Analysis of students' mathematical reflective thinking skills and habits of mind

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Abstract. The purpose of the study is to describe students’ mathematical reflective thinking skills and habits of mind. The method in this study was qualitative with phenomenological approach. The data were collected by using mathematical reflective thinking written test, habits of mind scale, and interview. The subjects were two students of grade-ten of one high school in Kebumen, Central Java. The study was conducted as long as one year, especially in observing student’s habits of mind. The results show that the first student can solve all of phases of mathematical reflective thinking skill, namely reacting, elaborating, and contemplating. The other student can solve only two phases of mathematical reflective thinking skill, namely reacting and elaborating. Moreover, the first student is better than the second student in three habits of mind indicators, namely persisting, thinking and communicating with clarity and precision, and then gathering data through all senses.

1. Introduction

Developments in science and technology are very fast in the era of industrial revolution 4.0 which are inseparable from the role of mathematics as one of the basic sciences. The developments are certainly comparable to the increasingly complex challenges. It requires high skills to address these challenges, one of which is the mathematical reflective thinking skills. Skill to think reflectively is defined as a person's skill to recognize and understand themselves by identifying what things are known and being the case to apply the concept to get a strategy of a problem encountered, making inferences from such problems and evaluating the measures that have been used in solving problems. Reflective thinking is described as a mirror that shows a lot of objects that can be used as the norm and guideline, just like when the train guide should see the back side mirror to obtain guidance in order to move forward [1]. Mathematical reflective thinking skills are beneficial to support students to choose and consider the decision to be taken to perform an action that is appropriate and responsible. Therefore, students are expected to have the provision of reflective thinking skills.

Mathematical reflective thinking skills consist of three phases: reacting, elaborating, and contemplating [2]. Reacting means for action against situations or problems encountered with an opinion based on the theories or concepts. In this study, reacting is a ability to use mathematics in other areas of study or daily life and the ability to identify concepts or mathematical formulas involved in a math problem. Elaborating in this study is defined as a ability to compare a situation with other experiences, such as referring to a general principle. Contemplating is to think deeply to solve the problems and re-evaluate the settlement that has been used.
To achieve mathematical reflective thinking skills in mathematics requires behavioral support, one of which is a mathematical habits of mind. Habits of mind are the affective aspects that can encourage students to behave intelligently when confronted with a problem, especially answers that are not immediately known [3]. Habits of mind equip individuals to work on real-life situations that complement the ability of individuals to merespins with consciousness, thinking, and strategies to obtain the right solution [4]. The habits of mind can be used to assess their mathematical skills in understanding, searching strategies, and solving the problems that they face. Indicators of using habits of mind include: persisting, thinking, and communicating with clarity and precision, managing impulsivity, gathering data through all senses, listening with understanding and empathy, creating, imagining, innovating, thinking flexibly, responding with wonderment and awe, thinking about thinking (metacognition), taking responsible risks; striving for accuracy; finding humor; questioning and posing problems; thinking interdependently; applying past knowledge to new situations; and remaining open to continuous learning [3].

This study was conducted to determine the high school students' mathematical reflective thinking skills and habits of mind. It was expected to provide an overview of high school students’ reflective thinking skills and habits of mind.

2. Methods
The method used in this research was qualitative with phenomenological approach. The subjects studied are two classes grade-ten of one high school in Kebumen. Data collection procedures involve the use of written tests, scale habits of mind, and interview. Essay test instrument consists of two questions to measure the mathematical reflective thinking skills. The study was conducted as long as one year, especially in observing students’ habits of mind. Habits of mind scale that was used in this study adopts a Likert scale by Umar [5]. Meanwhile, the unstructured interview was conducted in this research to obtain depth information on students’ mathematical reflective thinking skills and habits of mind and also to support what have been obtained from the written test and the response scale of habits of mind.

3. Result and Discussion
3.1. Mathematical Reflective Thinking Skills
Based on the results of mathematical reflective thinking skills test, the first and the second subject showed the different answers. The first subject was able to resolve both problems, while the second subject was only able to solve one problem.

In solving item 1, the first subject was able to identify the concept of rule by the right sine and write the steps to resolve the issue in the more detailed fashion. The first subject was also capable of comparing a state on item 1 with reference to the principle of a right triangle.

In working on item 2, the first subject was able to respond appropriately. The first subject was able to identify the concepts involved in math and apply them in daily life. At point C, the subject was able to check the veracity of any argument presented based on the concept of sine rule.

The second subject was able to identify the concepts involved in item 1 and compare the situation with reference to the principle of congruency. While on the second item, the subject was not able to identify the concepts involved and check the validity of a given argument.

Table 1 represents the recapitulation of the test results of two subjects by 3-phase mathematical reflective thinking skills.

| Phase     | Subject 1 | Subject 2 |
|-----------|-----------|-----------|
| Reacting  | √         | √         |
| Elaborating | √        | √         |

Table 1. Recapitulation of the test results of two subjects by 3-phase mathematical reflective thinking skills.
In terms of responding to the interview questions, the first subject took a long time in considering the answers to be given. This is in accordance with the characteristics of students with the ability to think reflectively, that consider various alternatives before responding carefully [6], so there is the possibility to respond properly. The answers given by the first subject also tend to be more sharp and detailed. It can be seen from the answers given by the first subject in which the first subject wrote with detail where to get the size of triangle corners unknown in the question. Based on the interview, it is known that what causes the second subject to not answer the question item 2 is because the subject found difficulty looking for a way to check the correctness of the statements presented.

3.2. Habits of Mind

Based on the results of the subjects’ responses to the scale of habits of mind and the interview, the first subject tends to focus more on solving the questions whose results have not been obtain and continue to work on it. These two activities show that the first subject is able to survive in facing the problems encountered.

The first subject is also superior in the second indicator, which is managing impulsive. The first subject questioned whether the procedures used are already appropriate and correct, and the subject also read the questions carefully before starting to work. Meanwhile, based on the interview and the responses to mathematical disposition scale, the second subject reveals that reading the questions is rarely done and asking whether the working procedures are appropriate and correct are not conducted too often. Students feel no need for validation their solution anymore when the solution looks right and satisfying for them [7].

The first subject tends to look more closely at the questions or the information on the math questions, and find a reason that is according to the concept before answering such questions. Consideration done by the first subject was longer and more accurate than the second subject. It shows that the first subject is able to use the senses to gather and process data. As for the 13 other indicators, the two subjects are likely to have similar or even the same responses.

4. Conclusion

From the result of the discussion and analysis, it is revealed that the subject who is able to meet all the phases of the mathematical reflective thinking skills has the advantage on three indicators of mathematical habits of mind which include persisting, thinking and communicating with clarity and precision, and also gathering data through all senses. The subject contemplates more on the answers and strategies used, as well as writes the calculation steps in the more detailed method.

5. References

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