did not answer one of the same questions. It is shown that the students’ decision making is still on behavioral types because they responded to the problem with unstructured form and gave only opinions but no evidence. Besides, there were few students have the slightly different solution with others, it was more structured but did not provide evidence. For instance, See the figure below and determine (a) the angle of C; (b) the shaded area, and (c) the length of BC.

![Figure 1. Trapezoid ABCD](image)

This question has all of the four indicators that will be analyzed. In section a, the problem is determining the angle of C. More than half of the students did not answer this question. It was possibly because students did not understand the concept of congruent and congruous or students thought that this question was more straightforward, so they concerned to do the problematic problem firstly. Only one student answered this question, but it had no explanation of the fact, evidence, and argument supporting his solution.

The result of the interview to some of the students that did not answer this question supported the assumption stated by the researcher that the students’ comprehension is still low because teacher rarely gave them exercises about the angle of congruent and congruous so they could not solve the question well. Most of the students were lacking in comprehension about the concept of angle in the congruent and congruous from a two-dimensional figure, and most of them were preferred to solve the difficult one firstly. Then, based on an interview with the teacher, it is found that the teacher usually used questions in the textbook that still used the old curriculum that was ‘KTSP (Kurikulum Berbasis Kompetensi)’. These questions were not able to stimulate students to do the higher order thinking or the other mathematical thinking skills. In section b, the question is determining the shaded area of the figure above. All of the students answered this question, but more than half of them explained in the same pattern of the solution. And for the last section, that is section c, students answered correctly, but they did not give further explanation why they applied this strategy to solve this problem. The model of students’ answers expressed that the students’ critical thinking skill was still lower according to the decision-making style. The model of students’ answer from this section could be shown as below.
The representative of student answer above showed that the solution of each student is the same. From the indicators of students' critical thinking skills, students just did the analysis and evaluation phases. The initial phase, interpretation, was skipped by the students. It might be due to the rarity of occasions where they were asked to find out the information given to every question. This leads to students' preference to do the calculation directly without through interpretation phase.

In the analysis and evaluation phase, students were able to express the mathematical model correctly based on the question given. However, students did not provide arguments as an explanation why the mathematical model chosen was the way used for solving this problem. Next, students were able to use the appropriate strategy in solving problem, but the answer was still incomplete, or there were errors in doing the calculation and giving the explanation.
Through guidelines of students’ critical thinking indicators modified by Facione (1994), it was found that students still did the analysis and evaluation phase imperfectly. Most of them did the calculation directly without explaining the details of the areas of two two-dimensional planes. Yet, the others did two steps in solving the problem. It showed that the students’ analysis phase was pretty good, but students still rarely give a further explanation why they chose the mathematical model to solve the problem. It might happen because the teacher hardly ever asked them to provide an argument about what they did or the teacher often asked the students to just do the calculation without understanding why they did it in the first place.

In the learning process, students were rather passive and rarely express an argument, refutation, or agreement of statements given by a teacher. It was supported by the results of the interview with the teacher that when the teacher made some statements or gave questions to students, they seldom give the feedback to the teacher. This negatively influence the teacher’s motivation in offering another question or giving another statement to the students. It might happen because students were seldom required to provide some responses such as arguments of what they have done. Moreover, they were often asked to just find out only the 'number', not the real results.

From the interview with the teacher, it was found that the students were required to do the more in-depth analysis of solving mathematical problems. The teacher also rarely gave further examples and individual assignments to them. These caused the lower level of students’ skill in understanding a mathematical concept. Meanwhile, the result of the interview to students described that the limited problems were proposed by the teacher, the students were never trained to do the inference phase, so they did not know the inference phase in solving the problems.

Furthermore, the results of observation showed that the method used in teaching and learning activity is direct instruction. Direct instruction is considered as the effective method in transferring knowledge to students. However, this method has not been able to develop students’ critical thinking skill because it is not centered on students, so they have difficulty in understanding the mathematical concepts. This result is in line with Sumiati (2008), who explained in her book 'Metode Pembelajaran' that proper direct instruction should be modified with the other instructional methods to enable students to be an active in learning activities [1].

CONCLUSION

To conclude, it is found that more than half of the students posses critical thinking skill that is still on the lower cognitive complexity based on the decision-making style. More than half of them have the behavioral style of decision making, in which it tends to give an opinion and unstructured. Therefore, the teacher should apply the innovative instructional method to enhance the students’ critical thinking skills so it can change the students’ decision making style be better. Furthermore, students should be trained by giving them a non-routine test to develop their critical thinking skill and decision making style.

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