An analysis of the ability of mathematical connection with the material of rectangles and triangles

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Abstract. This research aimed to analyze students' mathematical connection ability in the material of rectangles and triangles. The method put on research is descriptive qualitative method. The research subjects were selected using a purposive sampling technique according to the classification of high, medium, and low initial abilities consisting of 2 students in each category. The selected subjects composed of 2 students based on the measurement scale of high ability category and the selected students had received material on rectangles and triangles. The research consisted of a test question instrument of mathematical connection. The results represented that mathematical connection ability with the material of rectangles and triangles is in a medium ability, that students can recognizing and using mathematical concepts outside the context of Mathematics in solving real-life problems. Some students can use the connection among mathematical concepts with other mathematical concepts but student did not provide the correct solution to the problem and some students cannot identify problems and use mathematical concepts.

Keywords: Mathematics, Ability of Mathematical Connection, Rectangles and Triangles

1. Introduction

Mathematics is the science of logic, geometry, numbers, and conceptual relationships by utilizing symbols or mathematical language in resolving problems in daily life [1]. Mathematics is connected to one another, and cannot be separated from other knowledge and issues in real life [2]. This becomes the basis that mathematics have to flexibly and understood as a relationship among mathematical ideas with one another [3]. The significance of learning mathematics is to be able to improve students’ intelligence so that they possess the ability to think, interact with one another, and can provide solutions to problems in daily life [4].

NCTM (2000) revealed that there are five standards of the mathematical ability of objectives of mathematics learning that must be achieved by students in learning, including representation skill, problem-solving skill, reasoning skill, connection skill, and communication skill [5]. These abilities must be present in mathematics learning in schools to advance the quality of education.

One of the abilities that have to achieved by students is the ability of mathematical connection; which is explaining the relationship among the concepts and apply the concepts or be accurate, efficient, smooth, and correct in solving problems [6]. The mathematical connection of students cannot be separated from efforts to solve mathematical problems. The process of resolve mathematical problems is a form of student activity to improve students’ mathematical connections. This statement is relevant...
because in solving problems, students must possess the ability to be able to utilize or relate mathematical concepts or mathematical theorems to solve mathematical problems [7]. Mathematical connection ability will assist students show the relationship among concepts in a given problem [8].

The ability of mathematical connection can be considered as an activity process in connecting mathematical concepts and the connection of several mathematical ideas that will be utilized in completing problems, including in mathematics subject, other subjects, and problems in everyday life [9]. Mathematical connection is a high-level ability where every mathematical concept is related to one another [10]. Mathematical connection ability is the ability to connect and link mathematical concepts with other fields of science [11]. Indicators of mathematical connection cover: (a) identifying and utilizing mathematical concepts, (b) using linkages among mathematical concepts with other mathematical concepts, and (c) recognizing and occur mathematics in contexts outside mathematics [5].

Mathematical connection skill can improve students’ cognitive abilities including understanding and remembering the application of mathematical concepts [12]. Mathematical connection that is not applied will make it difficult for students to remember the material given and remember too many mathematical concepts [7]. Mathematical connection is the essential matter that students need to achieve in learning mathematics because by knowing the connection among concepts, students will understand math quickly, and create opportunities for them to further improve their abilities [13]. Mathematical connection plays a significant role in students’ understanding of the mathematical concepts they learned so that it will stick more in their memories in the long term [14]. By making a mathematical connection, students will learn about the utility of mathematics [15].

Mathematical connection skill has a crucial role for students, but those who master mathematical concepts do not necessarily have good mathematical connections [16]. Meanwhile, the low ability of students' mathematical connections will have an effect on the low achievement of students' mathematics learning and has a major influence on the quality of student learning [17]. According to research, students still difficult to determine mathematical concepts to be used in finding solutions to problems. Students are less able to identify the connection among mathematical concepts with mathematical concepts themselves, especially in solving problems in daily problems [18]. The weak ability of mathematical connection of students can be seen from those who make difficulty working on questions given by the teacher because of their inability to connect the concepts or materials that have been studied [19].

