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Research paper



Analysis of Mathematical Representation Ability Development in Secondary High School

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Abstract

This study aims to determine the development of mathematical representation skills of junior high school students (SMP) based on mathematical exam results data in 2014-2016. The research data was obtained from responses of students' answers consisting of 1,535 students in 2014 and 2,000 students in 2015 and 2016 classified based on indicators of mathematical representation ability. In addition, the classification of student response data is also by gender and type of school. This research is a descriptive research using tables and graphs to describe data analysis of the development of the ability of mathematical representation in each year. The results show that the average percentage of mathematical representation ability of junior high school students in creating and using representations to organize, record and communicate mathematical ideas decrease every year. In indicators uses representation to model and interpret the physical, social, and mathematical phenomena increase in 2014 to 2015 but decrease in 2016. In general, the average percentage of mathematical representation ability of male students is higher than female.

Keywords: *Mathematical Representation Ability; Secondary High School; Gender*

1. Introduction

Mathematics is one of science that is taught at every level of education with the concept which is related to each other or related to another science. One of the abilities required in mathematics learning is the ability of mathematical representation [1]. The ability of mathematical representation is one of the crucial and important things in understanding mathematics [2]. Understanding of mathematics can be enhanced by having good mathematical representation skills, so mathematical representation can help students in improving and developing students' understanding of mathematics [3].

There are various ways to improve the ability of mathematical representation there are using active learning method, Realistic Mathematics Education (RME), and context-based learning or also known as Contextual Teaching and Learning (CTL) [4]. Contextual learning giving the opportunity for students to construct and represent mathematical ideas into various forms of representation so the students can develop the mathematical understanding and problem-solving ability to solve the math problem [5]. The earlier research showed that context-based learning improves the ability of mathematical representation better than conventional learning [6].

The application of the real context in mathematics applied in the item of mathematical problem. The problem is based on real problems. The context of math problems can motivate students to make a mathematical representation. It implied the students use reasoning ability to help in understanding mathematics [7]. It shows that item based on context can stimulate students to perform mathematical representations. The earlier research conducted shows that students with the high and medium level of mathematical representation ability can represent mathematical ideas in tables, images, and mathematical symbols, solve problems related to mathematical modeling and can write problem steps math with words. While students with the low mathematical representation ability only solve problems related to mathematical modeling and write steps of mathematical problems with words [8].

Based on these conditions the mathematical representation ability analyzed by using the item based on context. The problems in these questions based on real problems (context-based). The development of mathematical representation ability can be analyzed by using mathematics test which is arranged by the item based on the indicator of mathematical representation ability. However, there is no further research that discusses the development of mathematical representation abilities in secondary high school based on indicators of mathematical representation ability and gender differences. Therefore this study aims to analyze the development of students' mathematical representation abilities based on indicators of mathematical representation of junior high school students in terms of gender.

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2. Literature Review

Mathematics has five content standards, namely communication skills, reasoning, problem-solving, connection, communication, and mathematical representation [1]. Five standards of such content are the goal of learning mathematics, so the purpose of learning mathematics is not just limited to the score of mathematics learning results only. Representation is one of the components in mathematics that has a connection with mathematical communication skills and is used to connect between abstract ideas with logical thinking to understand mathematics [9].

Mathematical representation ability is one of the processes in problem-solving as a tool for understanding, exploring math problems to make the visual representation and dependent on how well the mathematical problem is understood [10],[11]. When students construct ideas and use mathematical representation indirectly the student has developed the basic knowledge so it helps help students in doing problem-solving [5].

This research analyzes student response data based on two indicators of mathematical representation ability there are 1) creating and using representation to organize, record, and communicate mathematical ideas; 2) use representation to model and interpret physical phenomena, social, and mathematical phenomena [1].

3. Methodology

This research uses descriptive research approach, which describes without any manipulation. This research describes the development of students' mathematical representation abilities at the secondary high school in terms of gender-based on indicators of mathematical representation there are 1) represents math problems using drawings, tables, and graphs, and 2) uses terms, symbols, and structures to model situations or math problems.

This research uses data from UN mathematics response in secondary high school in 2014, 2015, and 2016 consisting of 1,535 students' responses in 2014 and 2,000 students in 2015 and 2016 students' response. The data is processed by using descriptive statistics. The sample selection by doing the randomization in the selection of UN (large scale assessment) in mathematics question and the randomization of students' responses data.

