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The Relational Thinking Process of Junior High School Students in Solving Contextual Mathematical Problems based on Gender Differences

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Thinking is a cognitive activity that occurs inside the human mind (Solso, 1995). In solving contextual problems, students are demanded to think to build a relationship between real situations and prior knowledge through some forms of relation. Such thinking process is called relational thinking process. Relational thinking is always present in human cognition, which underlies the process of thinking about everything from simple to something more complex (Doumas and Hummel, 2004). The thinking process that occurs in male students is different from female students (Jensen, 2008, p. 147-153). This study aims to describe the students' relational thinking processes in contextual mathematical problem-solving. Furthermore, this research is a qualitative descriptive study. In this study, the data analysis technique used is the Miles & Huberman (1992) flow, model. The results of this study concluded that, in solving problems, students read text and images on questions and found some information in the form of two different objects which were interpreted as what was known from the problems. Another information was found in the form of three sentences accompanied by question words and question mark symbols which are interpreted as what was asked from the problem. Based on the characteristics of relational thinking (Stephens & Wang, 2008), the male student belongs to "Established Relational Thinking", while the female student belongs to "Consolidating Relational Thinking".

Key words: *relational thinking, contextual mathematical problems, gender.*

Introduction

Mathematics is a branch of science that always applied to solve real-life everyday problems. In the context of a traditional market, for instance, purchasing and selling transactions between merchants and consumers must involve mathematics. Mathematics is knowledge of logical reasoning and numbers Soedjadi (2000) and Nunes et al. (2007).

In everyday life, people can hardly avoid mathematics involvement when faced with a problem. It is implying the importance of contextual mathematical problem-solving learning mathematics. In mathematics education, mathematics learning and problem-solving are two important interrelated components. In solving contextual problems, the skill of linking real-world situation with formal mathematical situations or prior knowledge is a major asset for students.

The ability of Indonesian students to solve contextual problems is still very low. It is based on the rankings obtained by Indonesian students in their participation in the PISA event because PISA requires students to use relevant abilities contextually that are not too structured, where the instructions are not very clear to students. Students must be able to determine what knowledge is relevant, what process must be gone through to be able to find the solution to the problem, and how to describe the accuracy and usefulness of the obtained solutions (Agustina, 2014). This is in line with Pranoto (2011) and Saputra (2018), which states that the poor PISA results indicate that Indonesian students are still weak in solving contextual problems.

Related to mathematical problem solving, students' thinking processes have a very important role since basically the occurrence of these thinking processes is originated in a condition when a student is given or faced with a problem. Thinking is a cognitive activity that occurs in a person's mental or mind (Solso, 1995). Dewey argues that thinking can be interpreted as imagination or awareness that is often associated with things that are not directly felt (Moseley et al., 2005). Thinking is a process of dialogue or question and answer that occurs within a person who presents the relationship between knowledge possessed appropriately, where the questions that occur are giving direction to the process (Sujanto, 2012). Thinking allows a person to reconstruct objects around him and represent them according to his wishes (Ling & Catling, 2012: 181). Mayer (Solso, 1995: 409) divides the process of normally thinking into three main components, namely:

1. thinking is a cognitive process occurring in one's mind, not visible but can be concluded based on appearing behaviour;
2. thinking is a process involving several knowledge manipulations inside the cognitive system. The knowledge stored in the memory combined with the current information result in one's knowledge change on the problem faced, and

3. thinking is directed and resulted in “solving” manner of a problem or directed to a certain solution.

When a student solves a problem, a thinking process occurs. To be able to solve contextual problems, students must be able to think to build a relationship between the real-world situation and formal mathematical situation and mathematical knowledge possessed then proceed to interpret relevant solutions by building a relationship between mathematical structures themselves. Such a process is called relational thinking process (Suryana, 2017).

Someone said to use a relational way of thinking if he/she is facing some mathematical objects. He/she is then looking for a relationship between these objects, analyzing, using these links to solve the problem, and making a decision or understanding more about the situation or concept being faced (Molina & Castro, 2005; Satriawan, Budiarto, & Siswono, 2018). Relational thinking involves using the basic properties of numbers and operations to change mathematical expressions instead of counting answers that follow a sequence of procedures (Carpenter et al., 2005). Meanwhile, Carpenter et al., 2003 and Sfard, 1991 (Stephens, 2006) explain that the term "relational thinking" is used to include more than the understanding of the relationship ‘equal’ sign. It is used to describe the students’ thinking skill using numbers and logical operations to consider mathematical expressions as objects instead of arithmetic procedures to be carried out.