The results represent that mathematical connection ability of seventh-grade junior high school students in completing problems of linear equations and inequalities of one variable was high-ability. This study used indicators to measure mathematical connection of students according to the reasoning of Ramdani [20]. The results of a study stated that mathematical connection of grade IX junior high school students in providing a settlement solution of material of congruence was relatively low. The study used indicators according to Mountage’s reasoning in measuring mathematical connection of the students [21].

This research aimed to decide mathematical connection ability of eighth-grade junior high school students in the material of rectangles and triangles. The indicators used based on NCTM (2000).

2. Methods

The method put on research is descriptive qualitative method. This research took in the eighth-grade of state junior high school 16 Surakarta in the 2019/2020 school year. The selection of subjects in the study used a purposive sampling technique, which was sampling techniques using certain considerations [22]. Research subjects were classified based on the classification of high, medium, and low initial abilities consisting of 2 students in each category. The chosen subjects composed of 2 students based on the measurement scale of high ability category and the selected students had received material on rectangles and triangles.

The research consisted of a test question instrument of mathematical connection. The data obtained includes three essay questions according to the ability of mathematical connection test on teaching materials of rectangles and triangles. Mathematical connection ability of students is assessed according to the indicators of mathematical connection. Data analysis techniques used include data
display, data reduction, and drawing conclusions. Data reduction focuses on the significant things, selecting the main things, and summarizing. Data display is compiled by processing information in narrative form and paying attention to transcripts of interview results to draw conclusions. This study used the method of triangulation for data validity. The method of triangulation is the use of different or the same data collection methods [23]. Figure 1 shows a flowchart of the research steps.

![Figure 1. Research Steps](image-url)

3. Results and Discussion
According to research, mathematical connection of students in solving mathematical problems on algebra material is in a low category. This study used the indicators of the ability of mathematical connection according to Noto et al. The research subjects were selected from the eighth-grade class of junior high school [24]. According to research, senior high school students had low ability of mathematical connection in working on HOTS (Higher Order Thinking Skills) questions on the material of a two-variable system of equations. The indicator used the opinion of Noto et al, for research subjects of ninth-grade students of senior high school [25]. The next result is the results of students’ answers representing the high-ability category of 2 students.

| Indicators | Question |
|------------|----------|
| 1          | Mrs. Tuti will make an isosceles triangle-shaped photo frame with a base length of 8 cm and a side length of 12 cm. If Mrs. Tuti has 5 meters of wood, what is the maximum number of photo frames that can be made? |
| 2          | Rizky and his friends are making a house plan. The circumference of the plan known is 26 cm. How is the way to know the length and width of the house plan if the length is 4x cm an width is x + 3 cm? |
| 3          | A farmer has a rectangular plot of land with an area of 240 m². If the width of the land is 12 m, how long is the land? What is the total price of the land if the land is to be sold for Rp. 600,000 per m²? |
Figure 2. Answer to Question 1 of Subject 1

Figure 2 shows that in the initial work, Subject 1 can apply the triangle concept, but in the final step of the work, Subject 1 made the wrong division and did not change the units first. It can be considered that Subject 1 could define and solve the given problems, but difficult to determine solutions to problems because Subject 1 could not apply the mathematical concepts. It is suspected that Subject 1 did not apply mathematical concepts.

These results are supported by the interview with Subject 1, stating that Subject 1 was confused when given different problems. Subject 1 did not understand the mathematical concepts being studied. Therefore, it can be interpreted that Subject 1 can not identify and use mathematical concepts.

Figure 3. Answer to Question 2 of Subject 1

Figure 3 shows that Subject 1 could apply connections among mathematical concepts with another mathematical concept. Subject 1 could complete the concept of rectangle into algebra form to determine solutions in solving problems, even though Subject 1 made mistakes in calculations. It is suspected that the student can understand the connection among mathematical concepts with other mathematical concepts.

