Students’ mathematical reasoning ability viewed from self-efficacy

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Abstract. Mathematical reasoning ability is one of the mathematical competencies that need to be developed in school learning. Mathematical reasoning is indispensable in learning in school, where students are asked to think logically or critically and creatively in solving problems. Students must have confidence in solving these problems. This research is a qualitative descriptive study that aims to analyze the ability of reasoning in solving set problems in terms of self-efficacy. The subjects of this study were 31 students from class 8 of Junior High School 1 Polokarto. The instrument used in this study was a matter of mathematical reasoning ability tests and non-tests in the form of a self-efficacy questionnaire. Based on the results of the study, it was stated that students who have high self-efficacy still have difficulty in solving mathematical reasoning problems, students who have medium self-efficacy still have difficulty in solving mathematical reasoning problems, while students who have low self-efficacy always have difficulty in solving mathematical reasoning problems. Teachers should pay more attention to guiding students so that they do not despair to improve mathematical reasoning abilities so as to reduce student learning difficulties.

1. Introduction

Mathematics is a very important science because mathematics plays a role in the development of other sciences in supporting the advancement of science and technology [1]. This resulted in mathematics is very potential to be taught at all levels of education starting from the lowest level of education to the highest level of education. Mathematics is knowledge gained from observations, studies and experiments which are derived from real objects. Mathematics is a human activity with mathematical objects in mathematics learning that starts with real problems in daily life or that are close to students' minds [2]. In this case, mathematics can be said as an exact knowledge which includes principles, concepts, and thinking patterns related to daily life.

Mathematics learning in schools aims to practice mindset and reasoning in concluding, developing the ability to solve problems, and developing the ability to convey information or ideas [3]. Mathematics and mathematical reasoning are two inseparable things, namely, mathematics understood through reasoning, and reasoning understood and trained through learning mathematics.

The reasoning is one of the most important things in mathematics. NCTM states that the standard mathematics learning process consists of reasoning and proof, representation, problem-solving, connection, and communication [4]. The reasoning is one of the most important NCTM process standards that students must possess or master. The reasoning is a thought process that connects the process of analysis, synthesis, planning experiments, generalizing, evaluating, and proving a
conclusion [5]. The reasoning is the process of concluding principles and evidence to make new conclusions or evaluate conclusions proposed [6]. Reasoning can be said as a process of thinking systematically and logically to obtain a conclusion or proof. The reasoning is needed in solving a mathematical problem. Mathematical reasoning is the basis of mathematics in understanding ideas, concepts, and procedures [7]. Mathematical reasoning needs to be fully integrated into classrooms, schools, and districts across the country to produce students and employees who are quite prepared for the 21st century [7]. This is very influential in students' mathematical reasoning abilities. Mathematics and mathematical reasoning are two inseparable things because mathematics is understood and done using mathematical reasoning [8]. The importance of mathematical reasoning ability, the teacher should invite students to reason or think to reason. But the fact is that in learning at this time students are still listening to the explanation from the teacher, re-writing what the teacher wrote on the blackboard and doing the questions that are not much different from what is exemplified by the teacher.

According to one mathematics teacher at Junior High School 1 Polokarto, students tend to memorize formulas without understanding and reasoning the formulas they get so that students easily forget the material taught by the teacher. Many students do not want or do not like to use their reasoning to solve mathematical problems. The nature and characteristics of students who tend to be passive in reasoning will affect student learning outcomes. Students have difficulty in understanding mathematics learning material and tend to only memorize the concepts or principles learned [2]. Students still have difficulty thinking logically in solving problems and are still afraid to issue an opinion or idea from the student's thinking. Lack of imagination and creativity is one reason students are not able to use reasoning skills properly [9].

The learning process at school will succeed if it is supported by psychological aspects related to students' attitudes in learning. Self-efficacy is a psychological aspect that produces a significant effect. Self-efficacy is an assessment of someone's ability to carry out certain behaviors or achieve certain goals [10]. Self-efficacy is a person's assessment of his ability to plan and implement actions to achieve certain goals [11]. Based on this, the relationship with mathematical reasoning ability is self-efficacy has a function to assess the success of students in solving problems of mathematical reasoning ability. This makes students trained to be confident in their abilities, dare to face challenges, not easily give up in solving problems and can know their weaknesses and shortcomings.

