Statistical Literacy: Students in Presenting Data

Moh. Hafiyusholeh[1], I Ketut Budayasa[2], Tatag Yuli Eko Siswono[2], Cholis Sya'dijah[3], and Elly Susanti[4]

[1]*Department of Mathematics, UIN Sunan Ampel Surabaya*
[2]*Department of Mathematics Education, Unesa Surabaya*
[3]*Department of Mathematics Education, UM Malang*
[4]*Department of Mathematics, UIN Maliki Malang*

Keywords: Statistical Literacy, Data, Graph, Table.

Abstract: Statistics have become a key component of the mathematics curriculum. At a basic level, by studying statistics, one can inference, read and present data in a more easily understood form known as statistical literacy. Everyone is in one of the roles of being a consumer and as a data producer. The core element of static literacy for consumers is the ability to read and interpret data in tables and graphs published by the national statistical office. The core element for producers is the ability to create clear, understandable tables, graphs and reports. The purpose of this research is to describe the student profile in presenting the data. Therefore, this study is a descriptive explorative qualitative. The subject comes from grade XII students MIA 9 SMA Negeri 3 Sidoarjo. Data were collected through a combination of interview methods with written task analysis. The result of the research shows that the subjects had the ability to describe data in the form of tables or diagrams in accordance with the desired information, including building an alternative view for a set of data, that is in the form of line diagrams, histograms, and pie diagrams, as well as frequency distribution table that referred to the purpose of data communication, regardless of the characteristics of a data. by paying attention to the characteristics of the data.

1 INTRODUCTION

During the past quarter century, statistics have become a key component of the mathematics curriculum. Technological advances and methods of modern data analysis, coupled with the massive data in the global era, have led development of the mathematics curriculum to be introduced statistical concepts into the school curriculum. Even in the principles and standards of school mathematics evaluation, National Council of Teachers of Mathematics (NCTM, 1989) enter data analysis and probability as one of the five content standards.

Statistical material is important to be included in the school mathematics curriculum because by studying statistics, students can do simple inferences, read a presentation of data and present data in a form which is easier to be understood. Statistics are also needed to be able to conduct research effectively, because statistics are the main method used to generalize the results of research.

Without using statistics, it is very difficult to make decisions based on data that has been collected from a study (Watson, 2006).

One of the important objectives of statistical education in schools is that students have statistical literacy. Statistical literacy is the basic ability that must be possessed by everyone (Franklin, 2007). Statistical literacy is a new goal for statistical educators (Schield, 2011; Kasonga & Corbett, 2008). Statistical literacy is needed so that someone can read and interpret and present data both in tables and graphs (Schield, 2013), understand meaning, navigate, and interpret information in the form of tables, diagrams, or graphs (Murray & Gal, 2002).

Statistical literacy is a new goal for statistical educators. A core element of statistical literacy for consumers is the ability to read and interpret data in the tables and graphs published by national statistical offices. A core element for producers is the ability to create tables, graphs and reports that are unambiguous and comprehensible (Schield,

2011). Statistical literacy is needed not only for students but is needed for everyone as both data producers and consumers (Seifer, 2009).

The problem is that the questions were tested on the National Examination (UN), in fact only about calculating the center and variation of data with single number or data distribution like mean, median, or mode (UN 2006, UN 2007, UN 2008, UN 2009, UN 2010, UN 2011, UN 2012, UN 2013, UN 2014, UN 2014, UN 2015, UN 2016, UN 2017). These questions emphasize only the commutative and procedural aspects so that students' statistical literacy skills, especially in terms of presenting data were neglected.

Research on statistical literacy relating to the presentation of data by students is important to do because by knowing the description of students' statistical literacy it will be obtained an overview of the thinking process and the actions of students in dealing with data which can ultimately be made as a basis for developing more complete learning model and curriculum in preparing students to become statistical literates. That is in line with Carver in Hafiyusholeh, Budayasa & Siswono (2017). He states that statistical literacy is important knowledge needed by all people that must be developed starts at an early age and is built throughout the school level.

Not many researches have examined in the aspect of statistical literacy, namely the presentation of data, one of them is Hafiyusholeh, Budayasa & Siswono (2017) which described the presentation of data and interpretation of data with reference to gender aspects. This study described how students with high mathematical abilities in presenting data.

