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Exploration of students mathematical connections with negative attitudes in solving a contextual geometry problem

D S Pambudi

Department of Mathematics Education, Universitas Jember, Indonesia

*Corresponding author's e-mail: didikpambudi.fkip@unej.ac.id

Abstract. A mathematical connection is an essential aspect of the mathematics learning process. Students vary in mathematical connection ability, some are strong connection ability, and others are weak. This research aimed to explore the ability of the mathematical connection of Junior High School students with negative attitudes towards mathematics in solving the contextual problem. Research subjects were two eighth grade students in Jember. Subjects selected by giving attitudes questionnaire and based on the questionnaire scores. There were two subjects chosen with the lowest scores of category in negative attitudes towards mathematics. Data were collected through interviews based on tasking problem solving (TPS). The contextual problem given in the TPS contains the concepts of geometry and social arithmetics. Data were analyzed qualitatively using the categorization, reduction, presentation, interpretation, and conclusion. The results showed that the research subjects made connections using facts, concepts/principles, procedures, and representations. But unfortunately, these mathematical ideas are not sufficient, and some of them are not connected properly, so students fail to solve the problem. From these results, it can be concluded that mathematical connections of junior high school students with negative attitudes towards mathematics include in the weak connections category.

1. Introduction

Since NCTM [1] made problem-solving and mathematical connections, the standard of the mathematics learning process in the USA, curricula in many countries have also changed. In Curriculum 2013, the connection between mathematics and problem solving is used as the goal of learning mathematics in schools, so mathematics teachers need to teach these two things to students [2].

Mathematical problems are problems for students, where students cannot directly answer questions and must determine the right strategy or steps to solve them [3][4][5]. Besides, students need to have complex thinking skills to understand problems, make plans, implement plans, and check answers [5], [6]. Contextual mathematical problems or abbreviated as contextual problems, are problems that contain mathematical problems with the context of events that occur in everyday life or close to the life of a child [7]. In this research, the contextual problem given to the research subjects is a word problem that contains topics of social geometry and arithmetic by taking the context of buying and selling land and making fences around a plot of land.

It is realized that "mathematics is a study that contains a collection of related topics or ideas" [1]. Therefore, to learn mathematics, students must have the ability to connect these various ideas to produce a unified whole to be applied in solving mathematical problems [1][2]. Mathematical ideas in the form

of facts, concepts/principles, representations, and procedures need to be connected and used by students accurately in solving contextual problems [8][9][10].

Students' mathematical connections can be described as a collection of schemes that are connected in a student's mental network, where the number of systems and the accuracy of these network connections determines the strength of the network [10]. The mathematical connection has a close relationship with problem solving and mathematical understanding, where students' connection ability can determine students' success in solving mathematical problems, as well as making students' deeper mathematical understanding [1][10][11].

In this research, the strength of students' mathematical connections can be seen from the three indicators (1) the number of mathematical ideas that are connected in solving problem, (2) the accuracy of connections made between these mathematical ideas, and (3) students' understanding of the connection of ideas made and used to solve the problem [1][10]. If the three indicators are met, the students 'mathematical connections are categorized as strong connections. In contrast, if one or more of these indicators are not met, the students' mathematical connections are categorized as weak connections [1][10].

Scholars define mathematical attitudes as "likes or dislike about mathematics, a tendency to engage in or avoid mathematics learning activities, a belief that someone is good or bad in mathematics, and a belief that mathematics is useful or not useful" [12][13]. There are two types of students' attitudes towards mathematics, namely positive attitudes and negative attitudes [13][14][15]. The positive attitude of students towards mathematics means students like mathematics, want to learn mathematics, believe that they can work on mathematical problems, and believe that mathematics is useful for themselves and life. Conversely, students who are negative towards mathematics tend to dislike mathematics, do not want to learn mathematics, do not believe in their mathematical ability, and consider mathematics useless for themselves and for life [13][14][15].

For the Indonesian context, the ability of the mathematical connection of junior high school students are not the same, some are good, but many are weak [2]. Several factors affect the ability of students to connect mathematics, one of which is the attitude of students towards mathematics. The results of previous researches indicate that students' attitudes towards mathematics determine students' mathematics achievement, where students who have positive attitudes will have good students' learning outcomes, and vice versa [16][17][18][19].