Belief in one's ability to organize and carry out the actions needed to manage the situation [12]. In this case, self-efficacy is prioritizing mastery in the cognitive aspects to produce a good performance, so that it can achieve its goals properly as desired. Self-efficacy related to assessment someone for her inner abilities completes a certain problem task [13]. But in reality, the importance of the role of self-efficacy is not felt by some students. Sometimes students assume that if they are smart they always get good grades and vice versa. Even so, smart students do not necessarily always get satisfying learning outcomes, as has been stated above that learning is not only influenced by the level of intelligence of students, but learning is influenced by many factors. If these factors inhibit students, it will affect the learning outcomes.

2. Method
This research is a qualitative descriptive study that aims to analyze the ability of mathematical reasoning to solve the problem of set material in terms of self-efficacy. The subjects in this study were 31 students in grade 8th at Junior High School 1 Polokarto. The sampling technique uses purposive sampling. The instrument used in this study was a test of mathematical reasoning ability and non-test in the form of a self-efficacy questionnaire.

The first step in this research is to create a self-efficacy poll. Self-efficacy grouping using norm reference assessment obtains student results in the high, medium, and low categories. As grouping students are presented in Table 1 below.
The second step taken in this study was given a matter of mathematical punishment abilities. Student answers are analyzed based on indicators that exist on mathematical reasoning abilities. The indicator table below is presented in the Table 2 below.

**Table 2. Mathematical Reasoning Ability Indicator.** [15]

| No | Reasoning Indicators                                           |
|----|----------------------------------------------------------------|
| 1  | Submitting allegations                                        |
| 2  | Conducting mathematical manipulation                          |
| 3  | Conclude the statement                                        |
| 4  | Examining the validity of an argument                         |
| 5  | Find the pattern or nature of mathematical symptoms to make generalization |
| 6  | Draw conclusions, compile evidence, provide excuses or evidence against the correctness of solutions |

3. Result and Discussion

Data from the results of the distribution of the poll to 31 students in grade 8th, then obtained the overall data to see the level of self-efficacy. The results of the self-efficacy are obtained based on the norm reference assessment, the overall data will be presented in the Table 3 below.

**Table 3. Category Self Efficacy.**

| Self Efficacy | Category |
|---------------|----------|
| Score > 104   | High     |
| 96 ≤ Score ≤ 104 | Medium |
| Score < 96   | Low      |

The table above shows the student groupings based on the score students have gained in self-efficacy. Here is the percentage of self-efficacy presented in the Table 4 below.

**Table 4. Percentage of Self Efficacy.**

| Category | Frequency | Percentage |
|----------|-----------|------------|
| High     | 11        | 35%        |
| Medium   | 13        | 42%        |
| Low      | 7         | 23%        |

The Table 4 above shows students who have a high self-efficacy as much as 11 students with a percentage of 35%, self-efficacy being as much as 13 students with a percentage of 42%, and low efficacy of 7 students with a percentage of 23%.

From all of these data, each of the 2 subjects was chosen based on the category of self-efficacy to be analyzed based on mathematical reasoning abilities. The following results from the selection of research samples are presented in the Table 5 below.
Table 5. Samples of Self Efficacy.

| Category | Students’ Code |
|----------|---------------|
| High     | S-1, S-2      |
| Medium   | S-3, S-4      |
| Low      | S-5, S-6      |

The results of the analysis are based on the indicators of students' mathematical reasoning ability. Following are the results of student analysis:

3.1 Analysis of Mathematical Reasoning Ability

3.1.1 Answer for S-1 and S-2 who have high self-efficacy

The results of a survey of N people with the question whether they keep dogs, birds or cats at home are as follows: 50 people keep birds, 61 people do not keep dogs, 13 people do not keep cats, and at least 74 people who maintain at least two types animal at home. What are the maximum and minimum values of possible N values?

Figure 1. Question of Mathematical Reasoning Ability.

\[ \begin{align*}
\text{Keep birds} &= 50 \\
\text{not keep dogs} &= 61 \\
\text{not keep cats} &= 13 \\
\text{At least keep two animals} &= 74 \\
\end{align*} \]

Equation of (1) and (4)
\[ a + x + z + p = 50 \]
\[ a + x + b + q = 61 \]
\[ a + c + z + q = 13 \]
\[ x + y + z + q = 74 \]

