Mathematical connection ability of middle school students in solving quadrilateral

Novianti¹*, B A P Martadiputra² and N Priatna²

¹Program Studi Pendidikan Matematika, Sekolah Pascasarjana, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudi No. 229, Bandung 40154, Indonesia
²Departemen Pendidikan Matematika, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudi No. 229, Bandung 40154, Indonesia

*Corresponding author’s email: novianti@upi.edu

Abstract. The purpose of this study is to analyze the ability of students' mathematical connections in solving quadrilateral problems. This research used qualitative approach for a descriptive research. The population in this study was all students of grade VIII of junior high school in Bireuen, Aceh Provence, while the sample was 20 students (around age 13-14 years) who were selected by purposive sampling technique. Data collection techniques used in the study were tests and interviews. The results showed that overall mathematical connections were still low at 39%. While the percentage of each connection indicator between topics of mathematics is 35%, connections with other disciplines are 28%, connections with the real world are 53%. Students faced difficulty in linking among mathematical concepts, this is due to not mastering the prerequisite material optimally even some students only remember the concept but forget how to do operations correctly, meanwhile students forget about physics concepts in calculating distances so that many students had difficulty in associating concepts mathematics with other disciplines. Based on these results, the researchers suggest to: 1) improve students' mathematical connection abilities, 2) train students with non-routine problem solving.

1. Introduction
Mathematical connection is a cognitive process where one can connect mathematical ideas with other or more subjects, both in terms of concepts, theorems, procedures, representations to be more meaningful when connecting scientific disciplines with real life [1]. Students who have good mathematical connection skills are able to understand mathematical concepts in more depth [2]. This is in line with NCTM that there are five basic abilities that students must possess that become standard in learning, including problem-solving skills, communication, connection, reasoning and representation [3]. Thinking deeply about concepts related to mathematics before, is important in mathematical connection skills, because of the systematic and structured nature of mathematics [4]. According to Hidayati, Kartono, and Masrukan [5] important mathematical connection abilities are mastered by students in learning mathematics in order to be able to use mathematics in other fields of science, associate mathematics with other mathematical concepts, as well as with other fields of science and mathematics with everyday life. Thus, the more students can connect mathematical connections, the more meaningful and optimal learning will be [6].

However, the facts in the field show that students' mathematical connection skills are still low, caused students do not understand math problems that are associated with other subjects as well as in everyday
life [5]. This is similar to research [7], some students find it difficult to associate mathematical ideas and concepts to only reach 50%. While research [8] percentage of student achievement in the students' mathematical connection ability test is still relatively low, which is equal to 63.6% which is below the minimum completeness criteria (KKM).

NCTM describes indicators for mathematical abilities, namely (a) recognizing and utilizing the relationships between ideas in mathematics; (b) understand how the ideas in mathematics; and (c) recognize and apply mathematics in contexts outside mathematics [3]. Based on the description of the NCTM, it can be concluded that the indicators used in this study are the connections between mathematics, connections with scientific disciplines others, and connections with the real world or connections with everyday life.

The purpose of this study was to the mathematical ability of students of grade VIII of junior high school in Bireuen-Aceh in solving quadrilateral problems.

2. Methods
This research uses a qualitative approach to the type of descriptive research. Participants in this study were students studying in grade VIII of junior high schools in Bireuen, as many as 20 students (around age 13-14 years). Data collection used in the form of tests and interviews. The research location was conducted at a junior high school located in Bireuen, Aceh. The instrument used was a description for 90 minutes. The description test consists of three items. Item use 3 indicators of mathematical connections namely: (1) connections between mathematical topics; (2) connections with other disciplines; and (3) connection with the real world [3]. Whereas for each item a mathematical connection ability can be shown in Table 1. The details of the test question assessment rubric mathematical connection ability skills used in this study is provided in Table 2.

| No. | Connection Capability Indicator | Question |
|-----|---------------------------------|----------|
| 1.  | The connection between mathematical topics | Look at the parallelogram below! |
|     |                                  | D        |
|     |                                  | (3x + 4) cm |
|     |                                  | A        |
|     |                                  | B        |
|     |                                  | C        |
|     |                                  | 20 cm    |
|     |                                  | (5x-16) cm |
|     | a. Change the above equation into a mathematical model? |
|     | b. Using the parallelogram properties, determine the width of the parallelogram? |
| 2.  | Connection with other disciplines | Taufik took part in a running race around 4 rectangular pitches with an average speed of 2 m / sec for 5 minutes: |
|     |                                  | a. Determine the distance Taufik traveled in running? |
|     |                                  | b. Determine the width of the field if it has a length of 45 meters. |
| 3.  | Connection with the real world    | Pak Angga has a plot of land in the form of a long building with a length of 60 m and 40 m. Then, around the ground, a fence will be installed at a cost of Rp30,000.00 |
|     |                                  | a. From the problem above, change the equation into a mathematical model? |
3. Result and Discussion
Based on the average results of student answers, it can be concluded, that overall mathematical connection ability is still low, reaching 39%. While the percentage for each indicator of the connection between topics of mathematics is 35%, connections with other disciplines are 28%, connections with the real world are 53%. The average results were tabulated in Table 3.