The purposes of this study are to describe how junior high school students' mathematical connections with negative attitudes towards mathematics in solving a contextual geometry problem are categorized as strong or weak connections. This research is essential to do to describe the mathematical connections of junior high school students with negative attitudes towards mathematics. It can be input for mathematics teachers to improve students' mathematical connections skills in mathematics learning activities at school.

2. Methods

The instruments used in this study were 1) the researcher himself, 2) the standard attitude questionnaire (ATMI) developed by [15], translated into Indonesian and validated by three English language experts, and 3) the Tasking Problem Solving (TPS) which has been validated by three mathematics education experts. Both ATMI and TPS have been declared valid and can be used for data collection [15][19]. Table 1 gives four examples of statements in ATMI, which contain components of Self Confidence, Value, Enjoyment, and Motivation. Table 1 provides an example of four statements in the ATMI that students must answer. The answer choices consist of five choices, namely, Strongly Agree, Agree, Neutral, Disagree, and Strongly Disagree. Each answer choice is given a score ranging from 1 to 5.

Table 1. The examples of statements in ATMI.

Components	Statements in English
Self Confidence	Mathematics makes me feel uncomfortable.
Value	Mathematics is one of the important subjects to learn.
Enjoyment	I like mathematics.
Motivation.	I would like to avoid using mathematics in tertiary study

The mathematical contextual problem given to TPS can be seen in figure 1.

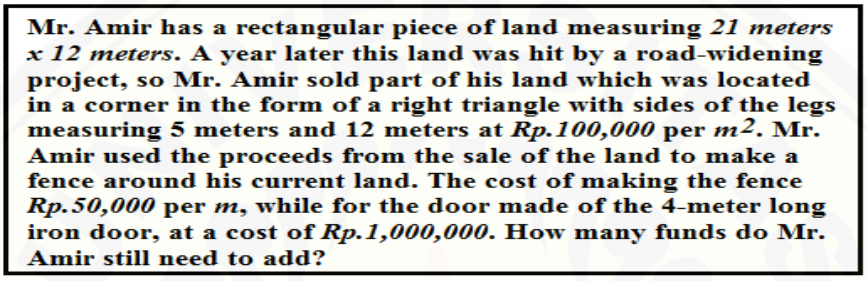

Figure 1. Contextual Problem in the TPS.

Figure 1 contains a contextual problem in geometry and social arithmetics that are given to research subjects. Several mathematical ideas need to be connected to answer this problem. These ideas include facts, concepts or principles, procedures, and mathematical representations.

Research subjects were selected by giving the ATMI to all eighth-grade students at an SMPN in Jember. The results of filling out the ATMI were scored, and all students were classified into three groups, namely the negative attitudes group, neutral, and the positive group. Then two students, the initials FAM (male) and CFA (female), who have the lowest scores of the group being negative attitudes towards mathematics, were chosen to be the subjects of research [19].

This research is an exploratory study with a qualitative approach. Research data collection begins by giving TPS to the subjects, and then the subjects complete the TPS according to their abilities and write the answer on a sheet of paper. Next, the researcher interviews the subjects to explore the subject's mathematical connections abilities. This activity was video-typed, noted, and transcribed. Time and method triangulation was carried out to obtain credible data, where TPS-based interviews were conducted. Besides, it also checks the suitability between answers written with the results of the interview. Credible data are analyzed descriptively by some steps, namely: data categorization, data reduction, data display, data interpretation, and making conclusions [20].

3. Result and discussion

3.1. Mathematical Connections of junior high school students with negative attitudes towards mathematics

The mathematical connection of students with negative attitudes in solving a geometry contextual problem can be elaborated as follows. The students' results can be seen in figure 2 and figure 3 and then expose theirs in many indicators of numbers, accuracy, and their connections.

