



Research Article

Pre-Service Primary School Teachers' Mathematical Reasoning Skills from Gender Perspectives: A Case Study

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Abstract

A person's reasoning can be seen through his or her way in solving a problem. A person's reasoning can be explored in systematic ways. This study aimed at exploring student reasoning at the stage of understanding the problem and looking back in terms of gender differences. The sample of this study were one male and one female students at Halu Oleo University Kendari, Indonesia. This research was a qualitative research. Student reasoning data were obtained using the main instruments namely the researcher and supporting instruments namely mathematics ability tests, problem solving tests, information form, and interview guidelines. Subject selection was based on a gender questionnaire analysis. The data obtained were analyzed qualitatively. The results showed that there were differences in the reasoning of male and female student teachers, in which at the stage of understanding the problem, the answers given by the male student was more detailed than those by the female one. Whereas in looking back stage, both male and female performed the steps in the same way both in terms of checking the problem solving and calculation steps.

Keywords:

mathematical reasoning skills, gender, pre-service primary school teacher

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Introduction

Mathematical reasoning is part of thinking. If someone is reasoning, that person must think, but on the contrary, thinking is not definitely reasoning. Reasoning is a skill that is demonstrated during the development of the thinking stages (Umay, 2003), during the problem solving process (Yildirim, 2000), which presents the ability to think at a higher level of mathematics (Kenney & Linqvist, 2000). Cultivation of reasoning will be possible to reach if the efforts to arrange the reasoning of students can go well so that they can develop the habit of reasoning (Soedjadi, 2000). Reasoning is a process to achieve goals in thinking (Hardin, 1968). Lithner (2008) implies that reasoning used for lines of thought, ways of thinking, adopted to produce assertions and reach conclusions. This gesture is supported by Susanah (2017) assertion that reasoning is related to drawing conclusions resulting from the premises given in solving problems. Furthermore, Susanah (2017) stated that if students are accustomed to drawing conclusions based on valid arguments, they will be easier to deal with or solve a problem through a process of reasoning. In addition, through the process of reasoning students can connect the linkages between concepts and structures so that students train always to think rationally (Huda et al. 2019).

Reasoning is the process of combining past experiences to solve problems, and not merely reproducing problem solving. It is also an analysis that gives a careful, systematic reason for each organizational function (Lahey et al. 1995). Reasoning is an activity of thinking to draw conclusions or make a new statement that is true based on several statements whose truth has been proven or assumed beforehand. In other words, involving a mental activity that can be observed from behaviours that appear in the form of statements and the results of problem-solving by prior knowledge that is already known and considered to be correct and reasonable (Peter & Yani, 2002). Furthermore, Sadiq (2008) states reasoning is a process or an activity of thinking to draw a conclusion or thought process in order to make a new statement that is true based on several statements whose truth has been proven or assumed previously. One of the factors that determine the success or failure of students in reasoning itself is their ability to reason (Keitel, 1998). The low reasoning ability will affect solving the given problem. Potential students use reasoning (reasoning) in each answer; the problem has not developed to the maximum. For this reason, special attention is needed to develop students' potential in using reasoning. It supports a students' ability to think critically, solve problems, make deductions and creative thinking (Karaduman & Erbas, 2017).

The process of reasoning or thinking is different from one child to another. The implication of the difference in structure occurs in the way and style of doing things. Female's mathematical reasoning is different from the reasoning that the male has (Sumpter, 2016). In addition to influencing reasoning, gender also influences one's problem solving ability (Sagala, 2019). The ability to solve

mathematical problems is influenced by differences in knowledge, gender and experience (Zhu, 2007). In research, Artzt & Yaloz-Femia (1999) reasoning in solving problems does not pay attention to gender differences yet even though gender differences also influence the way of thinking to solve problems (Zhu, 2007). Gender is a trait and behavior that are attached to women and men that is formed socially and culturally. In addition, gender is a characteristic of individuals that are attached to the men and women who are socially and culturally constructed (Wang & Degol, 2017). Zhu (2007), in his study, explains that gender differences also affect the way we think to solve the problem.

