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Multiple Representation of Students in Solving Fraction Problems: Case Study of Androgynous of Junior High School Students

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Abstract
This research aims at describing multiple representation of androgynous students in solving fraction problems. The research is the case study analyzed with the qualitative method. Subject of the research is the students of SMPN 2 (Junior High School) Sukodadi Lamongan with the androgynous gender. There are two subjects in the research, that is, androgynous students 1 (A1/male), and androgynous students 2 (A2/female).Technique of subject collection used BSRI (Bem Sex-Role Inventory) questionnaire. Technique of subject collection is with giving test solution problems consisting of fraction of 2 questions. Based on data analysis of two androgynous subjects in solving the fraction problems apply the aspect of multiple representation. In the symbolizing aspects, subjects of A1 symbolizes known information, asked on the given problems with certain symbols.Whereas, subjects of A2 only write with the words. In the describing aspects, subjects of A1 use three representation (visual, verbal, and symbolic). Meanwhile, subjects of A2 use one representation (verbal). In the referring aspects, subjects of A1 and A2 are confident with the answers obtained/aligned with the given information.
Keywords: Androgynous, Problem Solving, Multiple Representation
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Introduction

The use of multiple representation in mathematics learning is very important for the process of construction of student mathematical understanding, and for the success of solutions in mathematics problems. Multiple representation can help students in developing better conceptual understanding. The representation can be in the forms of pictures, diagrams, graphs, or the other forms of representation which can be used by teachers and students during the learning process. Somebody needs good representation to communicate something. Something perceived problems in which difficult and complicated will be easier solved with representation. Hutagol (2013) stated that "is needed good representation in mathematical learning process which is abstract, so the abstract mathematics is easier understood". Ainsworth (2006), stated that "multiple representation can function as the instrument that facilitated and supported *meaningful learning*, and/or *deep learning*. The usage of multiple representation is excellent for teaching the abstract scientific consepts.

Serving a concept or phenomenon by using various different representations can make the concept or phenomenon to be easier to understand and enjoyable for students. Waldrip, et al (2006) stated that "*Multiple refers to the practice of re-representing the same concept through different forms, including verbal, graphic and numerical modes, as well as repeated student exposures to the same concept*". This can be interpreted that

"Multiple representation can be interpreted as representing the same concepts in different shape, it is possible verbally, pictures, graphs, and mathematics". Meanwhile, Gyamfi (1993) stated that "*Multiple representations entail the use of different representations (e.g. graphs, tables, equations, diagrams) at the same time*". This means that multiple representation required the use of different representation (for examples, graphs, table, equation, diagrams) at the same timep. Ozgun Koca (1998) stated that "*Multiple representations can be defined as external mathematical embodiments of ideas and concepts to provide the same information in more than one form*". Multiple representation can be defined as the embodiment of mathematical external of the ideas and the concepts to give the same information more than one form. Next, Math Vault (2019) defined that "*multiple representations are ways to symbolize, to describe and to refer to the same mathematical entity*". This means that the multiple representations are the methods to symbolize, to describe, and to refer to the same entity of mathematics. Symbolizing happens when a student can write or symbolize, present, formulate information in the form of letters, numbers, or the representative signs or other operations. Describing happens when a student can mention, differentiate, generate, categorize, assess, construct, apply information visually, verbally, and/or symbolic. Referring happens when a student can harmonize, adjust, interpret information already obtained. Students can bring up one of the representation, even they can also bring up more than one representation to the same concept in different shape. From researchers who conducted the multiple representation, there are the similar indicators, schematically, the aspects of multiple representation presented in following figure:

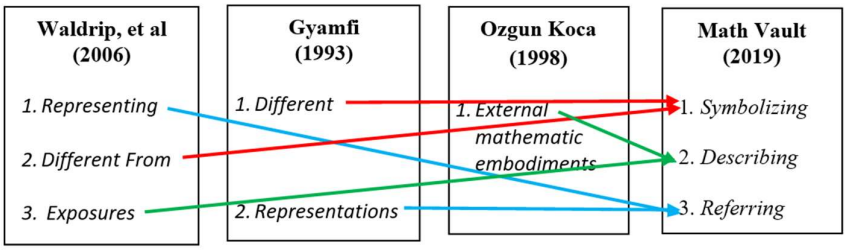


Figure 2.1 Scheme of the aspects of multiple representation

Indicators of the research are shown on Table 2.