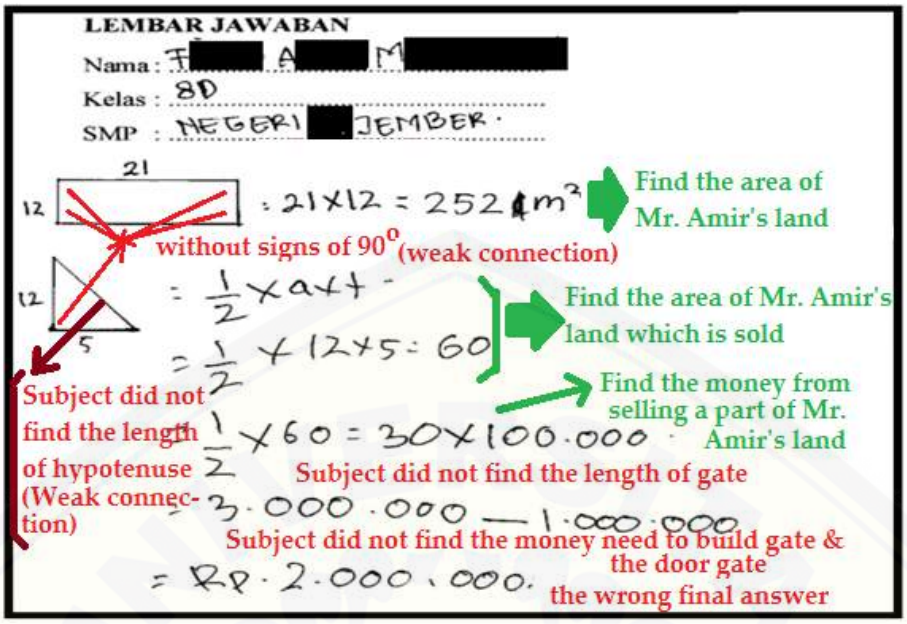

Figure 2. The written answer to subject FAM.

It can be seen from figure 2 that some facts are not made up, such as the right angle mark on the rectangle. The FAM subject also did not make any connections with the Pythagorean theorem concept, fence circumference, and the cost of building a fence. The result of this weak mathematical connection makes the FAM subject's answer wrong. Besides, the work of the subject CFA can be seen in figure 3.

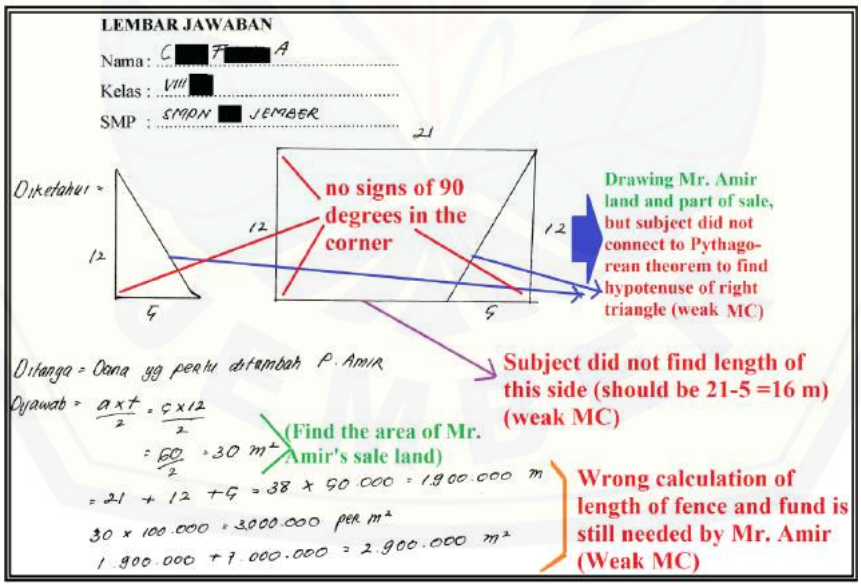

Figure 3. The written answer to subject CFA.

Figure 3 shows the results of the mathematical connections made by the CFA subject. The student did not make some essential facts, such as the symbol of right angles in the four corners of the rectangle and right triangle. The student also did not make a connection with the concept of the Pythagorean theorem to find the hypotenuse. The student writes down the answers to find the fence circumference and the cost of making the fence, but it is not clear. Due to this weak mathematical connections, the CFA subject's answer is wrong.

