

# Students' Mathematics Representation of the Statistics: A Case Study

Alfian Eka Utama<sup>1</sup>, Sufyani Prabawanto<sup>2</sup>  
{alfianeka25@upi.edu<sup>1</sup>, sufyani@upi.edu<sup>2</sup>}

Mathematics Education Study Program, School of Postgraduate, Universitas Pendidikan Indonesia, Jl. Dr. Setia Budi No. 229, Bandung 40154, Indonesia<sup>1</sup>, Mathematics Education Department, School of Postgraduate, Universitas Pendidikan Indonesia, Jl. Dr. Setia Budi No. 229, Bandung 40154, Indonesia<sup>2</sup>

**Abstract.** The purpose of this study is to investigate students' mathematics representations of the statistics. This research is qualitative research with a case study design. The subjects of this study were five 9<sup>th</sup> graders. The data were collected using the student's worksheets and interviews. The students' mathematics representation was seen through the statistics problems' results; then, we continued with the interview. The findings of this research indicate that the student's high-ability can represent their answers visually in the form of bar, line, and circle diagrams well. Meanwhile, students with low-ability present their work differently on line diagrams drawn upside down, and unanswered circle charts because they have difficulty calculating and measuring percentages in circles, so they are not able to express their ideas visually optimally. For verbal representations, each student presented his answer briefly, which only wrote down the final result of the answer being asked without providing any information. Then for the ability of symbolic representation, students can represent their answers symbolically in algebraic form and solve the problems given systematically.

**Keywords:** mathematics representation, statistic

## 1 Introduction

Representation is the translation of a problem or idea in a new form, including images or physical models, into symbols, words, or sentences [1]. Mathematical representation is an expression of mathematical ideas displayed as a model of a problem, which can be presented in the form of tables, pictures, verbal or mathematical symbols [2]. In mathematics education, representation is significant in simplifying and solving mathematical problems [3]. Besides, the word is notable both as a tool that supports reflection and as a means of communicating students' mathematical ideas [4]-[6] both verbal or numeric [7]. Representation is one of the standard mathematics learning processes that students must master [1]. The ability to express is one of the essential skills to be developed and must be owned by students.

[8] state that tables, pictures, graphs, mathematical statements, written text, or a combination are all kinds of representations that are often used in communicating mathematics. [9] the name consists of several forms, graphical models, verbal presentations, diagrammatic terms, and mathematical representations. Mathematical expressions can be represented as visual and non-visual representations. Visual representations include graphs, tables, pictures, or diagrams. Then non-visual illustrations include numerical drawings and mathematical equations or mathematical models. The representation ability can be seen clearly whenever visual and

numeric representations are used in terms of ratio, proportion, and percent [10]. The ability to represent cognitive activities according to [11] includes visual representations (making images of real-world situations clarifying problems and facilitating their solutions), verbal representations (answering questions using words or written text), and symbolic representations (problem-solving involving symbol).

Some of the results of research in mathematics education on representation, on cube and block material [6] circle [12], Pythagoras [10] algebra [13] [14]. Previous research has found that many students have poor mathematical representation skills [6] [10] [15]. One of the mathematical materials that require good representation skills is statistics. In statistics, students are required to explain data presentation techniques in the form of diagrams or tables or graphs, then interpret the meaning of charts or tables or maps, and find solutions from centralizing data [16]. This study aimed to determine students' mathematical representation in statistical material, which includes visual name, verbal expression, and symbolic representation.

## **2 Method**

This research is qualitative research with a case study design. A case study is a strategy taken by researchers and understanding the object under study specifically and deeply in a case through relevant data [17] [18]. The issue in this study is the mathematical representation of students in statistics material. This research was conducted in September at a middle school in Mataram, West Nusa Tenggara. There are five grade nine students, as subjects in this study. All subjects had previously studied the statistic material in 7<sup>th</sup> and 8<sup>th</sup> grade. Subjects were selected based on mathematics achievement as well as recommendations from mathematics subject teachers. Two students, AS and BA, have low levels, two other student's RF and MD, have moderate mathematics achievement, and one student CK has high mathematics learning achievement. The data were collected using worksheets and interviews with students. The research was conducted during one meeting for all students within 40 minutes. Each students was interviewed about the answers they gave in text to clarify the results of their oral representations. why do they answer as written or have different meanings about the given representation. First, the students were evaluated for twenty minutes using statistical problems; students' answers are analyzed; then, the interview was conducted for twenty minutes. There are four problems related to the statistics presented in this study. These problems are taken from middle school mathematics textbooks. one concern was to see the ability of visual representation, one issue to see the power of verbal expression, one question to know the capacity of symbolic representation, and another to see the combination of representations visual, symbolic and verbal.