Table 2 Indicators of Multiple Representation
(Waldrip et al, 2006; Gyamfi, 1993;
Ozgun Koca,1998 ;Math Vault, 2019)

No	Aspect of Multiple Representation	Description	Indicator
1.	Symbolizing (Waldrip, Gyamfi, Math Vault)	1. Manipulating symbols and language of mathematics	1. Writing/symbolizing known information, asked on the given problem. 2. Formulating/ Presenting information on problems in forms of letters, numbers, or representative sign or the other operations.
2.	Describing (Waldrip, Ozgun Koca, Math Vault)	1. Explaining through illustration or imagination.	1. Constructing/forming representation of information visually, verbally, and/or symbolic. 2. Applying information to solve the problems.
3.	Referring (Waldrip, Gyamfi, Math Vault)	1. Seeing suitability	1. Checking formed representation. 2. Harmonizing/adjusting the results of the obtained representation.

A number of research denoted that to increase the understanding of students' concepts need to be supported by the use of *multiple representation* in learning process (Adadan et al, 2009). According to Hwang, et. al (2007), stated that the ability of elaboration in solving problems with various explanation and illustration are the factors which

influenced the skills of multiple representation in problems solving. Akkus and Cakiroglu (2009), described that the learning process based on representation gave the significant influence on the algebra ability compared with conventional learning. Panasuk & Beyranevand (2012), the research denoted that the relationship between achievement and ability in recognizing and solving the problems involving linear equation of one variable presented in the models of different representations (words, diagram, and symbol). Apart from that, the research also revealed that the capable students recognized the same structures as proposed in different representation denoted the understanding of conceptual which in turn will cause more achievements. However, level of achievement is not the strong indicator of the conceptual understanding. The research also states that the more diverse knowledge of students in representation the more the possibility they can produce the right solution to solve the problems and the representation helps students in developing their knowledge of mathematics. In line with Faridah's findings, et.al (2022), that the multiple representation influenced students in problems solving. Researchers conducted the research to 65 students (7B = 32 students, 7C = 33 students) in SMP Negeri 2 Sukodadi Lamongan. The results of the research denoted that (1) score of ability test of multiple representation of students Grade 7B and 7C on gender increased, where for Grade 7B (32 students), sum of test score A = 1.950, and test score B = 2.325. Whereas for Grade 7C (33 students) sum of test score A = 1.175, and test score B = 1.500.

Related with the mathematics learning at school naturally involved male and female students, factors which influenced to mathematics ability are gender. That enabled there were differences in strategies used by male and female students in the ways to solve the problems. There are several opinions stating that male students are successful enough in learning mathematics compared with female students. An education research found the strong proof of male students dominant in science and mathematics learning (Benboy & Stanley, 1980; Halpen, 1986; Hyde, et. al, 1990; Reis & Park, 2001). Usman, et. al (2017) explained that "each gender, male and female students had different characteristics of thinking which could differentiate the action in understanding, representing, and providing the aspects of mental description". In line with that, Branata (1987), said that female students in general better in memory and male students better in logical thinking. Furthermore, Keitel (1998), stated that "process of conseptualization influenced by gender factor". Result of research findings above, basically, only seeing male and female students in relation with the roles of gender. On the other hand, results of research of Dzarian (2021), denoted that the differences of gender roles on students can influence mathematics ability. Male students were androgynous more superior than feminine male students and masculine male students.

METHOD

Research Design

Research is the case study analyzed with the qualitative which is the main data in the forms of words and sequence of sentence. This can be seen from the goals of research, namely: describing multiple representation of androgynous students in solving the problems of fraction. Descriptive data of the subject of research can be in the forms of words (written or oral) or observed behavior.