4. Result and Discussion

Based on the analysis of student responses from UN in 2014, 2015, and 2016 then obtained the following results:

A. Analysis of students' mathematical representation abilities in 2014

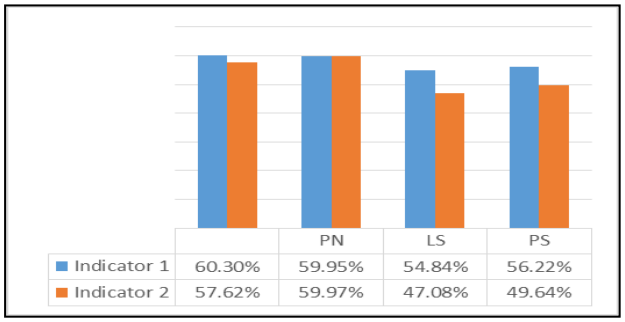


Fig.1 Percentage of Mathematical Representation Ability Viewed from Gender and type of school in 2014.

Tables and graphs above showed that in 2014 in public schools male students have higher mathematical representation ability than female students for the first indicator, which is different by 0.35%. While the second indicator of female students is higher than male, that is different by 2.35%. In private schools, female students have higher mathematical representation ability than male students for the first and second indicators, which are different by 1.38% and 2.56%.

In general, the mathematical representation ability of male and female students in 2014 showed in the following graph:

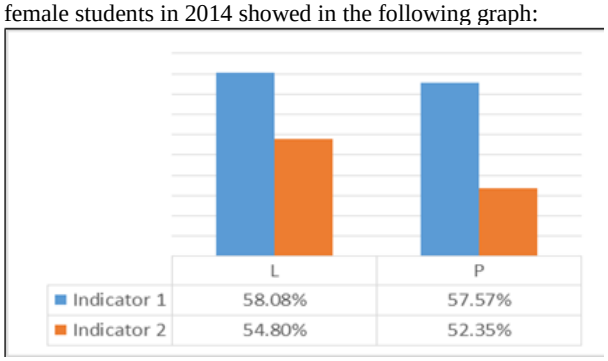


Fig.2 Percentage of Mathematical Representation Ability in General 2014

Based on the graph it showed that male students have a higher average mathematical representation ability than female students in the first and second indicators, which is different by 0.51% and 2.45%.

B. Analysis of students' mathematical representation abilities in 2015

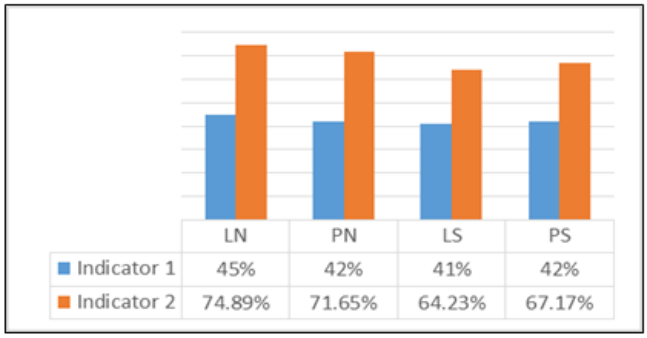


Fig.3 Percentage of Mathematical Representation Ability Viewed from Gender and type of school in General 2015.

Based on the above tables and graphs showed that in 2015 in public schools male students have superior mathematical representation abilities than female students for the first and second indicators, which are 3% and 3.24% different. However, in private schools, female students have higher mathematical representation skills than male students for the first indicator, which is 1% and the second indicator is 2.94%. In general, the ability of mathematical representation of male and female students in 2015 showed in the following graph:

Fig.4 Percentage of Mathematical Representation Ability in General 2015.

The graph showed that female students have a higher average mathematical representation ability than male students in the first and second indicator, which is different by 1% and 0.15%.