3.1.1 Numbers of mathematical ideas that are connected in solving the problem. From figure 2 and Figure 3, we can see that the subjects in solving contextual mathematical problems made a rectangular image as a representation of Mr. Amir's initial land. Still, the subject did not make a right angle at all four corners. Then they calculate the area of the land. Here, the students relate the concept of a rectangle, the representation of a rectangular image, to the idea of multiplication, the multiplication calculation operation, and the unit of area and its symbol. Then the students draw a right triangle showing a part of Mr. Amir's land that for sale. Here, the subjects relate the concept of the triangle area to the multiplication and division concept. It's arithmetic operations and the price of the land being sold. However, the students did not use rupiah. The students also did not associate the hypotenuse of the right triangle with the Pythagorean Theorem, and they did not find the length of the fence. They have linked mathematical ideas, such as facts, concepts/principles, representations, and procedures. Mathematical facts written by students on the answer sheet include information on the shape of the land and its size, the land for sale, and its size. The concepts used are the concept of rectangles, right triangles, the concepts of addition, subtraction, multiplication, and division. These concepts are associated with representations in the form of images, numbers, symbols, units. The principles used are the formula for calculating the area of a rectangle and the area of a triangle. The procedures used are to carry out problem-solving steps, such as drawing a problem situation, calculating land area with a formula, calculating the amount of money.

The students have tried to link various mathematical ideas, but unfortunately, the number of connections made is still low, and the amount is lacking. For example, students do not use the Pythagorean Theorem concept to calculate the length of the hypotenuse of a right triangle, and they do not calculate the perimeter of a fence. Students do not look for the cost of making a fence that should be associated with the cost of making a gate. Finally, they do not look for the amount of money that Mr. Amir needs to add, which is the answer to the problem being asked.

3.1.2 Accuracy of connections made between mathematical ideas. From the connections of mathematical ideas made by the subjects, there are some improper connections or links. First, the inaccuracy in the use of units and symbols, for example, length data is not written or written but is incorrect, such as meters, Rupiah (Rp) is not written, meters (m), and square meters (m^2) are not reported. The connections of mathematical ideas that are not made by the students indeed show that the students are not able to associate mathematical concepts that have been learned and mastered to solve the contextual mathematical problem faced. For example, the subjects do not look for the right triangle hypotenuse using the Pythagorean Theorem and do not look for the perimeter of the fence. It means that the subjects are not able to find new ideas that must be linked to the ideas that they have already known.

3.1.3 Students understanding of the connections ideas made and used to solve the problem. The ability of the students to understand mathematical connections from the ideas they make can be seen from the fragment of the interview below (R = Researcher, S1 = FAM).

R : What do you think about answering this problem?
S1 : I plot Mr. Amir's land before being sold.
R : What shape?
S1 : Rectangle
R : Is this picture you made correct?
S1 : Already correct.
R : What are the conditions for a rectangle?
S1 : The lengths of the sides are the same length, and the sides are the same width.
R : Are there any other conditions?
S1 : No longer.
R : Try to explain what the purpose of this calculation is? (½ × *a* × .....)

S1 : I am finding the area of sale land the formula area of the triangle, base times height divided by two
R : Is there anything you did not write from this area calculation? (½ × 12 × 5 = 60?)
S1 : No, it's not. It is correct, 30.
R : Then what is this (researchers point to 30 × 100,000 = 3,000,000).
S1 : The money that Pak Amir earns from selling land.
R : Is it 3,000,000?
S1 : Yes, exactly three million.
R : What's next? (The researcher appoints 3,000,000 - 100,000 = Rp. 2,000,000.00).
S1 : Then, I am calculating the money that must be spent, Mr. Amir.
R : Are you sure your answer is correct?
S1 : Sure Sir.

and also to the student S2 below,

R : Try to explain what you are looking for? (21 + 12 + 5)
S2 : Find the length of the fence
R : Do you think it's correct?
S2 : I did
R : Is there anything to forget?
S2 : None
R : Ok, then what does this 1,900,000 mean?
S2 : Amount of money to make a fence
R : Why 1,900,000 m? Is it Ok?
S2 : It is Ok
R : Then what is this 3,000,000 per m^2?
S2 : That is Mr. Amir's money from selling his land
R : Do you think it is correct to write down the amount of money per m^2?
S2 : Yes, correct
R : Then what is this? (1,900,000 + 1,000,000 = 2,900,000 m^2)?
S2 : That is the money that must be added by Pak Amir
R : Are you sure your answer is correct?
S2 : Not sure, but that's all I can

The interview fragment clearly shows that subjects do not deeply understand the connections of mathematical ideas made and used in the process of solving problems where the students do not know the terms of a rectangle having four right angles. The subjects unsure about the meaning of units, such as meter (m), centimeter (cm), rupiahs (Rp). Besides, the connections between the concepts of multiplication with the results of multiplication operations are less profound because the subject FAM assumes the correct calculation $\frac{1}{2} \times 12 \times 5 = 60$. The subject FAM does not understand the steps to solve the problem because he already thinks that the answer to the problem being worked on is 3,000,000 – 1,000,000 = 2,000,000 even though the students do not connect the results of land sales with the cost of making fences and gates. Where to find out the cost of making fences should the subjects look for the length of all sides of the fence, including finding the hypotenuse triangle. The students are also sure that the answer is correct, but in fact, the answer is finally wrong.