Sample and Data Collection

Subjects of the research are the students of 7B of SMP Negeri 2 Sukodadi Lamongan total of 32 siswa. 2 subjects are selected of 6 with androgynous gender. Process of subject selection to determine androgynous gender by using BSRI (Bem Sex-Role Inventory) developed by Bem SL (1974). From the results of students' answers were classified by using the method median division, that is, comparing the score of masculinity and femininity with the scores of sample median (Miller, Lurye, Zosuls & Ruble, 2009):

a) Students classified as masculine if they own score of masculinity taller than median of score of feminity.
b) Students classified as feminine if they have score of feminity taller than the median of score of masculinity.
c) Students classified as androgynous if they have scores of masculinity and feminity above the median.
d) Students classified as undifferentiated if they have scores of masculinity and feminity below the median.

Technique of data collection used in the research is by giving test of problem solving of fraction concept on subjects of the research.

Questions used shown in Table 3 below.

Table 3: Instrument of Mathematical Problem Solving

No	Problem	Question
1	Students of Grade 7A SMPN 2 Sukodadi consisted of 25% of male students and $\frac{1}{3}$ of a lot of male students wearing glasses, $\frac{1}{3}$ of a lot of female students not wearing glasses, and a lot of female students wearing glasses is 12 students.	a. Determine many male students wearing glasses! b. Determine many female students not wearing glasses! c. Determine many male students not wearing glasses!
2	Mr Ahmad had land shaped rectangle. The land will be inherited to his 5 children, that is, 3 sons and 2 daughters. Part for his daughters is $\frac{1}{2}$ is part for his sons. The circumference of Mr Ahmad's land is 280 m, and the width is $\frac{3}{4}$ of length of the land, the width and the length of the land are multiples of 10.	Determine wide part of the land for his daughters!

Data Analysis

Data analysis of the research is the transcript of interview, written answers of subjects, and field notes. Data Analysis of data of the qualitative research used interactive model according to Miles, et. al (2014). Processs of data analysis covered data collection, data condensation, data presentation, conclusion and verification.

RESULT AND DISCUSSION

Data Analysis of Gender Questionnaire

After the analysis of gender questionnaire of 32 students following data obtained.

Table 4. Result of Gender Questionnaire

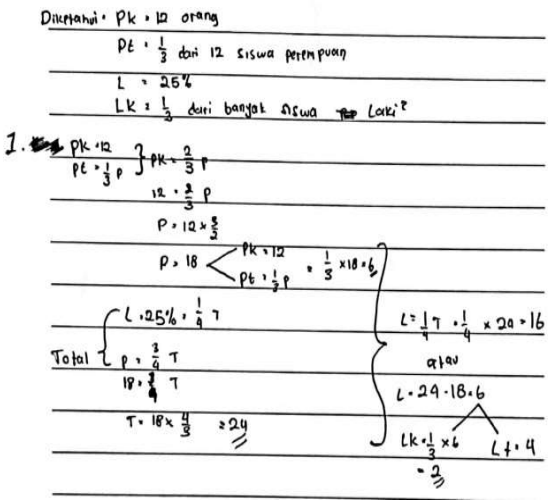
Gender	Students
Masculine	7
Feminine	8
Androgynous	6
Undifferentiated	11
Total	**32**

1. **Description of Multiple Representation of Androgynous Students 1 (A1/Male Students).**

   Problem 1

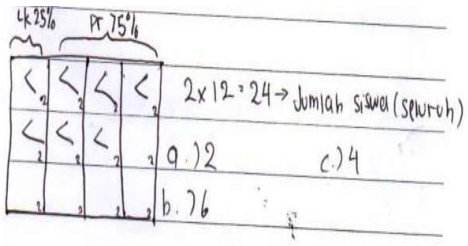
   In Aspect of Symbolizing: subject with for example: a number of male student (M), a number of female student (F), a number of male student wearing glasses (Mg), a number of female student wearing glasses (Fg), male students not wearing glasses (Mn), female students not wearing glasses (Fn).

   In Aspect of Describing: subject constructed and implemented information with the visual verbal, and symbolic representation. Subject looked for a number of student first, then determined a number of male student and female student so that it is obtained the answers of male students wearing glasses and female students wearing glasses. Visually, subject solved the problems by making a picture which is coded with a tick (✓) to show the number of students.