Relational thinking always appears inside every human being, which underlies the process of thinking about everything from easy (simple) to something more complicated (complex) (Kusuma, Subanti, & Usodo, 2018, January). To explain the understanding of relational thinking, Alexander (2016). When students use relational thinking, they can complete several sentences that focus on the relationship between numbers in equations instead of doing the whole calculations. For example, in the equation 10 + 52 - 52 = ..., the problem allows students to think that adding a number and then subtracting the same number will not affect the value of the numbers added and subtracted, because it is the same as not doing calculations. This particular problem does not require a broad understanding of the "equal" sign, because all calculations take place to the left of the sign. Another example, 10 + 6 = ... + 8. The problem can be solved by relational thinking if students have a broad understanding of the "equal" sign, which allows students to think that eight is two more than 6, so the value of an unknown number must be two less than 10 (Molina & Ambrose, 2006).

In solving mathematical problems, understanding the sign "equals" as a relation is an important measure of students' relational thinking in mathematics, that the sign "equals" is more interpreted as a relationship than interpreted as an outcome (Carpenter et al., 2004). Hermanto, Budayasa, & Lukito (2017) suggests some basic elements of relational thinking that are used to explain some examples of students' answers that use relational thinking on several questions in the form of the objective with true/false types, including 1) the use of

similarities between numbers in sentences and knowledge about the effects of operations, 2) the use of fact numbers contained in sentences and the similarity between numbers, 3) the use of classification relations between numbers in sentences and the similarity between numbers, and 4) the use of large differences in values between numbers and knowledge of the effects of operations. Related to students' relational thinking, Stephens and Wang (2008) divided the characteristics of relational thinking into three categories whose explanation was packaged through the results of Polya's third step of problem-solving from 2 items (18 + A = 20 + B and c + 2 = d + 10), as follows:

1) Established Relational Thinking, which is indicated that students can always (a) specify the relation between the numbers used for score A and B clearly, (b) describe the relation of the amount score A and B using words so that the problem remains true, and (c) explain the relationship correctly between *c* and *d* so that the equation becomes true for any number of *c* and *d.*

2) Consolidating Relational Thinking, which is indicated that students (a) can specify the relation between the numbers used for score A and B, (b) can sometimes describe the relation of the amount of score A and B using words so that the problem remains true, and (c) can determine the values of *c* and *d*, but cannot provide a comprehensive explanation of the relation.

3) Emerging Relational Thinking, which is indicated that students (a) can identify the characteristics of the numbers used for score A and B, but do not explain the relationship between the numbers, (b) focus on the characteristic of the numbers used to explain how any number can be used for score A and B so that the problem remains true, but cannot describe the relation comprehensively, and (c) tries to determine the true score of *c* and *d*, but it is unlikely that the problem will be true, or not attempting to answer the question at all.

The context of the task can influence the students' thinking process because the tendency of students to do the thinking activity can be caused by an order to carry out something or certain tasks (Kaluge, 2019). If the thinking process often occurs among the students, then the students' thinking process becomes increasingly trained, so that it will have an impact on improving the quality and capability of students' thinking skill. The ability to think does not necessarily form in a person, but regular exercise needs to be done regularly. The ability to think can be formed through the learning process, which is a combination of one's gift and the environment. With the process of learning or training to solve problems, a person's brain will be trained or accustomed to doing thinking activities (Handayani et al., 2020). It can be interpreted that when a student solves a problem, then there is a thinking process inside the student's mind.

To be influenced by the context of the task, the thinking process can also be influenced by gender differences. It is in line with what was stated by Jensen (2008: 147-153) about physical differences between men and women's brains, which can cause differences in cognitive processing between men and women. It gives a picture that when people solve a problem, there are differences in the cognitive process that occurs in men and women so that the relational thinking process will also be different.

Methods

This research is an exploratory study with a qualitative approach since this study aims to describe the students' relational thinking processes in contextual mathematical problem-solving in terms of gender differences and data collected in the form of qualitative data obtained through interviews with the subjects. The research subjects were drawn from class VIII of junior high school, consisting of 1 male student and one female student, each selected from the same mathematic ability group, which is moderate. Subject selection was based on subject selection criteria, including gender differences, subject availability, being able to communicate well, and based on the same mathematical abilities.

The supporting instruments used were the Problem Resolution Task (TPM), and Interview Guidelines. The instrument has gone through several validations. Thus it can be said to be a valid instrument—data collection techniques using task-based interview techniques. Task-based interview techniques are used to uncover the subject's thought process in solving contextual mathematical problems. The process of collecting data starts with giving TPM to the subject.

Furthermore, the subject was asked to understand the questions on the task and continued with in-depth interviews. To obtain valid data, time triangulation was carried out, namely giving TPM and conducting interviews with subjects at different times to see then the consistency of the results of the previous interview. Data analysis techniques in this study use the model of Miles & Huberman (1992), which consists of three activities called data reduction, data presentation, and concluding.

Results and Discussion

Based on the task of solving problems 1 and 2 that have been done by the subject, obtained data both from interviews and the results subject's work completing the task of solving the problem. The task of solving the problem given is a contextual problem adapted from the questions designed by Zulkardi and Ilma, Ratu (2006), as follows.

