Students' ability of mathematical representation on statistics topic in elementary school

Students' ability of mathematical representation on statistics topic in elementary school

L Farokhah[1,*], T Herman[2] and A Jupri[2]

[1]Program Studi Pendidikan Dasar, Sekolah Pasca Sarjana, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudi No. 229, Bandung 40154, Indonesia
[2]Departemen Pendidikan Matematika, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudi No. 229, Bandung 40154, Indonesia

[*]laely_farokhah@student.upi.edu

Abstract. Mathematical representation is the ability to represent a mathematical problem in the form of symbols, images, manipulative objects, and other mathematical ideas. Most of previous research have described about mathematical representation ability in the middle schools. So this research aims to describe the mathematical representation ability including visual representation, symbolic representation, and verbal representation in statistics topic especially in elementary school. This research employed qualitative research using descriptive method and conducted in 35 students of 5th grade in one of elementary schools in Bandung, Indonesia. The instruments used mathematical representation test and interview. The result showed that (1) 20% students can draw a bar chart based on the known data and use the bar chart as a visual representation to solve the problems, but 80% students have difficulties in using visual representation, (2) 31% students can use mathematical expression or symbols to solve problems appropriately, but 69% students have difficulties in using symbolic representation, and (3) 34% students can answer question using verbal representation, but 66% students can not answer question using verbal representation. This result can be a reference for teachers to develop the learning process so that it can improve mathematical representation ability of elementary school students.

1. Introduction

Basically, mathematics learning process prepare students to face the challenges in 21st century by teaching students some of mathematical abilities. According to NCTM (National Council of Teachers of Mathematics), standards for school mathematics of Prekindergarten through Grade 12 consists of problem solving, reasoning and proof, communication, connections, and representation ability [1]. Representation as one of standard process indicates that mathematical learning process in school should develop the student's ability of representation. Mathematical representation is the ability to represent a mathematical problem in the form of symbols, images, manipulative objects, and other mathematical ideas. The ability of representation emphasizes the use of symbols, graphs, object manipulations, and diagrams as the appropriate method for expressing ideas as well as interrelationships of mathematical concepts [2]. The importance of mathematical representation is that it can be used to communicate mathematical ideas, arguments, and other student's mathematical understandings [1]. By given students the opportunity to construct their own representations of mathematical concepts, rules, and relationships, they also should be encouraged to develop the ability to use symbolic representations, rather than to rely on concrete ones [3].

Representation is an important process that aims to develop and optimize students' thinking skills in learning [4]. The ability of mathematical representation consists of two types which are internal representation and external representation. Internal representation involves the thought process of a person who can not be observed directly, while external representation includes the embodiment of the idea in the form of oral and written and can be observed directly. The inability of students to use representation in solving a problem can cause them find difficulties in mathematics [5]. In problem solving activity, a solver need to use representations not only to help her or him organize and make sense of the problem but also to communicate his or her thinking to others [3].

Moreover, primary education is an important phase to develop mathematical representation ability. Three reasons that describe why representation is one important part of the process standard are 1) fluency in translation between different representations of things is the basic ability that students need to develop mathematical concepts and thinking, 2) mathematical ideas presented through various representations of teachers will have a big influence on students in learning mathematics, and 3) students need to practice in building their own representation so that students have good skills and understanding and flexible concepts that can be used in problem solving [6]. In addition, representation help students to develop, understand, and translate mathematical concepts and relationships between different modes of representations [7]. Representation serves to help organize ideas mathematics more concrete and real for material thought [8].

Elementary school as an important education phase has a big role to identify and develop mathematical representation ability. Teachers need to describe and analyze mathematical representation ability earlier especially in elementary school. Previous research showed that most of students can not find the general form or mathematical model of the representation used in answering questions and lack of flexibility in constructing representations [8]. Other previous research showed that based on essay test, students' ability of mathematical understanding and representation in Junior High School is low category [9]. Most of previous research have described about mathematical representation ability in the middle schools [10, 11]. Based on that, in this study the researchers focus on mathematical representation ability specifically in elementary school. Moreover, there are three types of mathematical representation ability to be studied are visual representation, symbolic representation, and verbal representation. The ability of visual representation is the ability of students to use representation through picture, table, or graphic. Symbolic representation ability is student ability in using representation through mathematical expression in the form of mathematical symbols. The ability of verbal representation is student ability in using representation through written words.