Table 2. Mathematical Connection Ability Assessment Rubric

| No | Indicators | Description | Score |
|----|------------|-------------|-------|
| 1. | The connection between mathematical topics | a) No Answer | 0 |
|    |            | b) Can arrange a mathematical model of the problem asked | 0-2 |
|    |            | c) Can connect between mathematical topics that are similar to topic of mathematical with problems presented | 0-2 |
|    |            | d) Can connect between mathematical topics that are similar to topic of mathematical problem. | 0-2 |
|    |            | e) Can solve problems between mathematical topic Sub-total | 0-8 |
|    |            | a) No Answer | 0 |
|    |            | b) Can arrange a mathematical model of the problem asked | 0-2 |
|    |            | c) Can connect mathematical topics with other disciplines with problems presented | 0-2 |
|    |            | d) Can connect mathematical topics that are similar to other disciplines | 0-2 |
|    |            | e) Can solve mathematical problems with other disciplines Sub-total | 0-8 |
| 2. | Connection with other disciplines | a) No Answer | 0 |
|    |            | b) Can arrange a mathematical model of the problem asked | 0-2 |
|    |            | c) Can connect mathematical topics with the real world or everyday life with problems presented | 0-2 |
|    |            | d) Can connect mathematical topics similar to the real world (daily life) | 0-2 |
|    |            | e) Can solve math problems with the real world (daily life) Sub-total | 0-8 |

Table 3. Average students' mathematical connection ability on each indicator

| Indicator | Student's Score | Total Score | Percentage | Category |
|-----------|----------------|-------------|------------|----------|
| The connection between topics of mathematics | 56 | 160 | 35% | Low |

(Modified from [9])
3.1 First Analysis: Indicators connection between mathematical topics

The results of the analysis of student test answers based on connection indicators between mathematical concepts indicate that the percentage of students reaches 35% and is categorized as very low. This is because students have difficulty in connecting between mathematical topics and students have not mastered the prerequisite material optimally even some students only remember the concept but forget how the concept operates.

The results of interviews of the three subjects namely NVP, PTR, and RRY said that they have not been able to solve problems related to one mathematical topic with another mathematical topic. Furthermore, students forget how to substitute and broad formula ladder, so the completion is incomplete. NVP’s has been able to create mathematical models, connect topics between mathematics and solve what is known from the problems, but has not been able to solve correctly. After being interviewed, it turns out that NVP’s forgot the broad formula of ladder, so that the problem solving was not done in full. PTR’s has been able to connect concepts between mathematical topics, it can be seen from the answers given in completing a linear variable, but doesn’t substitute the equation to find the basis of the ladder level, so that the width of the network is not completed. When interviewed it was found that, PTR’s, was confused of its completion. RRY’s answers only write what is known from the problem and add up the results and when interviewed the researchers found RRY’s did not understand the problem and confused how to solve it.

3.2 Second analysis: Indicator of connection with other disciplines

The question number 2, students are asked to determine the distance and width of the field. The number of students who are able to solve problems with connections with other disciplines is 28% and classified as low. This is because students have forgotten about the physics concept in the calculating distance so that many students have difficulty in connecting mathematical concepts with other disciplines. So, the answers given are not complete. NVP’s and PTR’s were able to write down what is known from the problem, linking the concepts of mathematics with physics, so that in determining the distance from the question being asked is correct. Meanwhile, PTR’s problem solving step number is slightly different from NVP’s, but the answers given by PTR’s are correct. Furthermore, RRY’s only make mathematical models, but there is no solution. So, it can be concluded RRY’s have not been able to connect mathematics with other sciences. From the interviews RRY did not understand the concept of mathematics connected with other sciences, while NVP and PTR were able to connect mathematics with other fields of science.

3.3. Third analysis: Indicator of connection with the real world

As for question number 3, the question (a) makes a mathematical model and (b) the number of costs needed to make a fence. The number of students who are able to solve problems in the connection indicator with the real world is 53%. NVP’s able to connect mathematics with real life or everyday life. The subject of PTR’s did not make a mathematical model, but directly did calculations around the length of the ladder. However, when interviewed. "Why don't you make a mathematical model? "Because in my opinion, it's too complicated to make mathematical models, so I immediately calculated the results, so the NVP answers given were correct. Meanwhile, NVP’s and RRY’s are also able to connect mathematics with real life, this can be seen from the problem solving. PTR’s have written a mathematical model of the questions asked by researchers, but the completion steps are not correct and
still make mistakes because of the concept of circumference, while RRY’s only make sketches of the ladder without calculating the circumference, this is because RRY’s have not been able to connect mathematics in real or everyday life. According to [2, 10] students who have ability to associate the relevance of ideas, mathematical ideas that are have good for subject that have been studied with the new lessons he gets.

The results of the analysis can be concluded that the ability of student connections is still very low. This is because there are still many teachers in schools who only provide simple calculation questions and very rarely even give a question that connects the three indicators. This is in line with the opinion [5] that student cannot connect concepts in mathematics, mathematical concepts to other subject, and problems in everyday life.

4. Conclusion
The results of the analysis of students' mathematical connection ability in solving non-routine problems on quadrilateral are still low, reaching only 35%. While the percentage on each indicator of connections between mathematical topics is 45%, connections with other disciplines are 25%, connections with the real world are 35%. Nevertheless, students are able to demonstrate the ability of mathematical connections in making known mathematical models of problems, even though they are unable to solve problems correctly and correctly. In this study, the most visible ability of students' mathematical connections is the mathematical connection indicators in real life. Based on these results, the researchers suggest to: 1) improve students' mathematical connection abilities, 2) train students with non-routine problem solving.

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