The difference between male and female believed to be due to differences in tradition in caring for males and females and with a broad view of the profession as masculine and feminine (Krutetskii et al. 1976). It confirmed from the statements Sumpter (2016) that the female students of different mathematical reasoning with reasoning possessed boy. Besides the influence on reasoning, gender also affects a person's problem-solving ability. The gender difference, in this case, shows that the difference in understanding between concepts, differences of knowledge and positively affects the reasoning process and result in problem-solving abilities. Grouping individuals into feminine and masculine gender groups can be done through BEM Role Sex Inventory exercise which details 20 characteristics of gender roles in masculine and feminine criteria. It is done to find out trends and help students learn about aspects of orientation of their sex roles in society (Monto, 1993). Mathematical abilities or skills between males and females will certainly affect each other's reasoning. The skill is obtained through a logical thinking process to make conclusions or decisions in the form of statements. Therefore, researchers are interested in studying this.

Problem of Study

The purpose of this study is to exploring of reasoning for students of elementary school teacher education at the stage of understanding the problem and looking back reviewed from gender differences. Based on the information that has been described the problem of the study is what is the mathematical reasoning skills profile of preservice primary school teachers from gender perspective?

Method

The approach used in this study was a qualitative approach because the data were collected and presented in the form of words arranged in a sentence, in depth to the subject concerned, not to generalize and with a natural setting. This research included exploratory research with a qualitative approach intended to explore student reasoning reviewed by gender. The instruments used to explore student reasoning were the main instrument and supporting instruments (Moleong, 2013; Fraenkel et al. 2009). The main instrument was the researcher herself while the supporting instruments were the tests of mathematical ability, problem solving

tests, interview guidelines and recordings. This research was carried out in tertiary institutions, so the subjects of this study were students of the Elementary School Teacher Education at Halu Oleo University.

The determination of the subjects was carried out using a mathematical ability test given to elementary school teacher education students. Furthermore, the subjects of the study were reviewed about gender roles through a gender questionnaire, namely the role or personality as: masculine, feminine, androgynous, or undifferentiated. The subjects chosen were subjects with feminine and masculine personalities. Data analysis in this study used qualitative data analysis. The process of data analysis follows an analysis model consisting of three steps, namely: (1) data condensation (2) data presentation, and (3) drawing conclusions (Milles et al., 2014).

Participants

This research was conducted in tertiary institutions, so the participants of this study were Halu Oleo University Elementary School Teacher Education student of semester IV (even) 2016/2017 academic year who had studied Mathematics Education II in which there were plane and solid geometry that acquire. Research Subjects selection of this study refers to the research goal; is to a profile of mathematical reasoning skills of primary School Teachers in solving geometry problems from gender perspectives. Subject selection is made through the following steps:

- Select a group of students from Teacher Education Department
- Classify the selected Primary School Teacher Education students by gender
- Check whether each group filled with at least one student with additional criteria, namely equivalent (moderate) math skills
- If each group has been filled with at least one student then proceed to the next stage, if there is an empty group then the researcher returns to action 1 to 3
- Restrictions based on mathematical ability members than other abilities of the research are expected to be more extensive.

Data Collection

In this study required two categories of data, which are first data to determine the research subjects of mathematical ability test given to students of primary school teacher education as quantitative data and questionnaire results to determine the gender identity. In addition, the data collection instruments consist of Instrument-instrument which is used as an instrument to help in the study were (a) the geometry problem-solving test; (b) interview guidelines; (c) information form; (d) recording advice.

Data collection in this study was obtained by using interview techniques based on problem-solving tasks that are supported by recording to uncover the subject's reasoning activity in solving geometry problems. The process of collecting data starts with giving a problem-solving task to the subjects. The researchers recorded made the behaviour of the subjects, including the unique things that the subject when solving geometry problems. After that, the researcher interviewed the subjects after solving a problem related to their reasoning. To ensure the credibility of the research results we do triangulation.

Data Analysis

Data analysis in this study used qualitative data analysis. The process of data analysis follows the analysis model Miles, Huberman & Saldana (2014) consisting of three steps: (1) data condensation (2) data display, and (3) conclusion withdrawal. In its description, data condensation includes the process of selecting, focusing, simplifying, abstracting and or transforming. In this study, these data analysis steps were refined in more detail: (1) data categorization, (2) data reduction, (3) data, (4) data interpretation, and (5) drawing.