From three indicators of the strength of mathematical connections established in this study, it turns out that the subjects 1) make connections of mathematical ideas in an amount that is less than needed, 2) some connections made between these mathematical ideas are inaccurate and clearly still many mathematical relationships that are not visible, and 3) students' understanding of the connections of ideas made and used to solve the problem have not been profound. Based on this, it can be said that students' mathematical connections of Junior High School with negative attitudes towards mathematics are included in the weak connections category.

3.2. Discussion

From the results of data analysis of junior high school students who have negative attitudes towards mathematics, the results are obtained that the students' mathematical connections fall into the category of weak mathematical connections. Where there are not enough connected mathematical ideas, and some connected mathematical ideas are inaccurate or wrong. Due to the weak mathematical connections of students, students experience failure in solving a contextual mathematics problem.

The results of this study are following the theory and some similar research results concerning mathematical connections. For example, eighth-grade junior high school students with a positive attitude towards mathematics have a strong mathematical connection profile [18][21], so it is natural for students with negative attitudes towards mathematics to have weak mathematical connections profile. In addition, students who have poor abilities in making mathematical connections cause the students to fail in solving problems of daily life [2][21]. Finally, the strong mathematical connections prove to be effective tools in solving math problems; on the contrary, weak mathematical connections cause students to fail in solving math problems [1][2][18].

Factors that cause the research subjects to have weak mathematical connections can be seen from the following interview fragment.

R : I want to ask you, do you like math?
S1 : I don't like it, Sir.
S2 : I don't like it, Sir, but in elementary school, I like math.
R : Why do you not like math?
S1 : Ehm...because math is tough.
S2 : Because math is a tough lesson, but in elementary school relatively easier.
R : If you were told to choose the subjects that you least liked, which ones? ... mathematics, social studies, sports, arts, Bahasa?
S1 : Mathematics
S2 : Mathematics
R : Do you think learning mathematics is useful or not?
S1 : I do not know.
S2 : Ehmm, I think math is useful for smart children.
R : During math class, what do you do?
S1 : I was listening to the teacher.
S2 : Listen, my teacher :
R : Have you ever asked your teacher or friend?
S1 : Rarely Sir
S2 : Sometimes
R : Are you confident in being able to answer math problems well?
S1 : No, Sir, I'm afraid of being wrong.
S2 : No, Sir, I'm worried about answering the problems.
R : What at-home do you like to study mathematics?
S1 : I lazy to study at home, Sir.
S2 : Very rare.

From the interview excerpts, it is clear that the research subjects 1) do not like mathematics, 2) do not know what the point of learning mathematics for himself and life is, 3) do not have good self-confidence, 4) do not act in the process of learning mathematics in class or at home. It is consistent with the opinion [14][15][16], which states that students with negative attitudes towards mathematics tend to dislike mathematics, useless to mathematics, do not want to learn mathematics, and is not confident if asked to do math problems.

From these results, it can be recommended that mathematics teachers try to create mathematics learning activity that can improve students' positive attitudes towards mathematics. After students

already like mathematics, students are expected to be motivated to learn mathematics, and their mathematical connections' ability to solve problems can improve.

4. Conclusion

Mathematical connections of junior high school students who have negative attitudes towards mathematics are included in the weak category. Where there are not enough connected mathematical ideas, and some connected mathematical ideas are inaccurate or wrong. In addition, the students are not able to produce new coherent ideas to be applied in answering contextual mathematics problems. The students' weak mathematical connections ability and the failure of students to solve the known mathematical problem are caused by negative attitude factor. Students with negative attitudes tend to dislike mathematics, do not actively learn mathematics, do not know the benefits of learning mathematics, and are not confident about answering math problems. Based on this result, mathematics teachers should always try to improve student's positive attitudes towards mathematics. The hope is after students have positive attitudes towards mathematics, the ability of mathematical connections and solving math problems will increase.

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