2. Method

This research employed qualitative research using descriptive method and conducted in 35 students of 5^{th} grade in one of elementary schools in Bandung, Indonesia. This research aims to describe the mathematical representation ability including visual representation, symbolic representation, and verbal representation in statistics topic especially in elementary school. The instrument used mathematical representation test. The mathematical representation test includes visual representation, symbolic representation, and verbal representation. The indicators consist of using a visual representation to solve the problem, solving problems by involving mathematical expressions, and answering questions using written words or text. This research also used interview to clarify students answer and find the difficulties of students' mathematical representation ability.

3. Result and discussion

Based on mathematical representation test conducted by researcher in 35 students of 5^{th} grade on the statistics topic, it is found that students find difficulties in making representations of a mathematical problem. Table 1 below show the results presented descriptively quantitative student scores as follows.

Table 1. Descriptive statistics data of mathematical representation test.

N	Min	Max	Mean	Std. Deviation
35	0	100	56.50	15.33

Based on Table 1, the descriptive statistics data showed that the mean of mathematical representation test is 56.50 from 35 students of 5th grade. Comparing with the score standard of minimum test, it showed that most of students find difficulties in using mathematical representation ability to solve a problem on statistics topic. For this reason, this results indicates that mathematical representation ability should be emphasized in mathematics learning process from elementary school.

3.1. Visual representation ability

In visual representation ability, students were given a question of visual representation ability with indicators to measure students' ability in using visual representation to solve problems. The results showed that 20% of students who are 7 students from 35 students can use the image correctly and can find the solution of the problem correctly.

Question 1: A total of 100 students of State Elementary School of Sukamaju like sports activities. 30 students like football, 25 students like volleyball, 10 students like swimming, 15 students like basketball, and the others likes badminton sport.

- Draw a bar chart from the data of favorite sports of students in State Elementary School 1 Sukamaju!
- How many students like badminton?

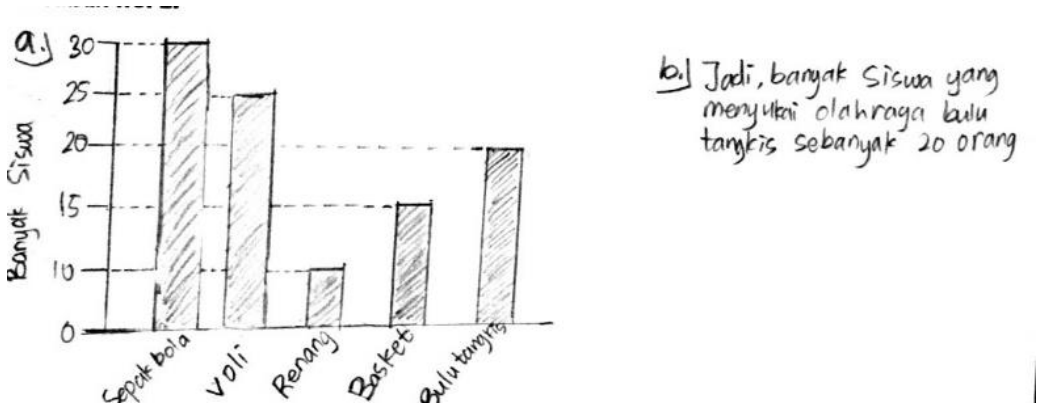

Figure 1. Visual representation of students with high mathematical representation ability.

On the Figure 1, Students with high mathematical representation is able to draw a bar chart based on the data known in the problem correctly. This categories of students can identify what the data known and represent to the diagram representation. Then they use the bar chart as a visual representation to find solutions to the problem.

In contrast to students with high mathematical representation ability, 80% of students who are 28 students from 35 students have difficulties making visual representation of a mathematical problem. Some cases have been found that students can draw bar charts and enter data correctly, but have not been able to find the correct problem solving using the bar chart. In other words, it was also found that students with difficulty did not seem to respond the question or problem. Therefore, it can be concluded that students' visual representation ability is still low. Figure 2 is an example of the results of students' answers who have difficulty in making visual representations.