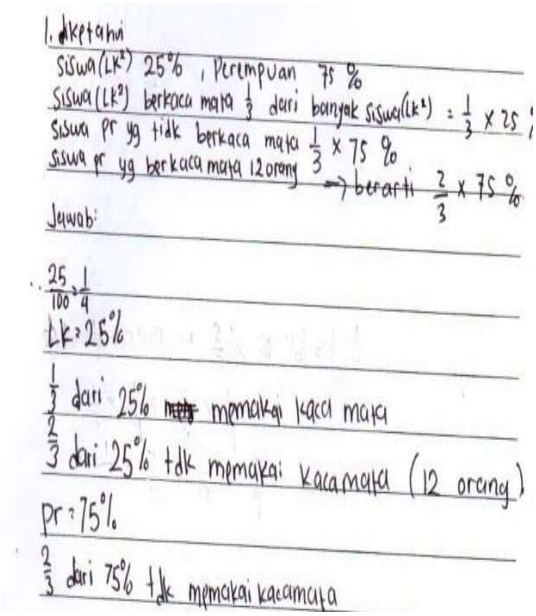
Known:
Fg= 10 students
Fn = $\frac{1}{3}$ of 12 female students
M = 25%
Mg = $\frac{1}{3}$ of male students

Figure 1 Symbolic Representation



M = 25%
F = 75%
2 x 12 = 24 (Total of Students)

Figure 2 Visual Representation



Known:
Male Students (M) = 25%, Female (F) = 75%
Male Students Wearing Glasses $\frac{1}{3}$ of number of male students = $\frac{1}{3}$ x 25% = $\frac{2}{3}$.
Female Students Not Wearing Glasses $\frac{1}{3}$ x 75%.
Female Students Wearing Glasses are 12 students, means that $\frac{2}{3}$x 75%.

Figure 3 Verbal Representation

In Aspect of Referring: subject checked the formed representation, and adapted the result of obtained representation. Following interview.

Researcher	Now is your answer in accordance with the information given?
Subject (A1)	Yes, it is
Research	Where do you think the suitability lies?
Subject (A1)	Here, male students 25% then female students 75%.
Researcher	Why are female students up to 75%?
Subject (A1)	Because 25% of them are male students.
Researcher	What is your conclusion about problem solving in these 3 ways?
Subject (A1)	The answer is the same

Problem 2

In Aspect of Symbolizing: subject with for example: Around Land (A), female students (F), male students (M), wide land (W), long land (L).

In Aspect of Describing: subject constructed and implemented information with the visual verbal, and symbolic representation. Subject described the solution by making the sketch of first. Writing what is known, namely: f = $\frac{1}{2}$ x m, k =280, m = $\frac{3}{4}$ dari f. Then find the length and width to get the area known. Subject obtained the answer that the share of land for male 1.200 m^2 and for female 600 m^2.

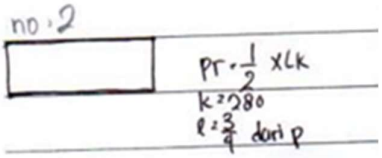


Figure 4 Visual Symbolic Representation

Following Interview

Researcher	What information do you know about question number 2?
Subject (A1)	(*Subject explained the answer verbally/* ***verbal representation***) Known: Male = 3 persons. Female = 2 persons Part for female = $\frac{1}{2}$ of male Around Land of Mr Ahmad = 280 m Width = $\frac{3}{4}$ of length of land The width and length of the land are multiples of 10
Researcher	So what is asked in the question?
Subject (A1)	Width of land for his daughter.

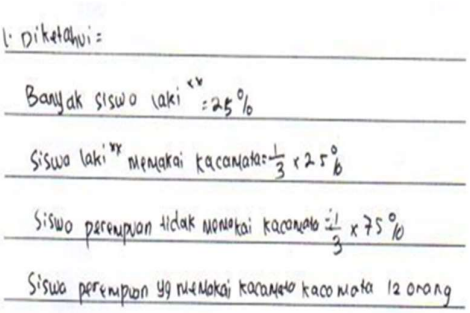
In Aspect of Referring: subject checked the formed representation, and adapted the result of obtained representation.

2. Description of Multiple Representation of Androgynous Students 2 (A2/Female).

Problem 1

In Aspect of Symbolizing: subject only wrote what is known without symbolizing.

In Aspect of Describing: subject constructed and implemented information with the verbal representation verbal.