Research Procedure

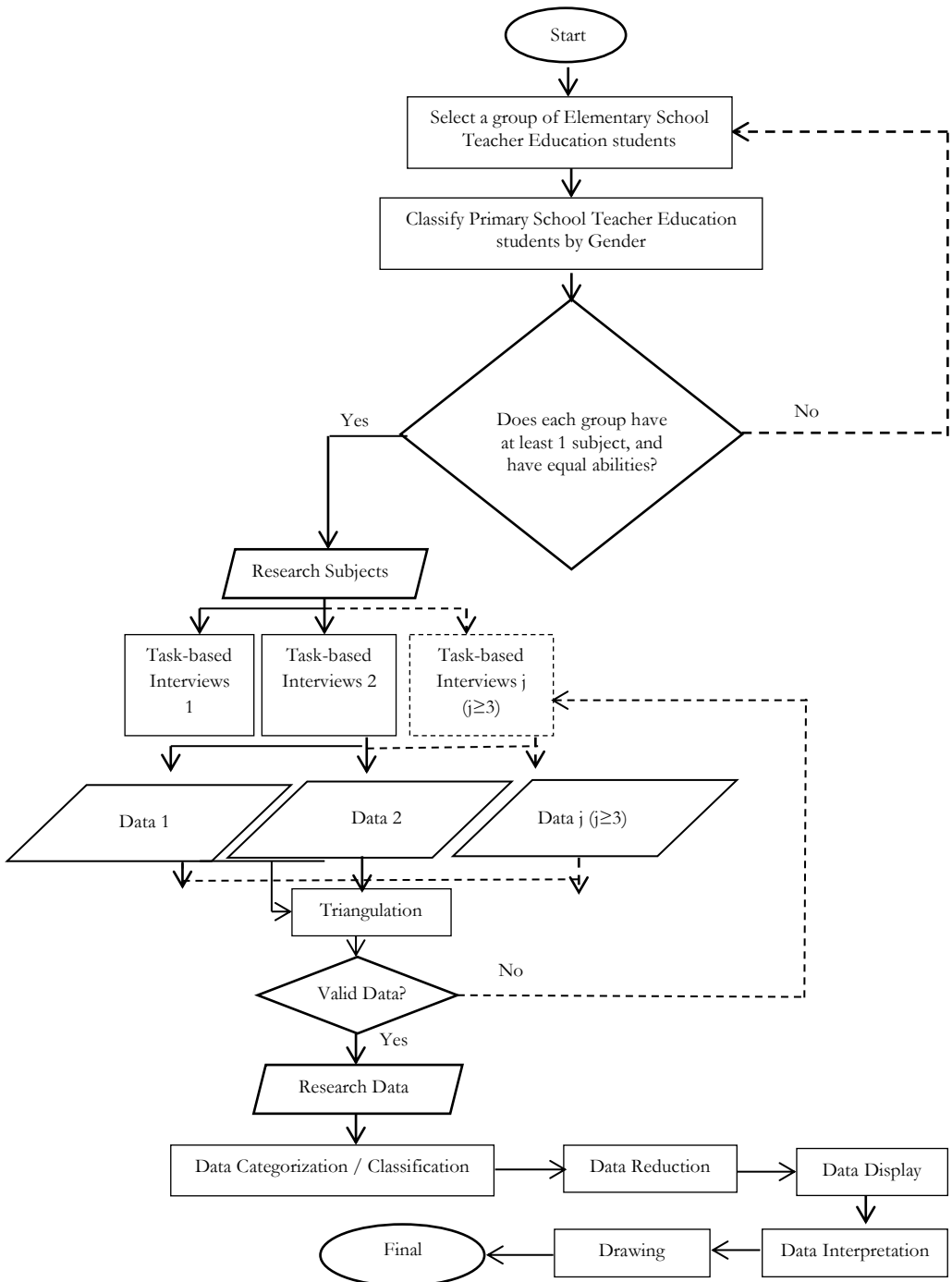


Figure 1.
Flow Chart Research Procedure

Result and Discussion

For decades, researchers have shown that there are differences between the achievements of female and male students in many fields of mathematical content, including spatial visualization, problem-solving, computing, and assessment (Halat, 2008). Gender has been considered as an important factor in the investigation of mathematics achievement (Solazzo, 2008). In terms of gender, psychological factors influence learning achievement because gender is a socio-cultural and psychological dimension of men and women (Santrock, 2003). Men typically have larger brains 10 to 15 percent of the women, who make a difference in behaviour or cognitive processing between the two. Differences in learning achievement of men and women caused by different levels of intelligence (Clerkin & Macrae, 2012). Reasoning and solving problems are two interrelated things. When someone is faced with a problem, then someone will think to solve the problem. In solving problems, a process of thinking is needed, starting from understanding the problem, devising a plan, implementing the plan, checking the problem solving that has been done so that a logical conclusion is reached.