Equation of (1) and (4)
\[ a + x + z + p = 50 \]
\[ a + x + z + p + y = 50 + y \]
\[ a + 74 = 50 + y \]
\[ 74 - 50 = y - a \]
\[ 24 = y - a \]

\[ N = \text{The total number who raise animals} \]
\[ N = a + b + c + x + y + z + p + q \]
\[ N = (a + b) + c + 4 + y + y + 2 + p + q + a - 0 \]
\[ N = 61 - x - q + 13 - 2 - q + 24 + x + 2 + p + q \]
\[ N = 98 - q + p \]

Maximum and minimum values:
Maximum value
\[ N > 98 \]
Minimum value
\[ N < 98 \]

Figure 2. Answers of High Self-efficacy Student Subject S-1.
Figure 2 shows the answer to the S-1 students answering questions quite complete and fulfilling several indicators of mathematical reasoning ability. The first indicator of mathematical reasoning ability, submitting conjectures is to write things that are known and asked clearly and completely. Subject S-1 has written all the information that is known from the problem by using a fairly good mathematical symbol. They can submit their assumptions by assuming set members with letters a, b, c, x, y, z, p, and q which are the set of dogs, cats, and birds. In the second indicator of mathematical reasoning abilities, doing mathematical manipulation is changing statements into mathematical form and making illustrations of problems with pictures and mathematical symbols.

The third indicator, drawing conclusions, compiling evidence, giving reasons or evidence of the correctness of the solution that is the subject of S-1 has made conclusions obtained from the problems obtained. The conclusions made are already connected with the context of the problems that exist in the problem, although not yet perfect. In the fourth indicator, drawing conclusions from a statement that is from a statement S-1 subject can already conclude the statement obtained from the problem.

In the fifth indicator, checking the validity of an argument, subject S-1 still does not show in checking the validity of the answers to an argument again.

The sixth indicator finds patterns or properties of mathematical symptoms to make generalizations. On this indicator, the subject of S-1 can find a new form or mathematical symbol obtained from the problem obtained. So that the subject of S-1 can solve the problem in the problem. Based on the results above it can be seen that students can solve all such problems that students who have high self-efficacy tend to solve problems with various levels difficulty and not easily discouraged in solving mathematical problems [16]

![Diagram]

Figure 3. Answers of High Self-efficacy Student Subject S-2.

Figure 3 shows the results of the S-2 students' self-efficacy answers by fulfilling several indicators in solving problems.

In this first indicator of mathematical reasoning ability, submitting conjectures is to write things that are known and asked clearly and completely. Subject S-2 has not written all the information that is known and asked clearly. Also, S-2 subjects write information that is known and asked non-coherently. There is information that should be written as a known thing instead of as written as a question.

The second indicator of mathematical reasoning abilities, doing mathematical manipulation that is manipulating what is known, making illustrations of problems in problems with pictures, and making mathematical modelling of problems. Both the S-2 subjects have done mathematical manipulations in
the form of images but are still unclear. This is because the picture on S-2 is presented on the answer sheet is incomplete and is not equipped with clear information. In the third to sixth indicators, the S-2 subject is not fulfilled and is not completed, so the S-2 subject's answer is not completed.

Based on the description above, information is obtained that subjects with high self-efficacy are S-1 and S-2 but there are differences in solving problems. It is known that S-1 students have high reasoning abilities in solving problems, while in S-2 students still have difficulty in solving problems. the results of the study said that students who have high self-efficacy do not mean they have no difficulty in solving problems of mathematical reasoning ability [17]

| Known: |
|--------|
| Keep birds = 50 |
| $a + x + 2 + p = 50$ |
| not keep dogs = 61 |
| not keep cats = 13 |
| $a + 2 + c = 13$ |
| At least keep two animals = 74 |
| $x + p + y + z = 74$ |
| $N = \text{the sum of all who keep animals}$ |
| $N = a + b + c + x + y + z + q + p$ |

| Answer: |
|--------|
| $N = (a + b) + c + x + y + z + p + q + (a - a)$ |
| $N = 61 - x - q = 13 - 2 - q + 76 - 24 + x + z + p + q$ |
| $N = 98 - q + p$ |

| Maximum value: |
|----------------|
| $N \geq 98$ |

| Minimum value: |
|----------------|
| $N \leq 98$ |

Figure 4. Answers of Medium Self-efficacy Student Subject S-3.

