Visual-Spatial Ability in Solving Geometry Problems Viewed from Gender Using the Flipped Classroom Model

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ABSTRACT

Visual-spatial ability is the ability to understand the perspective of space and dimensions. Good visual-spatial skills will make it easier to learn spatial geometry because it is easy to remember images and has a strong imagination. One of the visual-spatial abilities is influenced by gender factors. So in this case the ability of a person, especially a prospective elementary school teacher, must be able to have good special visual abilities. This study uses a descriptive method with a qualitative approach. This study aims to describe the visual-spatial intelligence of students in understanding spatial structures viewed from gender using the flipped classroom model. The researcher himself as the main instrument of the study, while the supporting instruments are in the form of tests of visual-spatial abilities and interview guidelines. The results of this study indicated that visual-spatial intelligence that is assumed to be owned more by men than by women is not necessarily true, because the intelligence of each person is not only seen from their gender but also their ability to understand spatial or visual patterns they have. Therefore, in the future teachers or lecturers are expected to frequently train students' spatial intelligence in their classes so that students will be able to visualize images and translate images in their minds.

Keywords : Visual-Spatial Ability, Geometry, Gender, Flipped Classroom Model

I. Introduction

Ability is one that distinguishes humans from other God's creatures. This ability will help humans in solving everyday problems, one of which is related to mathematics. Therefore we need an ability that can be used to solve problems in life related to mathematics. So far, ability is measured only through Intelligence Quotients (IQ) tests. As opposed by Hodward Gadner (2011: 17), the instruments used in the test have many shortcomings because the predictions given are only accurate at school and not in the future.

Hodward Gadner (2011) in his book entitled "The Theory of Multiple Intelligences" suggests that every person's ability has a relationship with the various intelligences he has. Intelligence is one of the important factors in one's achievement. Success or failure, whether or not a student can be determined by his own intelligence. Someone who has low intelligence, it is difficult to be expected to be high achievers. However, intelligence here is not only in the form of understanding concepts and good at arithmetic, but also intelligence in other forms. Thus, it is possible for someone who has low intelligence in certain fields to excel in other fields. In other words, there is no guarantee that intelligence someone's height will automatically affect the school.

The intelligence of a child or a student at school cannot be separated from his or her education. An educator is required to have multiple or at least almost all intelligences. Gardner (2011: 9) says that there are multiple intelligences and everyone may has several types of them.

The theory of multiple intelligences illustrates the importance of understanding the development of one of the intelligences possessed by a person. Gardner (2011: 77) suggests that multiple intelligences are divided into eight types of intelligence, namely (1) verbal-linguistic intelligence, (2) logical-mathematical intelligence, (3) visual-spatial intelligence, (4) musical intelligence, (5) kinesthetic intelligence, (6) interpersonal intelligence, (7) intrapersonal intelligence and (8) naturalistic intelligence. One type of intelligence that has a role in a person's achievement is visual-spatial intelligence.

According to Gardner, visual-spatial intelligence is the ability to perceive the visual-spatial world (architect). This intelligence includes imagining, presenting ideas visually or spatially, and orienting oneself appropriately in the spatial matrix including sensitivity to lines, shapes, colors and relationships between elements. In the world of work that supports visual-spatial intelligence are photographers, room

decorators, fashion designers, architects, filmmakers, animators, pilots, interior designers, painters, sculptors and computer programmers (Dadang, 2007).

Someone who has good visual-spatial intelligence will find it easier to learn spatial geometry because it is easy to remember images and has a strong imagination. The ability to recognize space and images in mathematics is visualized in geometry. Geometry according to Ismadji (1993) is a study in mathematics that studies points, lines, planes, shapes and their properties, sizes and relationships with each other. The objects discussed in spatial geometry are abstract objects and are related to two-dimensional and three-dimensional shapes, including cubes, blocks, prisms, pyramids and other spatial forms. The ability to capture the world of space precisely, like to connect mathematics with the physical world or the real world, is a characteristic of someone who has visual-spatial intelligence.

Good visual-spatial ability is also influenced by several factors, one of which is the gender factor (the influence of male and female differences). In mathematics, biological differences in the brains of men and women known through observation suggest that girls are generally better spatially than boys. McGee (1979) found that between men and women in solving a problem in mathematics caused by gender. Boys' visual-spatial abilities are better than girls. Another study found that there was no relationship between spatial ability and mathematics (Learn & Clemens, 1982) this was all based on the influence of each person's way of thinking.

This is clearly very important to know the level of visual spatial ability of students who will become teachers for their students in the future. This was stated by Nasution (2017) based on research results from the National Academy of Science, where every student must be able to develop his spatial sensing ability to understand relations and properties in geometry to solve mathematical problems in everyday life. However, in learning now, the situation of the Covid-19 pandemic has changed the form of learning into online learning. Despite changes in the online learning environment, students are still required to be active in the lecture process

and be able to hone every ability they have and be able to develop their talents and interests. One model that is effectively implemented to be able to see the ability of students in this online learning period is the flipped classroom model which is one of the learning strategies that changes what should be in the classroom to be outside the classroom and vice versa.