Mathematical Reasoning Skills Profile of Female Preservice Primary School Teachers

Understanding Problem

An interview based on problem solving task was carried out for the reasoning of female student at the stage of understanding the problem with the following results:

Table 1.

The Content Analysis of Understanding Problem Skills for Female Preservice Primary Teachers

Label	Data Exposure
	the subject was given a problem solving task and given the opportunity to read and understand it
PFT1101	Tell me what you understand from the problem?
SFT1101	What I understand from this problem is that there is a water container in the form of a beam that has a base and height
PFT1102	Do you still have more to say?
SFT1102	Yes, the water in a place when it is freezing, it will increase the volume of water.
PFT1103	In your opinion what is known about the problem?
SFT1103	What is known is that the size of the base of beam-shaped water container is 22 cm and 33 cm, and the height is 44 cm. And if the water freezes, the volume of water will increase by 10%.
PFT1104	10% of what volume actually (water or beam)?
SFT1104	10% is 10% of the volume of water before freezing

Label	Data Exposure
SFT1107	The question is what is the depth of the water that must be filled so that when the water is frozen, the volume was exactly the same with the place?
PFT1108	Why saying that it is the thing being asked?
SFT1108	My reason is because in that problem there are question sentences such as the words "how much" and there is "question mark symbol."
PFT1109	Do you think that the information provided in the problem is enough to answer the question in the problem? Why?
SFT1109	I think that's enough. The reason is because what is known about the problem can already represent to answer the problem.

At the data collection stage in the form of the results of the problem solving task interview (Table 1), the female student said that after she finished reading the problem, she was able to understand the problem that there was a beam-shaped water container that had a base and height (SFT1101). Things that were told by the female student related to what was known and the reason were logical because what was mentioned by the female student was like that in the matter. The reasons stated were also logical because the situation was indeed so. When they work on problems that do not have a precise solution method, they discuss and reject each other's arguments making thought a collaborative activity. A study of the discussion the students can provide valuable insights on how students develop their reasoning skills today when they are working on a problem (DeJarnettes & Gonzales, 2013). Geary et al. (2000) demonstrate that in general the boys are superior in math skills and have the ability to better space than women, while women are superior in language and writing abilities for their biological differences in the brains of girls and boys. The existence of these differences results in learning achievement obtained by each individual, also influenced by behaviour, development, and cognitive processing.

Furthermore, the female student revealed that in this problem there was something asked, namely how deep the water that had to be filled so that when the water had frozen, the volume was exactly the same as its place (SFT1107). The reason was because in that problem there were questions such as "how much" and "question mark symbol" (SFT1108). What was expressed by the female student was a logical thing because the problem being asked was like that and the reasons given by the female student were logical because in the problem there were the words "how much" that state them as a question.

Based on the explanation, it was concluded that the reasoning of the female student of elementary school teacher education at the stage of understanding the problem were:

- a) Representing problems in other forms correctly (U1).
- b) Uncovering correctly what information is asked with the logical argument (U2).
- c) Uncovering correctly the information asked with the logical argument (U3).
- d) Uncovering correctly the adequacy of information known to answer the problem along with the logical argument (U4).

Looking Back

To find out the reasoning of the female student in solving problems during the looking back stage, an interview was conducted based on problem solving task with the following results as presented in Table 2.

Table 2.