These results are supported by the interview with Subject 1, stating that Subject 1 understood the mathematical concepts of the questions given. Subject 1 could take advantage of mathematical concepts that had been studied, which was the material of the linear equation system of one variable with the
mathematical concept being studied, which was the rectangles material, but realize that there were errors in doing calculations. It can be interpreted that the student understood the connection among mathematical concepts with other mathematical concepts.

![Image of mathematical calculations]

**Figure 4. Answer to Question 3 of Subject 1**

Figure 4 shows that in the initial work, Subject 1 was able to identify problems and apply mathematical concepts outside the context of Mathematics in daily life, but at the completion step, Subject 1 made mistakes in giving answers. It is suspected that the student was not careful in reading the questions, but was fully able to recognize and use mathematical concepts outside the context of mathematics.

These results are supported by the interview with Subject 1, who stated that Subject 1 understood the meaning of the questions and could identify the concepts to be used but not through in reading the question. Therefore, it can be interpreted that Subject 1 could recognize and apply mathematical concepts outside the context of mathematics especially in the daily context.

![Image of mathematical calculations]

**Gambar 5 Answer to Question 1 of Subject 2**

Figure 5 shows that Subject 2 could analyze the problems. Subject 2 could use mathematical concepts correctly, even though Subject 2 made mistakes in calculations. It is suspected Subject 2 could understand mathematical concepts, but not careful in the process.

These results are supported by the interview with Subject 2, showing that in fact Subject 2 understood the questions, but Subject 2 realizes of making mistakes the calculations. Therefore, it can be interpreted that Subject 2 could identify and use mathematical concepts.
Figure 6 shows that Subject 2 can analyze rectangle problem and apply the connection among the rectangle concept and the variable linear equation concept but did not provide solutions to the problems given. It is suspected that Subject 2 did understand how mathematical concepts are connected and constructed with one another.

These results are supported by the results of the interview with the student, stating that Subject 2 was still confused when faced with problems outside the concepts being learned. Therefore, it can be interpreted that Subject 2 understand the connection among mathematical concepts with other mathematical concepts.

Figure 7 shows that Subject 2 could identify problems, recognize problems, and apply mathematical concepts outside the context of mathematics. It is suspected that the student could understand and apply mathematical concepts in daily problems.

These results are supported by the results of the interview with the student, stating that the student better understood questions in the form of problems of daily life. Therefore, it can be interpreted that the student could recognize and apply mathematical concepts in contexts outside mathematics.

According to results of the analysis, subject 1 could not identify and utilizing mathematical concepts but can use the connection among mathematical concepts by other mathematical concepts and use mathematical concepts outside the context of mathematics in solving real-life problems. Subject 2 could identify and make use of mathematical concepts, could recognize and occur mathematical concepts in solving real-life problems, but did not yet understand the connection among mathematical concepts with other mathematical concepts.

Different from previous studies, the novelty of this research is to analyze the ability of mathematical connection of students with the material being tested of rectangles and triangles. Indicators of mathematical connection this research make use of NCTM include: (1) identifying and utilizing
mathematical concepts, (2) using linkages among mathematical concepts with other mathematical concepts, and (3) recognizing and occur mathematics in the context of everyday life in solving real-life problems. Research subjects were eighth-grade students of junior high school.

5. Conclusion and Suggestion

According to the results, it can be resumed that mathematical connection with the material of rectangles and triangles is in a medium ability, that students can recognizing and using mathematical concepts outside the context of mathematics in solving real-life problems. Some students can utilizing the connection among mathematical concepts with other mathematical concepts but student did not provide the correct solution to the problem and some students can not identify problems and use mathematical concepts. For further research, the results of this study can be utilized as a comparison and reference for research and as a consideration. It suggests further research to analyze mathematical connection ability of students in rectangles and triangles material using HOTS (Higher Order Thinking Skills) questions in junior high school or senior high school students.

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