Mubarok, et al. (2019) said that the flipped classroom model is the latest breakthrough in the world of education because it can save learning time in class where students can review what they learn at home without having to explain thoroughly. The use of this model changes traditional classroom activities that were originally passive and classic to active and personal (Li, 2013; Gardner & Willey, 2013). Not only changing the traditional classroom which seems to make students have low thinking skills (LOTS), this flipped classroom can also improve higher order thinking skills (HOTS) in students (Williams, 2013). The following is a comparison of cognitive levels between the traditional class and the class that uses the flipped classroom.

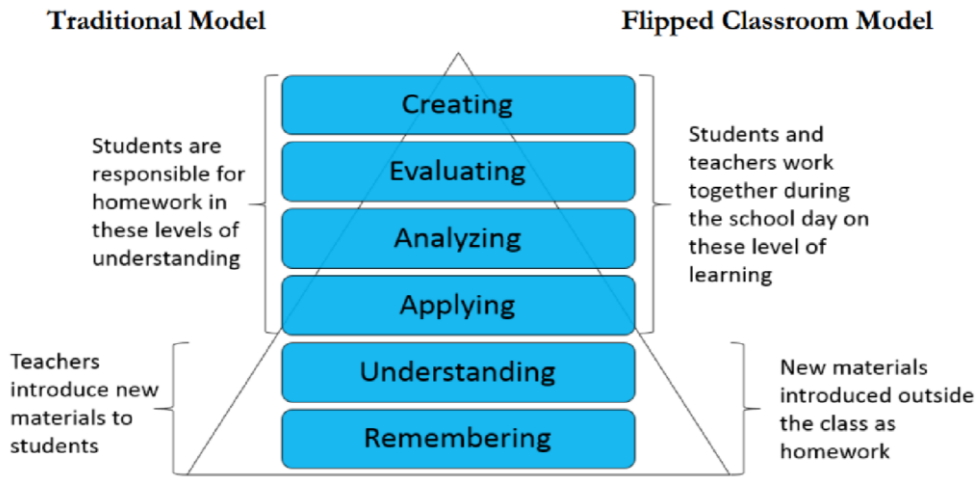

Figure 1. Cognitive level used in the flipped classroom model (Williams, 2013)

This study used a descriptive method with a qualitative approach. This study aimed to describe the visual-spatial intelligence of students in understanding spatial structures in terms of gender using the flipped classroom model. The researcher

himself was the main instrument of the study and the supporting instruments were visual-spatial abilities test and interview guidelines.

The subjects of this study were the third semester students of PGSD (elementary school teacher education program) FKIP University of Palangka Raya which consisted of 3 male students (ML) and 3 female students (MP). The data were collected by giving a visual-spatial ability test to each subject, then the results of each subject' work was verified by the researchers through interview techniques. Data collection was done by pre-test, worksheets and interviews. To find out the extent of visual-spatial abilities between female and male genders, the material used in this visual-spatial ability was two questions regarding spatial webs that will describe their visual-spatial abilities seen from the understanding of images, understanding and the application of the concept, as well as the accuracy of the answers in collecting data using the flipped classroom model, where in the classroom the students already had provisions in understanding space-building networks before the lectures.

II. Discussion

The researchers used visual-spatial ability test instruments to find out how the visual-spatial level possessed by students who previously studied geometry. In the initial test results, the researchers separated students based on their visual-spatial abilities: students with high, medium, and low spatial abilities. Thus, the researchers obtained 6 students based on gender, namely 3 male students and

3 female students with each high, medium and low spatial ability, respectively.

After getting the subject, the researchers gave a form of worksheet to determine the problem-solving ability of a solid figure image that they had to solve how the net pattern was formed. After the research subjects worked on the worksheets, the researchers conducted interviews with the research subjects regarding the problem-solving process they had done. Then the research data were

analyzed to obtain a description of how visual-spatial intelligence in understanding solid figures in terms of gender. For more details, the data are presented in Table 1 below.