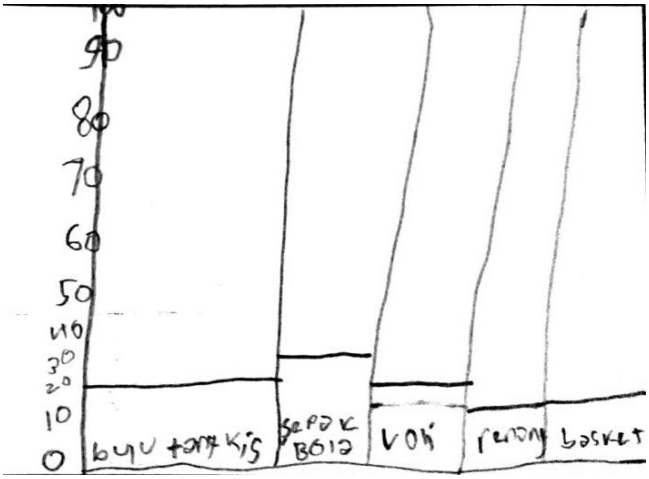

Figure 2. Visual representation of students with low mathematical representation ability.

In Figure 2, the student tried to draw bar charts but were inappropriate and less meaningful. Student can not represent the known data from the question to form of bar chart. So that he can not find the solution of the problem using visual representation. In using representations to solve problems, although students have known that the problems can be solved using enough data, students were still not realize yet what they should do [12].

3.2. Symbolic representation ability

In the ability of symbolic representation, students were given problems with indicators of students can solve problems by involving mathematical expressions. The results showed that 31% of students who are 11 students from 35 students can use mathematical expression to solve the problem correctly and find the right answer.

Question 2: Look at the bar chart below!

The Data of Total Students in State Elementary School of Sukajaya

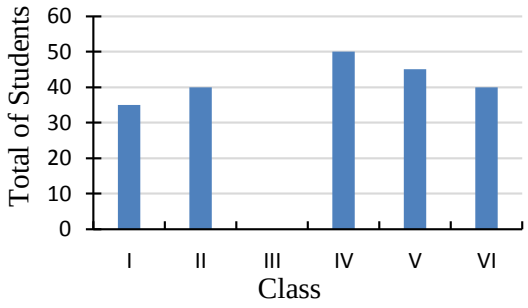

Figure 3. Bar chart of total students in state elementary school of Sukajaya.

Based on the bar chart, answer the question below!

- If the number of students in class III is more than 15 people compared with the number of students in class II, then the number of students in class III is ...
- The total number of students of SDN 1 Sukajaya is ...

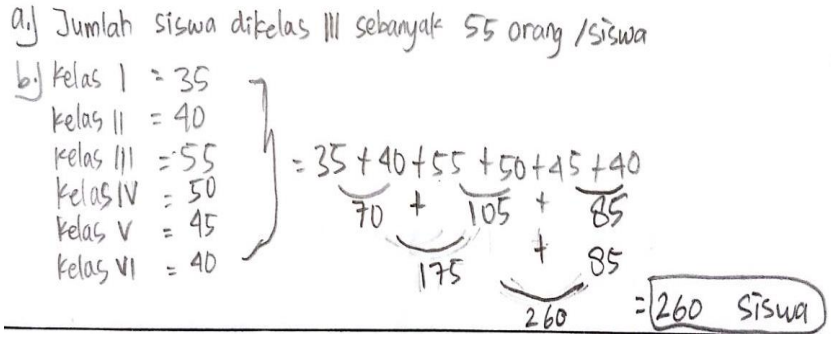

Figure 4. Symbolic representation of students with high mathematical representation ability.

In Figure 4, student use symbolic representation to find the solution of problem. Student try to do mathematical operation based on the known data from the question. He can answer the problem correctly and find the right answer without difficulties.

However, 69% of students who are 21 students from 24 students have difficulties in using symbolic representation to solve problems appropriately. The majority of students who have difficulty do not answer questions. Here are examples of student difficulties in solving problems by involving mathematical expressions or symbolic representation.

Figure 5. Symbolic Representation of students with low mathematical representation.

Based on Figure 5, student with low mathematical representation try a little mathematical expression but the answer is still not appropriate. Student write a symbolic representation but it less meaningful. There is no mathematical operation and another mathematical expression showed from student.

3.3. Verbal representation ability

Third, in the ability of the verbal representation, students were given a problem with the indicator students can answer the problem by using words or written text. The result indicates that 34% of students who are 12 student from 35 student able to answer problem use word or written text.

Question 3:

Table 2. The data of the borrowers of book in the library for a week.

Day	Total of students
Monday	36
Tuesday	45
Wednesday	60
Thursday	52
Friday	40
Saturday	65

- The most book borrowers are on.....
- The order of days that most borrower of his book to which the borrower of his book is the least is.....