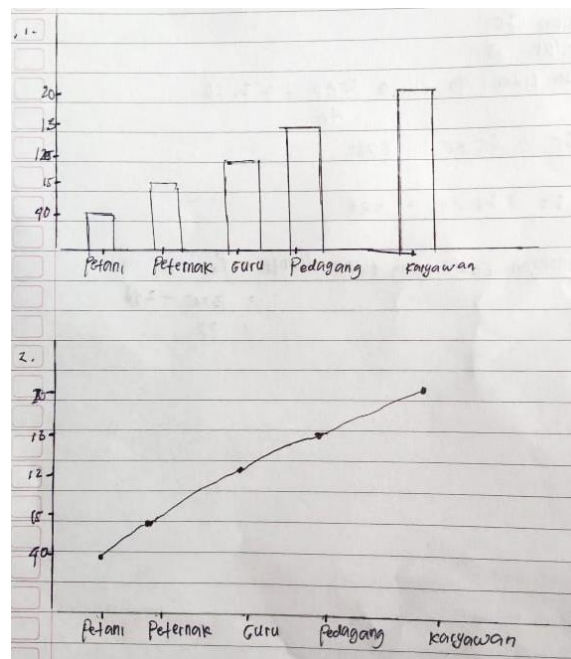
## **3 Result and Discussion**

There are four problems related to the statistics presented in this study. In the first problem, students are asked to give data in the form of bar, line, and circle diagrams to see their visual representation ability. In the second problem, students are asked to describe their observations on a graph to see the student's verbal representation skills; in the third problem, students are asked to solve a daily concern to see the symbolic representation ability, and in the fourth

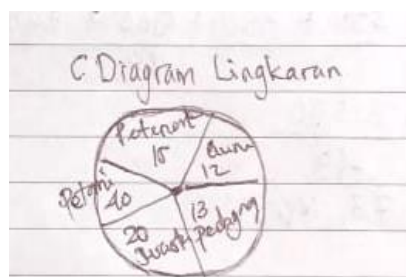
problem, students are asked to find a solution from the diagram given to know the combination of representation abilities that students have.

*Problem 1*

This problem presents data in the form of a story text problem. Students are asked to convert the data into bar charts, graphs, and pie. Solving this problem will maintain the ability of students to visual representations.



**Fig. 1.** Solution problem one by a student BA



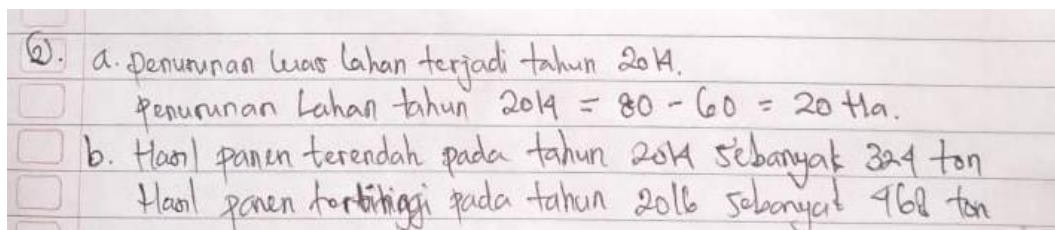
**Fig. 2.** Solution problem one by a student MD

In this problem, the subjects CK, RF, MD, and AS can visually represent the given data, turning the data into bar and line charts. However, BA subjects present bar and line charts in different ways, see figure 1. Based on the interview, BA subjects only pay attention to the numbers in the data. In the circle diagram of CK students with high ability and moderate RF ability to visually represent, MD represented the data into a pie chart but was less than perfect.

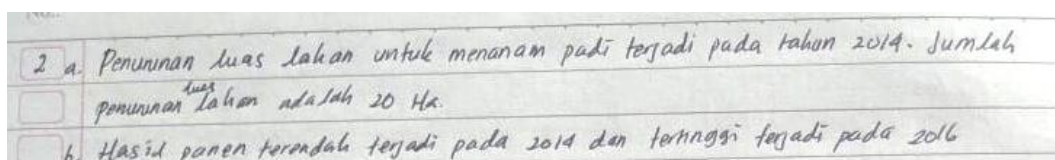
See Figure 2. BA and AS did not answer. Based on the results of the interview, MD only paid attention to the numbers in the data. BA and AS said they could not show a representation because of the difficulty of calculating and measuring percentages in circles.

**Problem 2**

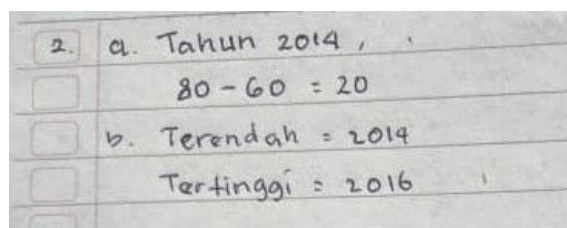
In the second problem, students are given a line diagram, and then students are asked to analyze the data.