2 THEORETICAL FRAMEWORKS

A person is said to have statistical literacy if the person is able to read and interpret data in both tables and graphs (Schield, 2011); to create, evaluate and communicate messages by involving words, numbers, and graphs together (Forbes et.al, 2011); to understand statistical concepts, vocabulary, and symbols, and including an understanding of probability, to organize data, to compile and display data in table form, to work with different data representations, to make clear and understandable tables, graphs and reports (Ben-Zvi & Garfield, 2005); to know what basic statistical terms mean, to understand the use of simple statistical symbols, to recognize and to interpret different data representations (Ben-Zvi & Garfield, 2008; Gal, 2002); to understand and interpret data (Schield, 2013); to critically evaluate the use of statistical data by others or the media (Goodall in Wade & Goodfellow, 2009); to read and understand statistics in news, media, and others (Garfield et.al, 2002). Statistical literacy can also be understood as a person's ability to read (understand); analyze; interpret; and represent a data in the form of tables or graphs (Hafiyusholeh, Budayasa & Siswono, 2017; 2018, Hafiyusholeh, 2015).

Representing (presenting) data is a person's ability to describe data in the form of certain tables or diagrams/plots in accordance with the information to be communicated. Including in this process is being able to construct data displays for a given set of data and build alternative views for a set of data (Mooney, 2002); including consideration of what is involved in making graphics as a tool for compiling data.
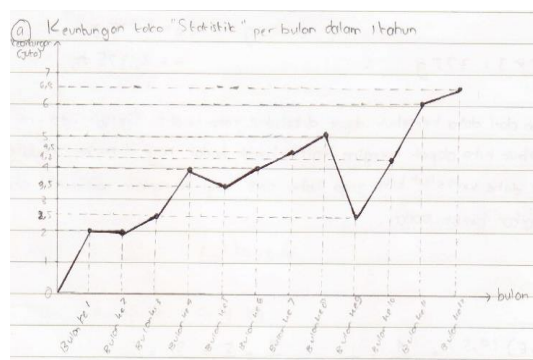
3 RESEARCH METHOD

This research was a qualitative exploratory research. The research subjects consisted of two subjects with high mathematical abilities. Data were collected by researchers through a combination of interview methods with written task analysis and student activity record results during the task completion process. To obtain the validity of the data obtained, time triangulation was carried out. The process of data analysis in this research referred to Miles & Huberman (1994) which was done by the following steps: (1) data reduction; (2) data exposure; and (3) drawing conclusions and verification.
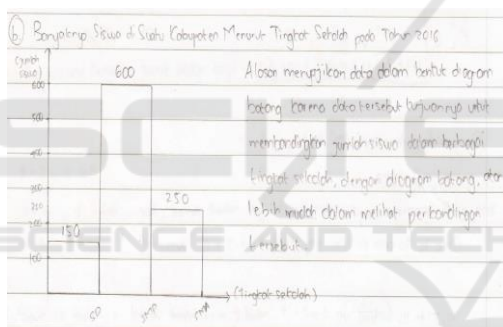
4 RESULTS AND DISCUSSION

To explore and describe students' statistical literacy in terms of data presentation, several questions were given with different data types. The first given question was data regarding the profits from the store every month for one year. The second given question was data on the number of students based on education level. The last question was data on students' math test scores in one class.

The results of the data presentation of each question are presented in Figure 1 as follows.

Figure 1. Presentation of data by subject

For each question given, (a) Subjects presented data in the form of line diagrams with the reason to facilitate in knowing the increase or decrease in profits as the following interview excerpt.

P :   The data (a) can be presented in what form?
S :   Line diagram sir
P :   Why is that?
S :   Because with a line diagram, people easily find to know the increase or decrease in

profits from the store for 1 year. In addition, the data is in the form of decimal or continuous so that it fits using line diagrams, not bar charts

For the case (b) the subject presented it in the form of a bar diagram with the aim of comparing students to each level in the district, as for the case (c) The subject presented it in the form of a frequency distribution table with the reason that it is easy to get the mean, median and mode. It was shown from interviews as follow.

P :   What is your opinion about data (b)?
S :   I think student data in all districts is suitable to use bar charts
P :   Why?
S :   Because it can be seen from the goal that is to compare between the number of elementary, middle and high school students. And this is also discrete data. So, it is suitable to use a bar diagram.
P :   What do you mean?
S :   For example, if we want to provide information on the number of elementary school students, secondary and high school, it is more suitable to use a bar chart. Because we want to compare the number of students

P :   As for the case (c)?
S :   I present it using a group table
P :   Why is that?
S :   The data is about the score of 40 students presented irregularly. And my goal is to make it easier for someone to find average, median and mode
P :   Why don't you use a single data table?
S :   That's because the data is too much, so as not to make a lot of tables

By paying attention to the presentation of the data performed by the subjects and the results of the interviews carried out, the results are as follows: Subjects in planning data presentation for case (a) are using line diagrams and bar charts. The main thing to consider is the purpose of presenting data and the type of data provided. In this case, the purpose of the subject in presenting data was to provide information about the increase or decrease of the profits obtained by the store. Another thing that was taken into consideration in presenting data is the characteristics of the data. Because the data presented was continuous data which is called

decimal data, the subject presented it in the form of a line diagram. While the bar diagram was not used, because the data from the store in each month was incompatible with the characteristics of the bar chart. The data corresponding to the bar diagram were discrete data. In addition to those considerations, the subject also considered the aspect of effectiveness in making or presenting the data.