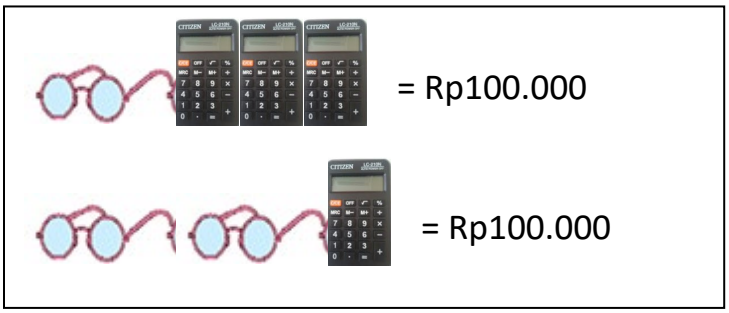

Figure 1. Stationery put up promotional prices

From promotional prices above,

a) With the unknown price for each item, which one is more expensive? The glasses or the calculator?
b) With the unknown price for each item, how many calculators can be bought with IDR 100,000?
c) How much is the price for one calculator and one pair of glasses?

Results and Discussion Relational Thinking Process of the Male Student in Solving the Problems

In solving the problem, male students read the text and pictures on the problem and found some information in the form of two objects, each object containing two different material elements, equal sign, and a number that was interpreted as what is known from the problem. Another information was found in the form of three sentences (a), (b), and (c) accompanied by question word and question mark symbols interpreted as what was asked from the problem. In completing question (a), the male student related the first to the second object focused on the number of material elements contained in each object. From this relation, it can be concluded that with the same number, the acquisition of a large quantity indicates a low economic value. In completing question (b), the male student determined the estimated economic value of material so that with a certain nominal value, a quantity of a material can be obtained. Whereas in completing the question (c) the male student related the problem with previous experience that focuses on similar problems that have been encountered, where the solution uses computational methods with formulas called as mixed methods, namely substitution and elimination. The male student also did not mention the concept of solving a two-variable linear equation system. He only remembered the so-called substitution and elimination. Based on the characteristics of relational thinking proposed by Stephens and Wang (2008), the male student belongs to "Established Relational Thinking", which can specify the relation between numbers on two objects, including differences in the quantity and economic value of a material, using words to describe the relations between the quantities of material elements in the first and second objects, and explain the relationship between objects correctly. Based on Stephens (2008), male students are included in the group of students who think relationally. It is shown that the male student provided a relational

response to the two solutions out of three solutions. Based on the opinion of Bahri et al. (2019), the male student in solving the problems was using a relational way of thinking of two solutions where he used the similarity between numbers in objects, facts of material elements contained in objects, classification relationship between the elements in the objects, and the value differences between the material elements, whereas another solving uses computational thinking.

Results and Discussion Relational Thinking Process of the Female Student in Solving the Problems

In solving problems, the female student read the text and pictures of the problems and found some information in the form of two objects, in which each object contains two different material elements, equal sign, and number that was interpreted as what is known from the problems. Another information was found in the form of three sentences (a), (b), and (c) accompanied by question words and question mark symbols which are interpreted as what was asked from the problems. In completing question (a) the female student determined the estimated economic value of a material based on its compatibility with the value of existing numbers so that the level of the economic value of a material can be determined. In completing question (b), the female student correlated the results of the completion of the question (a) with the completion of the question (b). In terms of completing the question (c) the female student correlated the problem with previous experience of a two-variable linear equation. Based on the characteristics of relational thinking proposed by Stephens & Ribeiro (2012) the female student is classified as "Consolidating Relational Thinking", which can specify relations between numbers on two objects, including differences in the quantity and economic value of a material. Based on the opinion of Molina, et al. (2008), in solving problems, the female student uses a relational way of thinking on one of the solutions, in which female students use the similarities between numbers in objects, facts of material elements contained in objects, classification relationships between elements in an object, and the difference in value between material elements. The other two solutions, however, used computational thinking.

Conclusion

The results of the study entitled "Relational Thinking Process of Junior High School Students in Contextual Mathematical Problem Solving Across Gender Differences" can be summarized as follows: In solving problems, the students read the text and images in the questions and found some information in the form of two objects, in which each object contains two different, material elements, equal sign, and a number interpreted as what is known from the problem. Another information found was that the three sentences (a), (b), and (c) accompanied by question word and question mark symbols are interpreted as what was asked from the problem.

In completing question (a) the male student related the first to the second object focused on the number of material elements contained in each object. From this relation, it can be concluded that with the same number, the acquisition of a large quantity indicates a low economic value. On the other hand, the female student determined the estimated economic value of a material based on compatibility with the value of existing numbers, so that the economic value of a material can be determined. In completing question (b), the male student determined the estimated economic value of material so that with a certain nominal value, a quantity of a material can be obtained. Moreover, the female student related the results of the completion of the question (a) with the completion of the question (b). In solving question (c) the male student-related problems with previous experience which focuses on similar problems that have been encountered, in which the solution uses a computational method with the formula called as a mixed-method, i.e. substitution and elimination. Female students, however, related the problem with previous experience of a two-variable linear equation.

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