The Content Analysis of Looking Back Skills for Female Preservice Primary Teachers

Label	Data Exposure
PFT4101	Try to check your work again.
SFT4101	The female student checked the steps taken.
PFT4102	What did you check before?
SFT4102	What I checked was the formula and the numbers that I entered if they were correct or not and I tried to count them again.
PFT4103	Which numbers do you mean? Are the numbers in the problem or the numbers in the answer or operation (the calculation)?
SFT4103	I checked all the numbers because only the wrong numbers can make all wrong.
PFT4104	Why did you check the formula too?
SFT4104	Because in this problem the formula used is not a formula that does exist (permanent) but many formulas here are derived using mathematical properties. That is why I noticed (checked) them again.

From the data (Table 2) obtained at the stage of data collection in the form of interview, it showed that the female student checked the steps taken (SFT4101). Subject-1 explained what she checked was the formula and the numbers entered, whether they were suitable and tried to calculate them again (SFT4102). The numbers were all the numbers that were in the problem because if the numbers were wrong it could make all wrong (SFT4103). The formula was also checked because the formula used was a permanent formula but some were derived using mathematical properties (SFT4104).

The female student expressed that her answer was correct (SFT4106). The reason was that the female student worked according to the formula and

calculation operations and the results were logical. From these data, the female student could look back what had been done in solving problems and the logical arguments. The female student met three categories of reasoning.

Based on the explanation, the results showed that the reasoning of the female student of elementary school teacher education at the stage of looking back was:

- a) Checking the steps to solve the problem (Lb 1).
- b) Checking the calculations in solving problems (Lb 2).
- c) Making a logical revision of things that were found wrong in checking or fostering a logical belief in the truth that was done in solving problems (Lb 3).

Mathematical Reasoning Skills Profile of Male Preservice Primary School Teachers

Understanding Problem

To find out the reasoning of the male student in solving problems at the stage of understanding the problem, an interview was conducted based on problem solving task with the following results as presented in Table 3.

Table 3.

The Content Analysis of Understanding Problem Skills for Male Preservice Primary Teachers

Label	Data Exposure
	Subject was given a problem solving task and given the opportunity to read and understand it
PMT1101	Tell me what you understand from the problem?
SMT1101	What is in the problem is that there is a beam-shaped water container with a base size of 22 cm and 33 cm, height of 44 cm, and what to look for is how deep the water must be filled so that when it freezes the volume is exactly the same as the place.
PMT1102	Do you still have more to say?
SMT1102	Yes, when the water freezes, the volume of water will increase by 10%.
PMT1103	What is known about the problem?
SMT1103	The male student reveals what is known about the problem
PMT1104	There is a beam-shaped water container
SMT1104	The base is 22 cm and 33 cm
PMT1105	44 cm high
SMT1105	When it freezes, the volume of water increases by 10%.
PMT1106	10% of what volume actually (water or beam)?
SMT1106	10% is the volume of water before freezing
PMT1107	Why do you say 10% of the volume of water, why not the volume of the beam?
SMT1107	Because the problem says when freezing the water will increase by 10%. Thus, 10% is the volume of water before freezing.
PMT1108	Why do you say that those are the things known?
SMT1108	Because the problem says clearly that those are things that are

Label	Data Exposure
	known.
PMT1109	In your opinion, what is asked in the matter?

From the data obtained at the data collection stage in the form of the results of the problem solving task-based interview (Table 3), the male student understood the problem that there was a beam-shaped water container with a base size of 22 cm and 33 cm, height of 44 cm, and what to look for was how deep the water must be filled so that when it froze, the volume was exactly the same as the place (SMT1101). When the water froze, the volume of water would increase by 10% (SMT1102).

The male student revealed what was known from the problem that there was a water beam-shaped container with base 22 cm by 33 cm, height of 44 cm when frozen water volume increased by 10% (SMT1103). 10% was the volume of water before freezing (SMT1104) because the problem said when freezing the water would increase by 10%. Thus, 10% was the volume of water before freezing (SMT1105) because the problem was clear that the statements were things that were known (SMT1106).

The male student revealed that in this problem what was asked was how deep the water had to be filled so that when the volume was frozen it was exactly the same as the container (SMT1107). It was because the sentence had a question mark and because the statement was the core of the question in the problem (SMT1108). The male student revealed that the information provided was sufficient because the information given like what was known and what was asked was clear (SMT1109).