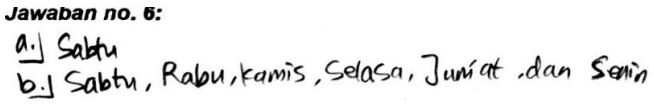

Figure 6. Verbal Representation of students with high mathematical representation.

In Figure 6, student can answer the question using verbal representation. However, it was found that 66% of students which are 23 students from 35 students were unable to answer questions using written words or texts. It is found that students answer the question but the answer not appropriate. Figure 7 are examples of student difficulties in answering questions using written words or texts.

Figure 7. Verbal Representation of students with low mathematical representation.

Based on the results, generally the ability of mathematical representation in elementary school students is still low. From the interview conducted by researchers, the difficulties students experience in representing a mathematical problem are: (1) students can not visualize a problem in any other form of mathematical model, (2) students find difficulty to connect the knowledge already possessed with representation form of a mathematical problem, and (3) students have missing in applying mathematical concept so they can not represent appropriately. This result in line with the previous research which states that only a small percentage of students find the general form (mathematical model) of the representation used in answering the question [8]. In addition, flexibility of students in constructing representations is largely lacking. Therefore it is needed a mathematics learning that can encourage students to be able to represent various forms of mathematical problems.

4. Conclusion

In summary, mathematical representation ability of elementary school students in statistics topic is still low. Based on the result, it showed that most of students find difficulties in using representation ability when they solve a problem. Students are difficult to represent in visual, symbolic, or verbal representation. This result indicates that mathematical representation should be focused on mathematics learning process. This result can be a reference for teachers to develop the learning process by applying learning strategy and model so that it can improve mathematical representation ability of elementary school students.

Acknowledgments

The authors would like to express thanks and the appreciation to LPDP (Lembaga Pengelola Dana Pendidikan) from Ministry of Finance of the Republic of Indonesia for providing financial support both for magister study and this research.

References

[1] National Council of Teachers of Mathematics 2000 *Principles and Standards for School Mathematics* (Reston, VA: NCTM)

[2] Walle J A V D, Karp K S and Williams J M B 2010 *Elementary and Middle School Mathematics: Teaching Developmentally* (USA: Pearson)

[3] Cai J and Lester F K J 2005 "Solutions Representations and Pedagogical Representations in Chinese and US Classroom," *J. Mathematical Behavior. Math.* **24** 221-237

[4] Rahmawati D, Purwanto, Subanji, Hidayanto E and Anwar R B 2017 "Process of Mathematical Representation Translation from Verbal into Graphic," *J. IJME. Math.* **12** 367-381
[5] Chen M J, Lee C Y and Hsu W C 2015 "Influence of Mathematical Representation and Mathematics Self-Efficacy on the Learning Effectiveness of Fifth Graders in Pattern Reasoning," *J. International Journal of Learning, Teaching and Educational Research*. *Math*. **13** 1-16
[6] Asmara A 2016 *Proc. Int. Conf.* on Innovation in Mathematics and Mathematics Education
[7] Pinter H H, Merritt E G, Berry R Q I and Kaufman S E R 2017 "The Importance of Structure, Clarity, Representation, and Language in Elementary Mathematics Instruction," *J. Investigation in mathematics learning*
[8] Dahlan J A and Juandi D 2011 "Analisis Representasi Matematik Siswa Sekolah Dasar dalam Penyelesaian Masalah Matematika Kontekstual," *J. Pengajaran MIPA.* **1** 128-138
[9] Minarni A, Napitupulu E E and Husein R 2016 "Mathematical Understanding and Representation Ability of Public Junior High School in North Sumatra," *J. Mathematics Education*. **7** 43-56
[10] Fitrianna A Y, Dinia S, Mayasari and Nurhafifah A Y 2018 "Mathematical Representation Ability of Senior High School Students: An Evaluation from Students' Mathematical Disposition," *Journal of Research and Advances in Mathematics Education* 3 46-56
[11] Widakdo W A 2017 "Mathematical Representation Ability by Using Project Based Learning on The topic of Statistics," *IOP Conf. Series Journal of Physics.* **895** 012055
[12] Juandi D and Jupri A 2013 "Developing Mathematical Communication and Representation of Students Grade VII: A Design Research," *J. Pengajaran MIPA.* **18** 135-145