C. Analysis of students' mathematical representation abilities in 2016.

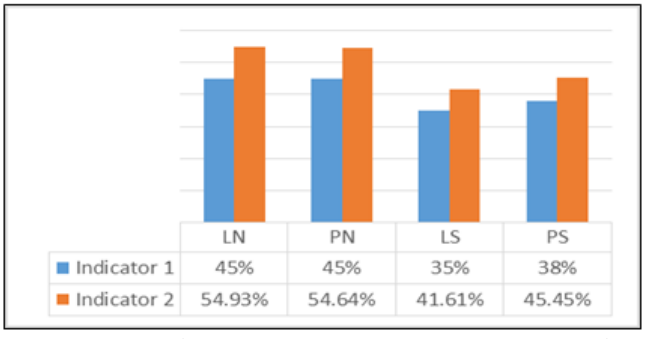


Fig. 5 Percentage of Mathematical Representation Ability Viewed from Gender and type of school in 2015.

Based on the data in the tables and graphs above, it is found that there is no significant difference in the percentage of mathematical representation ability of male and female students in public schools for the first and second indicators, but in private schools the mathematical communication ability of female students is higher than male students, Which different by 3%. In general, the mathematical representation ability of male and female students in 2016 can be seen in the following graph.

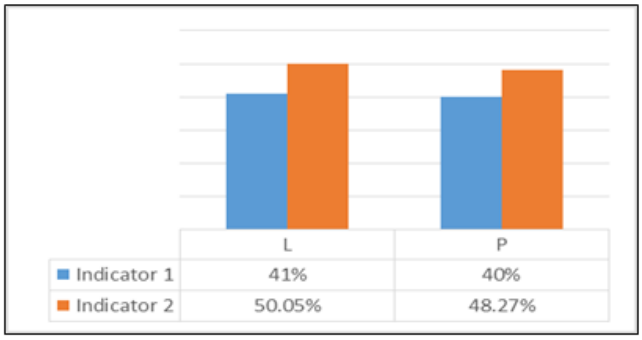


Fig.6 Percentage of Mathematical Representation Ability in General 2016

Based on the graph showed that male students have a higher mathematical representation ability than female students in first and second indicators, which is different by 1% and 1.78%.

5. Discussion

The analysis of the development of mathematical representation ability of secondary high school students based on students' response data on mathematics test according to mathematical representation indicator and gender. The results of the analysis show that male and female students have differences in mathematical representation ability on each indicator. The differences are based on gender differences.

Gender as one aspect that can affect a person's cognitive level because it is caused by psychosocial factors that have an influence on gender differences [12]. This biological aspect is seen to give rise to "gaps" or differences in one's ability, for example, male and female students experiencing different treatment from the surrounding environment, this occurs with the understanding of genetic factor differences [13].

Differences or "gap" between men and women also occurs in mathematics, it is also due to differences in biological factors. In addition, female students have lower self-esteem than men in mathematics learning, thus impacting the high anxiety of female students in solving mathematical problems [14]. These biological factors can make a difference in spatial ability, higher order thinking, and other cognitive aspects, resulting in differences in the achievement of mathematics learning [15].

The condition showed that spatial ability is one of the cognitive aspects in mathematics influenced by gender. The spatial ability relates to the ability to represent abstract ideas in various forms such as images, symbols, graphs, and tables. Performing visual representations in problem-solving provide a similar meaning with using spatial abilities by performing visual representations [16], so there is a correlation between mathematical representation and spatial ability. The interrelationship between the mathematical representation ability and spatial ability is based on the interrelationship of meaning, the ability to represent abstract ideas in visual form or other modeling forms [17].

The results showed that male has the higher percentage of mathematical representation ability than female. In the indicators of creating and using representations to organize, record and communicate mathematical ideas male students have an average percentage of mathematical representation ability, that is 47.1% while females 46.8%. In indicators using representations to model and interpret the physical, social, and mathematical phenomena of male students also have higher percentage of mathematical representation ability, that is 58.1% while females 56.7%. The results are consistent by the argument that men are seen to have a tendency to the spatial aspect while women have a tendency toward verbal skills (Fryerr, Levitt, 2009). It is, therefore, several psychological, biological, and spatial aspects that can affect the students' mathematical representation abilities.

The spatial ability is related to geometry, so the analysis of students 'spatial ability in mathematics can be done by looking at the development of students' geometry abilities. The results of the analysis show that geometry is a field of mathematics that has the lowest percentage of mathematical representation ability then algebra and statistics. The following is an example of geometry on indicators creating and using representations to organize, record, and communicate mathematical ideas.