Figure 4 shows the results of S-3 students' answers with moderate self-efficacy. S-3 fulfills several indicators of mathematical reasoning ability. In the first indicator of mathematical reasoning ability, submitting conjectures is to write things that are known and asked clearly and completely. Subject S-3 has written all the information that is known and asked in full. However, there is a slight error in writing which causes the information is unclear. In the second indicator of mathematical reasoning ability, doing manipulation is manipulating a problem in the form of mathematical modeling and the form of images. Also, the illustration of the picture is following the problem. In the third indicator conclude, compile evidence, provide reasons or evidence for the truth of the solution. On the subject of S-3, students can conclude and change the language of mathematics into the language used in problem problems. Subject S-3 has concluded but there are still errors. In the fourth, fifth and sixth indicators, S-3 is still not fulfilled. So the subject of S-3 is still said to be in the category of medium mathematical reasoning.
Figure 5. Answers of Medium Self-efficacy Student Subject S-4.

Figure 5 shows the results of S-4 students' answers with moderate self-efficacy. In the results of student answers, there are several indicators of mathematical reasoning ability that are not met, such as inferring, checking the validity of arguments, and finding patterns or the nature of mathematical symptoms to make generalizations.

In the first indicator of mathematical reasoning ability, put forward a guess that is writing things that are known and asked clearly and completely. Subject S-4 has written all the information that is known and asked in full. However, there is a slight error in writing which causes the information is unclear.

In the second indicator of mathematical reasoning ability, doing manipulation is manipulating a problem into the form of mathematical modeling and in the form of images. In addition, the illustration of the picture is in accordance with the problem.

In the third, fourth, fifth and sixth indicators, S-4 is still not fulfilled. So the subject of S-4 is still said to be in the category of low mathematical reasoning. It can be concluded that medium self-efficacy will result in low reasoning abilities.

3.1.2 Answer for S-5 and S-6 who have Low Self-efficacy

Figure 6. Answers of Low Self-efficacy Student Subject S-5.
Figure 6 shows the answers of S-5 students with low self-efficacy. S-5 answers show students still do not meet the indicators of mathematical reasoning ability. In the first indicator, which is to propose assumptions, S-5 does not solve the problem completely and there are still errors. While indicators perform mathematical manipulation, S-5 is still wrong in turning problems into mathematical models and drawing shapes. seen from the S-5 answer there is an error between the set of dogs, cats, and birds with a known statement. while other indicators of mathematical reasoning ability, S-5 are still not fulfilled.

```
Known:
Keep birds = 50
a + x + z + p = 50
Not keep dogs = 61
a + x + b + p = 61

N = a + b + c + x + z + p + q + a - a
N = b - x - q + 13 - z - 4 + 24 + x + 7 + p + q
N = 98 - q + p
```

Figure 7. Answers of Low Self-efficacy Student Subject S-6.

Figure 7 shows the answers of S-6 students with low self-efficacy. In this answer S-6, students still do not meet the indicators of mathematical reasoning ability. In the first indicator, the ability of mathematical reasoning put forward the allegations, then ask the things that are recognized and requested in full and complete. Subject S-6 has not verified all the information obtained and asked.

In the second indicator, the ability of mathematics, mathematical manipulation to manipulate what is known, make illustrations of problems with images and make mathematical modeling of problems. S-6 did not do mathematical manipulation correctly and still made mistakes. In the S-6 answers, students solve problems incorrectly and incorrectly. students with low self-efficacy are quite able to identify problem but are still unable to find strategies in solving problems [18].

Figure 6 and Figure 7 show the answers of students who have low self-efficacy because they do not meet several indicators of mathematical reasoning ability. based on research students who have low self-efficacy tend to have low math scores [19]. Students who have low self-efficacy tend to be easily discouraged and frustrated when they fail and when they are faced with difficult problems [20]

4. Conclusion
Based on the results of research and discussion, it can be concluded that the ability of mathematical reasoning in solving set problems in terms of students' self-efficacy. There are some difficulties in the ability of mathematical reasoning at each student's level of self-efficacy. It can be seen from the results of tests of mathematical reasoning ability and non-tests in the form of a self-efficacy questionnaire. Based on the results of the study, the students who have high self-efficacy still have difficulty in solving mathematical reasoning problems, students who have medium self-efficacy are also still having difficulty in solving mathematical reasoning problems, while low self-efficacy students always have difficulty in solving mathematical reasoning problems.

The teacher should pay more attention to guiding students so as not to be discouraged to improve mathematical reasoning abilities so as to reduce student learning difficulties. Researchers here hope that there will be more research on solutions that can solve students' self-efficacy problems in mathematical reasoning abilities in schools so that students' ability to solve problems can be improved.

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