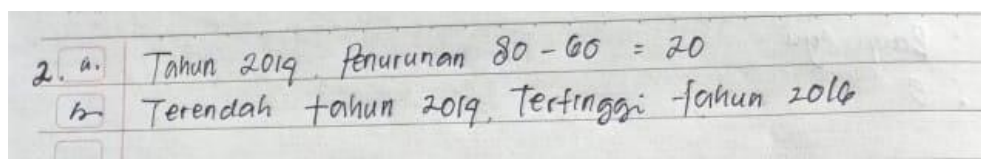
**Fig. 3.** Solution problem two by student MD



**Fig. 4.** Solution problem two by student CK



**Fig. 5.** Solution problem two by student AS



**Fig. 6.** Solution problem two by student BA

Students are given a line diagram; then, students are asked to analyze the data in written form. In this problem, all students can answer well. CK and MD can represent the results of their thoughts both verbally, in writing and orally from the diagrams well, see figures 3 and 4. BA represents their answers in an incomplete report. US and RF represent their answers in writing. They only answered with numbers without writing a complete description of the

diagram. The representation ability of students is still not good at conveying their ideas in writing [13]. Based on the interviews, CK, RF, MD, SA, and BA students were able to represent them orally well.

*Problem 3*

In problem 3, students are given a mathematical problem using a daily life situation; then, students find a solution to the problem mathematically by symbolic.

$$\begin{aligned} 3 \quad a + b + c + d + e &= 65 \times 5 \rightarrow a + b + c + d + e = 325 \\ a + b + c + d &= 62 \times 4 \rightarrow a + b + c + d = 248 \\ \hline & \qquad \qquad \qquad e = 77 \end{aligned}$$

**Fig. 7.** Solution problem three by student RF

3.  $\rightarrow$  Jumlah nilai awal =  $65 \times 5 = 325$   
 $\rightarrow$  Jumlah nilai 4 orang =  $62 \times 4 = 248$  -  
 $77 =$  nilai anak tersebut

**Fig. 8.** Solution problem three by student AS

3.  $\# \frac{n}{5} = 65 \Rightarrow n_1 = 325$   
 $\# \frac{n}{4} = 62 \Rightarrow n_2 = 248$   
 $\Rightarrow n_1 - n_2 = 325 - 248 = 77$   
 Jadi, nilai ulangan siswa yang tidak dikutkan adalah 77.

**Fig. 9.** Solution problem three by student CK

All students can answer this problem. Student RF represents the answers by first symbolizing in algebraic form the question given, see figure 7. Based on the interview, symbolic out the situation can make it easier for him to find a solution to the problem. Student AS does not represent it symbolically, only describe it in words. Student representation skills are the key to successful mathematical problem solving [19]. Meanwhile, student CK answered by directly looking for the value of the questions given.

Problem 4

4 a. Median = ~~50, 50, 50, 50, 50, 60, 60, 60, 60, 60, 60, 60, 60, 70, 70,~~  
~~70, 70, 70, 70, 70, 70, 70, 70, 70, 70,~~ 70, 80, 80, 80, 80, 80,  
80, 80, 80, 80, 80, 80, 80, 80, 80, 80, 90, 90, 90, 90, 90, 90,  
90, 90, 90

b. Modus :  $50 = 5$        $80 = 14$   
 $60 = 8$                $90 = 10$  } 80 ✓  
 $70 = 12$

Fig. 10. Solution problem four by student RF

4. a) Median :

(i) dikalikan dulu nilai siswa dgn byk siswa

- $50 \times 5 = 250$
- $60 \times 8 = 480$
- $70 \times 12 = 840$
- $80 \times 14 = 1120$
- $90 \times 10 = 900$

} jumlah data = 3590

jumlah siswa = 49

→ Jadi mediannya =  $\frac{49}{2} = 24,5$

berarti ada pada data ke-25, yaitu = 70

b) Modusnya adalah nilai 80, karena paling banyak muncul sebanyak 14

Fig. 11. Solution problem four by student AS

4. a. Median 70  
b. Modus 80

Fig. 10. Solution problem four by student BA

In four problems, students were given questions in diagrams; then, students were asked to find solutions to these problems. Student BA only represents answers in numerical form, without explaining in writing, see figure 12. Based on the interview, students only care about the final answer. Student RF represents their answers by describing the amount of data to find solutions to the problems given. Based on the interview, describing the data will make it easier for him to find solutions representation is very important in simplifying and solving mathematical problems [3]. Student AS represents a solution by adding up lots of data and then describing it symbolically and mathematically.

## 4 Conclusion

From this study, it can be concluded that student's high-ability can represent their answers visually in the form of bar, line, and circle diagrams well. Meanwhile, students with low-ability present their work differently on line diagrams drawn upside down, and unanswered circle charts because they have difficulty calculating and measuring percentages in circles, so they are not able to express their ideas visually optimally. For verbal representations, each student presented his answer briefly, which only wrote down the final result of the answer being asked without providing any information. Then for the ability of symbolic representation, students can represent their answers symbolically in algebraic form and solve the problems given systematically. We suggest continuing research on how students represent mathematics in more subjects.

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