Gender and mathematical communication ability

N H Firdiani¹, T Herman² and A Hasanah²

¹Pendidikan Matematika, Sekolah Pascasarjana, Universitas Pendidikan Indonesia, Jl Dr. Setia Budhi No. 229, Bandung 40154, Indonesia
²Departemen Pendidikan Matematika, Universitas Pendidikan Indonesia, Jl. Dr. Setia Budhi No. 229, Bandung 40154, Indonesia

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

Abstract. Communication skills were one of the abilities needed in the 21st century, but the reality showed that students' mathematical communication skills were still low. The aim of this study was to analyze the mathematical communication ability of male and female students for the content of Space and Shape. The research method used was the qualitative research method. The participants of the study were 6 male students and 6 female students of class VIII Junior High School with age characteristic between 13 -14 years old and have the ability of high, medium and low in general mathematics. Data was collected by using test and interview. Data analysis used includes data reduction, data collection, and conclusions. The study results showed that both male and female students with high ability in general mathematics are able to express situations in the form of pictures or mathematical models, analyse and evaluate mathematical ideas in other forms, but male and female students who have medium and low ability in general mathematics still have difficulty in expressing situations in the form of drawings or mathematical models, analysing and evaluating mathematical ideas in other forms.

1. Introduction

Communication skills in the 21st century were one of the ability that needed for life and work[1]. Communication skills effectively convey ideas including literacy skills tested in PISA. Based on the result of the PISA study in 2015, students’ mathematical literacy ability was in 61st rank from 69 participant countries and their scores around 390, below the score set by the OECD which is 490 [2]. It shows that mathematical literacy ability of Indonesian students include communication skill was still low. Gender is one of the factors that influence mathematics learning[3].

Our initial study found that the female students were better than male students in mathematical communication ability and also, space and shape content include material that is difficult for students. Based on that consideration, we conduct the study with the aim to find out mathematical communication ability in space and shape content depends on gender.

Mathematical communication is the ability of students to declare an idea, in the forms of words, symbols, mathematical models, and geometric drawing [4, 5]. The concept of gender is the inherent nature of men or women formed by social and cultural factors[6]. Men and women have different ability where women have higher verbal ability than men, but men are superior in visual-spatial and mathematical ability than women[7]. Male roles are more associated with mental rotation, spatial perception, and spatial visualization and female roles related to the phonological verbal fluently, synonym generation, and grammar[8]. The difference between male and female verbal ability cause the difference in gender mathematical communication.
2. Methods
This study used qualitative descriptive method. The participants were twelve students of grade VIII Junior High School in Bandung consisting of six male students and six female students (age range between 13-15 years old) with high, medium, and low math skills. Each level of math skill consists of two male students and two female students. The data collection techniques used are the triangulation techniques that include writing tests, oral tests, and in-depth interviews.

Oral and written tests were conducted to identify the mathematical communication skills of the students. The written test indicators adapted from NCTM[9]. The written test is a description, which consist of three problems with the time duration is 90 minutes. The oral test indicator consists of (1) The ability to explain what is known and asked; (2) the ability to explain answers; (3) the ability to express the reasons for answering; (4) the ability to describe the drawings, diagrams, languages, symbols, or mathematical models made. In-depth interviews were done to respond to the difficulties and problems that the students experienced in answering questions. Data analysis adapted from Miles and Huberman [10] consisting of data reduction, data presentation, and data verification.

3. Result and Discussion
3.1 Result
In general, male and female students with high ability in mathematics are able to solve all communication problems well. Although in writing test, the female students’ answers are more detailed and complete than male students, however they have the same ability orally. Male and female students with medium ability in mathematics have problems in communication due to lack of prior knowledge and calculation errors. Also, their ability to evaluate mathematical idea is still low.

Students with low math skills have low mathematical communication skills too. The male students with low ability are unable to solve all problems at all because they were unable to understand the intent of the problem. Obstacles occur, because of the lack of mastery of the concepts of the material and prior knowledge. Whereas, female students with low ability cannot solve problems due to obstacles in terms of prior knowledge and errors in calculations.

3.2 Discussion
In this study, students are asked to solve three mathematical communication problems related to space and shape (pyramid, cube, and cuboid) for the written test. The analysis of students’ answer is presented as follow.

3.2.1 The first problem
The first problem can be seen in Figure 1.

Harris will create a frame of a pyramid made of wire.
Base the frame is square with a side length of 12 cm.
The height of triangle on the upright side of the pyramid is 8 cm.
Calculate the length of the wire needed to create the pyramid frame, and draw the frame that Harris makes with its size!

Figure 1. The first problem

The first question of the indicator is the case which relates to pyramid with certain size is known. Students are asked to determine the amount of the wire needed to create the pyramid frame, and draw the pyramid frame with its size. In this first problem, the process of mathematical communication studied is expressing the situation in the form of an image or mathematical model. The male and the female students who have high ability can answer the first questions; explain elements that are known and asked, and the reasons for their answers. Based on the interview, the first question is a problem that familiar to them, they have a good understanding of pyramid material and have good prior knowledge. Male and female students with medium and low ability cannot answer the first question.
correctly. On the written test, male students with low ability only can answer by drawing frames and pyramid nets. During the oral test, they were unable to explain the known elements, meaning the length of the wire needed to make the pyramid frame. Based on the results of the interview, they do not understand the difference between the frame and the pyramid net; they do not understand what is meant to be the height of the pyramid and the length of the sides of the pyramid. Following is the part of interview section.