Based on the explanation, it was obtained that the reasoning of the male student of elementary school teacher education at the stage of understanding the problem was:

- a) Representing problems in other forms correctly
- b) Revealing correctly what information was asked with logical arguments
- c) Revealing correctly what information was asked with logical arguments
- d) Properly revealing the adequacy of information that was known to answer the problem along with the logical argument

Looking Back

To find out the reasoning of the male student in solving problems during the looking back stage, an interview was conducted based on problem solving tasks with the following results as presented in Table 4.

Table 4.*The Content Analysis of Looking Back Skills for Male Preservice Primary Teachers*

Label	Data Exposure
PMT4101	Try to check your work again.
SMT4101	The male student checked the steps taken.
PMT4102	What did you check before?
SMT4102	What I checked were the formulas, the numbers and the calculations.
PMT4103	Which numbers do you mean? Is the number in the problem or the number in the answer or the operation?
SMT4103	All numbers.
PMT4104	Why did you check the formula too?
SMT4104	So that there must be no mistake in deriving the formulas.
PMT4105	The formula that you use, among others, is the beam volume formula, $p \times l \times t$, can you switch the location to $l \times p \times t$ or $t \times l \times p$? Why?
SMT4105	Yes, because it is a commutative product, the result remains the same.
PMT4106	Are you sure your answer is correct?
SMT4106	I am sure that it is right.
PMT4107	Why are you so sure about your answer?
SMT4107	Because I think the answer I have done is in accordance with the request of the problem. I have also checked it repeatedly.
PMT4108	Are there other simpler ways you can use?
SMT 4108	There is no.

From the data obtained at the stage of data collection in the form of interview (Table 4), it showed that the male student checked the steps on what he had done (SMT 4101). The male student explained that he checked the formulas, numbers and calculations (SMT4202). The male student revealed the reason for checking the formula that was because there should not be any mistakes in deriving the formulas (SMT4104).

The male student expressed that he was sure the answer was correct (SMT4106). He felt very confident about the answer because "the answer that I have done is in accordance with the request of the problem. I have also checked it repeatedly" (SMT4107). From the data, he could look back what he made in solving problems with the logical arguments. The male student fulfilled three categories of reasoning,

Based on the explanation, the results of the research at the looking back stage obtained the results that the reasoning of the male student of elementary school teacher education at the looking back stage was:

- a) Checking the steps to solve the problem (Lb 1).
- b) Checking the calculations in solving problem (Lb 2).
- c) Making a logical revision of things that were found wrong in checking or fostering a logical belief in the truth that was done in solving problems (Lb 3)

The results of the study showed that the reasoning of female and male students in general did not differ at each stage of understanding the problem and looking back. However, there was a difference when representing the problems given to both of them. Samuelsson & Joakim (2016) opinion that girls are not too involved or not involved at all in the classroom tend to focus more on their work do not contribute help or ask from others.

Broadly speaking, the ability of the male student in presenting problems was more detailed and clear compared to the female one. It is not much different from Mhlanga's (2017) report that the woman can solve problems correctly and carefully and then re-check her work while for men able to solve problems correctly but he is not careful. But, at the stage of looking back, the two subjects really did the stage in the same way, in which both of them really did calculations and logical revisions to foster confidence in the truth in solving problems. However, Piraksa et al. (2014) will argue in a study he argued that the effects of scientific reasoning skills (checking back) does not depend on gender. Aside from that, Reynolds et al., (2015) suggested that it was difficult from their data to pinpoint the factors that could explain the gender differences they identified but recognized the role of high-level skills, for example, self-regulation strategies.

Therefore, it explains that there is no significant difference between female student and male student in their reasoning profile. Mahmud & Nul (2017) said that this review would contribute significantly to the learning process, especially in terms of building communication in the teaching process.

Conclusion

Based on the results of the study, it can be concluded that the male and female subjects: 1) correctly represent the problem in another form; 2) correctly reveal the information asked with their logical arguments; 3) correctly reveal what information is being asked with their logical arguments; 4) correctly reveal the adequacy of information that is known to answer the problem along with their logical argument. The most important is that there is no significant difference in the reasoning of both. Reasoning ability is not only needed by students when they study mathematics or other subjects but is needed by every human being when solving problems (Holisin et al. 2017; Shadiq, 2004). It is because the ability of reasoning affects their ability to solve problems (Rahman & Ansari, 2017). These

results provide a significant contribution in preparing specific instructional materials in learning mathematics in schools.

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