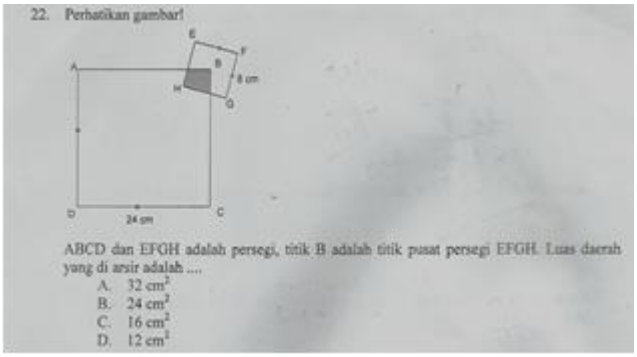


Fig.7 Example math problem of square area

The picture above is an example of geometry in the rectangular material. The problem aims to enable students to determine the black area on the square. The biggest obstacle that students experience when working on this problem is that students are not able to represent the black area is a square area. When the student has understood that the area is square, the student only needs to calculate the square area using the formula.

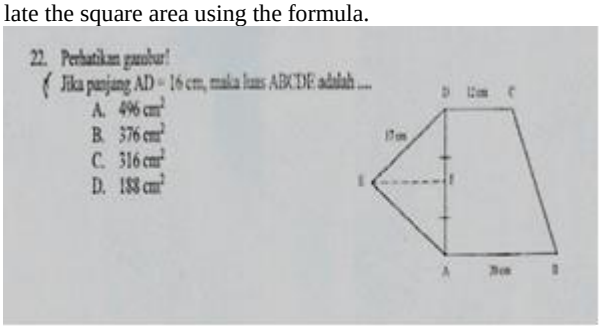


Fig.8 Example math problem of square area

The picture above is an example of geometry to determine the area of combined area. If the student wants to solve the problem then the student is required to be able to represent the combined form of triangle and trapezium. The steps in solving the problem are: 1) the student determines the height of the triangle using the Pythagoras formula, 2) calculates the area of triangle and trapezoid, 3) calculates the amount of triangle and trapezoidal area

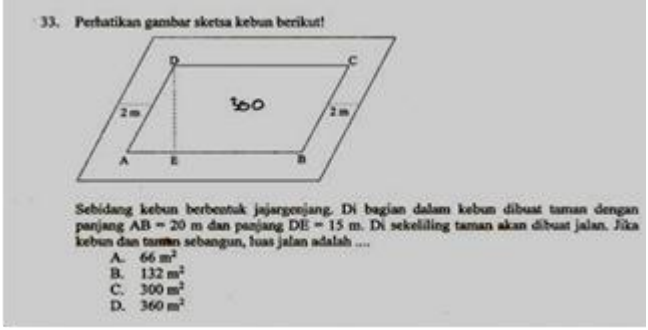


Fig.9 Example math problem of parallelogram area

The picture above shows an example of geometry related to context, which is determining the area of the road around the park in the form of a parallelogram. 1) Determine that there are two similarly shaped of a parallelogram, 2) determine the size of each side of the parallelogram, 3) calculate the area by finding the difference between the area of the large parallelogram and small parallelogram The problem requires students to represent the area of the road around the park in the form of a parallelogram. In addition, after representing the abstract idea the students are also required to linkink between the concepts.

Some examples of the analysis of the above problems show that students 'representational abilities are related to students' spatial ability in geometry. Students with low spatial ability will have difficulty in representing geometric objects to solve problems.

6. Conclusion

Based on results and discussion, the analysis of the development of students' mathematical representation abilities at the secondary high school reviewed by gender showed that the mathematical representation of male and female students in the indicators creates and uses representation to organize, record, and communicate ideas mathematics has decreased every year. In the indicators using representations to model and interpret the physical, social, and mathematical phenomena, the mathematical representation abilities of male and female students increase in 2014-2015 but decreased in 2016.

The mathematical representation ability related to spatial ability, that is changing the abstract idea into a form of visual representation. Gender is one of the biological aspects related to the psychological aspect of students in finding self-tendency towards mathematics ability. Female students have the tendency to verbal ability while male students have the tendency to spatial ability. This suggests that one of the reasons male students have higher mathematical representation abilities than female students is male students tend to have higher spatial abilities than female students.

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