**Interviewer**: Can you explain the meaning of the picture you made?

**LR**: The first picture is a picture of a pyramid, while the picture below is a picture of a pyramid frame.

**Interviewer**: Are you sure the image below is a pyramid frame?

**LR**: Um, actually I’m not sure. What I remember was the pyramid net, and I thought the pyramid nets were the same as the pyramid frame.

**Interviewer**: Then why did the picture you made do not write the size of the pyramid?

**LR**: I don’t know how to answer it.

From the students’ answers, it was found that the difficulties were related to the lack of student’s understanding of the pyramid material, and the student’s prior knowledge related to the prerequisite material to determine the upright edge length using Pythagoras formula. Students’ mathematical communication difficulties are concordant with the theory that the factors that affect students’ mathematical communication ability including prerequisites and mathematical understanding [11].

On the other hand, female students with low ability can draw a pyramid frame with size of pyramid height is 8 m, and the size of a pyramid base edge 12 cm, but they do not answer the length of wire needed. In the oral test, they only can mention what is known and asked. Based on the results of interviews, they cannot answer the number of wires needed to make the pyramid frame because they forgot how to calculate the pyramid upright side. The following is part of the interview:

**Interviewer**: The picture that you made only writes the size of the pyramid height and the length of the base edge. Why don’t you write down the wire size needed?

**PR**: To calculate the required wire length, first calculate the length of the pyramid upright edge. I think I have to use the pythagorean formula, but I forgot the method.

Female students with low ability answers are the same as the answers of male and female students with medium ability. Based on the results of interview, students’ difficulties were mainly due to lack of ability of students in connection with the prerequisite material. The difficulties that occur are related to prior knowledge, whereas prior knowledge has an effect on mathematics achievement[12].

### 3.2.2 The second problem

The second problem can be seen in Figure 2.

| Cafeteria room measuring 10 m × 6 m with a height of 3 m |
| Library room measuring 12 m × 5 m with a height of 3 m |
| In each room there is a door right in the middle of the room with window on it. |
| The door size is 1.6 m × 2 m and the window size is 1.6 m × 0.5 m. |
| The wall section in the Canteen room and library will be painted. |
| Each 10 m² spent one can of paint and the price of one can of paint Rp. 100,000,00 |

**Figure 2.** The second problem
The second question of the indicator is the case which relates to cuboids with certain size is known. Students are asked to compare the cost of the painting between two rooms. In the second problem, the process of mathematical communication studied is analyzing mathematical ideas in other forms. For the second test, only students with high ability can determine which room painting cost higher correctly. Students with medium and low ability cannot answer it correctly. For instance, male answers that to determine the cost of two rooms are calculate the surface area of the wall minus the area of the door and the window in each room. The mistake of the result was because of the mistake of the calculation process. The same mistake is made by another male student with medium ability.

For example, female student with medium ability answers that to determine cost of two rooms are calculate surface area of the wall minus the area of the door and the window in each room. Mistake of the result was mainly in the calculation process. The same mistake is made by another female student with medium ability. Both male and female students with medium ability, understand how to calculate the second problem, but make mistake in calculation. Orally, they can explain the element that is known and asked, and the reasons for their answers. But they have difficulty in decimal calculation. Difficulties in resolving communication problems were mainly computing problems. This is concordant with the results of research that computational ability affects written communication skills [13]. The male and the female students with low ability cannot determine how to calculate the second problem at all. This problem is something new for them.

3.2.3 The third problem
The third problem can be seen in Figure 3. Based on research results, female students with high ability have written mathematical communication skills better than male students with high ability. Male and female students with high ability have the same ability in mathematical communication orally. The result of this study contradicts with the research that found male subjects were better in writing [14], but similar to the results of the study which said female students responded in writing better than men [15]. Also, this study same from the results of previous study that male and female students have the same ability in communication as orally[16].

| The government plans to build a water shelter in a village. |
| Many people in the area are 600. |
| Assuming the need of clean water is 120 liters each person. |
| The water shelter is measuring 6 m × 6 m × 6 m. |
| Water-evacuation is done three days once until it meets the shelter. |
| Can the water shelter suffice the needs of all the villagers every day? Explain why! |

Figure 3. The third problem

4. Conclusion
The study results show only male and female students with high ability in math are good in mathematical communication. They have the same ability in oral communication, but female students answer more detail and completely than male students in writing. Their high ability is acquired because of experience and more practice. Male and female students who have medium and low ability in math still have difficulty in mathematical communication. It can be seen from the aspects of expressing situations in the form of drawings or mathematical models, also in analysing and evaluating mathematical ideas in other forms. Based on this, we suggest students who have difficulty in communication need to be accustomed to providing arguments for each answer and responding to answers given by others in learning so they learn mathematics meaningfully[17].

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