Known:
Number of Male Students = 25%
Male Students Wearing Glasses = $\frac{1}{3}$ x 25%
Female Students Not Wearing Glasses = $\frac{1}{3}$x 75%
Female Students Wearing Glasses = 12 students

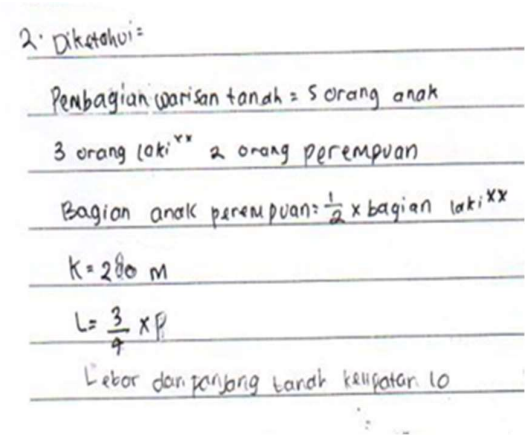
Figure 5 Verbal Representation

In Aspect of Referring: subject checked the formed representation, and adapted result of obtained representation.

Problem 2

In Aspect of Symbolizing: subject A2 symbolizing with for example: Around Land (A), Female (F), Male (M), width (w), length of land (l).

In Aspect of Describing: Subject constructed and adapted information with the verbal representation. Subject described solution by finding the length and width first using what is known, namely: a =280, $w = \frac{3}{4}$ dari l. So later the length and width will be known. Subject obtained the answers that part of the land for male is 1.200 m^2 and for female 600 m^2.



Known:
Division of land = 5 children
3 persons (male), and 2 person (female)
For Female = $\frac{1}{2}$ x for Male
A = 280 m
w = $\frac{3}{4}$x l
Width and length of land of multiples 10

Figure 6 Verbal Representation

In Aspect of Referring: subject checked the formed representation, and adapted the result from obtained representation. Subject was sure of the answers.

Following Interview

Researcher	Is your answer suitable with information provided?
Subject (A2)	Yes, it is
Researcher	Are you sure?
Subject (A2)	Yes
Researcher	Where are you sure?
Subject (A2)	Because I do it according to what is known.

CONCLUSION

Based upon the result of the research can be concluded that androgynous subject 1 (A1/male), and androgynous 2 (A2/Female) can solve the problems 1 and 2, and the answer is right. Subject A1 in solving problems used visual, verbal, and symbolic representation. This denoted that subject A1 used multiple representation. Meanwhile subject A2 only used verbal representation. Subjects A1 and A2 in symbolizing problems by writing what is known, what is asked, and presented it in the form of numbers which represented or other operations. Subject A1 symbolized with symbols. Meanwhile, subject A2 with the words. Subjects A1 and A2 described problems by constructing representation visually, verbal and symbolic and implemented the information to solve the problems. Meanwhile, subject A2 only used verbal representation. Subjects A1 and A2 in referring the answer namely by checking the formed representation, and adapted the obtained. Subject A1 is sure already appropriate, and the answers are the same by using different way. .

The result of the research is in line with the research conducted by Panasuk, et. al (2012), that "increasingly diverse knowledge of students in representation the more the possibility to produce the appropriate solutions to solve the problem and representation helping students in increasing their mathematics knowledge". Ability of subject A1in describing in line with the results of the research conducted by Hwang, et. al (2007), stated that "skills of multiple representation in solving the problems influenced by the factors of ability of elaboration". Subject A1 can develop ideas, thoughts, and creation through illustrations or imagination through various method orally or written. Subjects A1 (male) are more superior compared with subjects A2 (female). This is in line with Benboy and Stanley (1980), stated that male mathematics ability are more superior in spatial tasks, so in certain mathematics topics male students can get higher scores compared with those of female students, like fraction, geometry, and problems of knowledge of measuring space, meamwhile female students are better at verbal ability. Downing (2009), also said that male students are better in manipulating visual images and numerical ability, meanwhile female students in general are better in test of verbal ability.

RECOMMENDATION

The following provides suggestions of related research, namely: the use of multiple representation is very important for the process of construction of understanding of students mathematical concepts for the success of solving mathematical problems.

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