Table 1. Results of Test Analysis on Geometry Visual-Spatial Ability

No	Aspects of Assessment	Test 1						Test 2					
		ML1	ML2	ML3	MP1	MP2	MP3	ML1	ML2	ML3	MP1	MP2	MP3
1.	Picture understanding	√	√	√	√	√	√	√			√	√	
2.	Understanding and application of concepts	√		√	√	√	√	√	√	√	√	√	
3.	Accuracy in answers	√	√	√	√		√				√		√

Source: Hans (2003)

Based on the table of test results on the visual spacial geometry ability, it can be seen from the three aspects of the assessment analyzed:

1. Picture Understanding
   a. Male student subject 1 (ML1) on image comprehension was able to understand well on both tests because he was able to understand the images of the two tests and change the shape of the net pattern geometry to form a spatial shape correctly. The subject of male student 2 (ML2) in understanding the image was only able to understand the first question but on the second test the understanding of the image was less precise and did not match the net pattern geometry depicted. Meanwhile, the subject of male student 3 (ML3) in understanding the image was only able to understand on the first test but on the second test was less precise and did not match the net pattern geometry depicted.

   b. Female student subject 1 (MP1) on image comprehension was able to understand well on both tests because she was able to understand the images of the two tests and to change the appearance of the net pattern geometry to form a spatial structure correctly and even provide 3 models of shapes from various sides. Female student subject 2 (MP2) on image

comprehension was also able to understand well on both tests because she was able to understand the images of the two tests and change the shape of the net pattern geometry to form a proper spatial structure. Meanwhile, the female student subject 3 (MP3) on image comprehension was only able to understand on the first test but on the second test the understanding of the image was not quite right and even only formed blocks which definitely did not match the net pattern geometry depicted.

2. Understanding and Application of Concepts
    a. Male student subject 1 (ML1) and male student subject 2 (ML2) on understanding and applying concepts were able to understand and apply concepts from changing the shape of geometry on both tests. Meanwhile, the male student subject 2 (ML2) in understanding and applying concepts was only able to understand and apply the concept of changing the shape of geometry on the second test because in the first test the concepts used did not match the size according to the net pattern described.
    b. Female student subject 1 (MP1) in understanding and applying concepts was able to understand and apply the concept of changing the shape of geometry on both tests as well as female student subject 2 (MP 2). However, the female student subject 3 (MP3) in understanding and applying concepts was only able to understand and apply the concept of changing the shape of the geometry on the first test because in the second test the concepts used did not match the size according to the net pattern described.

3. Accuracy in Answers
    a. Subjects male student 1 (ML1), male student 2 (ML2) and male student 3 (ML3) on accuracy in the answers were only able on the first test because the second test was not accurate so that the shape was almost similar but not in accordance with the net pattern geometry depicted.

b. Subjects female student 1 (MP1) and female student 3 (MP3) on the accuracy of the answers were able to on both tests with a level of accuracy that was in accordance with the net pattern geometry they described. Meanwhile, the female student subject 2 (MP2) on accuracy in the answers was not able to on both tests because it was not accurate so that the shape did not match the net pattern geometry depicted.

The results of this study support and refute several previous studies. Some studies have claimed that there are cognitive differences between men and women in their visual abilities. Based on the research conducted by Kuretetzkii (in Wahab, 2012) says that boys are superior in logical reasoning while girls are superior in accuracy, accuracy and thoroughness of thinking. This study results, however, have showed that the ability to understand images in visual building spaces women are superior to men but in terms of understanding. Besides, men and women have a balance in applying concepts in building spatial understanding. The results of other studies have revealed that women are superior to men regarding accuracy in answering. In other words, Kuretetzkii's ideas (in Wahab, 2012) proves that the theory is correct.

During the interview process in this study, the female students were more proficient in expressing their opinions and the process of getting answers from the tests, compared to male students who only provided information in the written form. This is in accordance with the idea of Eleanor and Carol in Santrock (2013) which points that men have more abilities in mathematics and space recognition, while women have better abilities in verbal abilities.

III. Closing

Based on the results of the research and the discussion above, it is concluded that the visual-spatial ability of students in understanding spatial structures viewed from gender gives an illustration that men are superior in understanding and

applying concepts in spatial shapes. Meanwhile, women are superior in understanding images and accuracy in understanding a spatial structure and their verbal abilities in describing how they process their work. The use of the flipped classroom model is also very helpful in today's online learning process, where educators can minimize direct instruction in teaching practice by utilizing existing features that can be accessed online. This model is also very helpful in developing procedural knowledge which plays an important role in solving mathematical problems in geometry material.

In line with the results and discussion of this study, the researchers point out some suggestions below:

1. The results of this study indicate that the visual-spatial intelligence that is said to be owned more by men than by women is not necessarily true, because the intelligence of each person is not only seen from their gender but also their ability to understand spatial or visual patterns they have. Thus, in the future teachers or lecturers are expected to frequently train students' spatial intelligence in their classes so that students will be able to visualize images and translate images in their minds. The ability to visualize this image will encourage their problem solving skills in the form of images which so far students are only able to visualize a problem solving only in verbal form.
2. Instructors and prospective teachers should be more careful in choosing models and strategies in learning, especially during this online learning implementation. Therefore, this research is expected to be a reference in improving teaching skills and as a means of upgrading, especially in mathematics learning strategies.
3. In future researchers, it is recommended to further strengthen the indicators of the characteristics of mathematical visual spatial intelligence to explore the intelligence that appears when students solve a problem.

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