In the case (b), the subject presented data in the form of bar and circle diagrams. The two forms of presentation were chosen because the purpose of the subject was to provide information about the number of students at each level in the district.

In the case of (c) the subject presented data in the form of a frequency distribution table. This presentation was chosen because it is more effective than presenting data with a single data table. The presentation of the data was chosen because the purpose of the subject was so that the data reader was easier to see the maximum and minimum values, besides that, it is also easy for readers to determine the average value of math test.

In addition to considering the purpose of presenting data, subjects with high mathematical abilities also considered the characteristics of the data. If the data was presented in discrete form, then the data presentation used was a bar diagram, circle and histogram. However, if the data presented was in a continuous form, then the data presented is a line diagram. This condition was certainly quite different from the results of the research of Hafiyusholeh, Budayasa & Siswono (2018) which stated that the subject in presenting data was only influenced by the purpose of presenting data without considering the characteristics of the data.

By considering to these answers, it could be said that the subject had the ability to describe data in the form of a specific table or diagram in accordance with the desired information, including building an alternative display for a set of data. Subjects were also able to construct and make various forms of data presentation in line with the purpose of the information to be communicated to the reader. This is in line with the opinion of Mooney (2002) which stated that a person could be said to be able to represent (present) data, if someone was able to describe data in the form of certain tables or diagrams/plots in accordance with the information to be communicated. Including in this process was being able to construct data displays for a given set of data and build alternative views for a set of data; including consideration of what was involved in making graphics as a tool for compiling data (National Research Council, 2001).

These competencies also correspond to the competency standards set in the national curriculum. In the passing standard as stated in Permendikbud 2016 No. 021 which relates to statistical material and opportunities mentioned that in Class X-XII Senior High School, the competencies that must be mastered in relation to statistical materials and opportunities are comparing and assessing the effectiveness of various data presentation methods. In this case, if referring to basic competencies, then the basic competencies that should be mastered by students are able to present data in the form of tables, charts, lines, circles and ogives and their interpretations

5 CONCLUSIONS

The results showed that subjects with high mathematical abilities in identifying data presentation forms considered two aspects, namely the aspect of the objectives presented by the data and the second was the characteristics of the data.

ACKNOWLEDGEMENTS

REFERENCES

National Council of Teachers of Mathematics (NCTM), 1989. *Curriculum and evaluation standards for school mathematics*. Reston, VA: Author.

Watson, J. M., 2006. *Statistical literacy at school: Growth and goals*. Mahwah, New Jersey: Lawrence Erlbaum Associates.

Schield, M., 2011. Statistical literacy: A new mission for data producers, *Statistical Journal of the IAOS 27. 173-183*.

Kasonga, R. A. & Corbett, A. D., 2008. An assessment model for improving student learning of statistics. *SAJHE, 22 (3) 602-604*.

Schield, M., 2013. Statistical Literacy: Thinking Critically about Statistics, *Journal "Of Significance" Produced by the Association of Public Data Users. http://web.augsburg.edu/~schield/MiloPapers/984StatisticalLiteracy6.pdf* Accessed Jum'at, 25 October 2013.

Murray & Gal, 2002. Preparing for Diversity in Statistics Literacy: Institutional and Educational Implications. *ICOTS6*.

Seifer, R. 2009. Statistical literacy an essential competency for both producers and consumers of data. Vol. 25, No. 7 •ISSN 1058-1073 *Published online in Wiley InterScience* (www.interscience.wiley.com) •DOI: 10.1002/cbl.20095

Hafiyusholeh, Budayasa & Siswono, 2017. Literasi Statistik: Siswa SMA dalam Membaca, Menafsirkan, dan Menyimpulkan Data. *Prosiding SI MaNIs (Seminar Nasional Integrasi Matematika dan Nilai-Nilai Islami)*. (1). 79-85.

Hafiyusholeh, Budayasa & Siswono, 2018. Statistical Literacy: High School Students in Reading, Interpreting and Presenting Data. *Journal of Physics: Conference Series* (1). 012036.

Forbes, S., Camden, M., Pihama, N., Bucknall, P., and Pfannkuch, M., 2011. Official Statistics and statistical literacy: They need each other. *Statistical Journal of the IAOS* 27. 113–128.

Ben-Zvi D. & Garfield J., 2005. *The challenge of developing statistical literacy, reasoning, and thinking*. Netherland: Kluwer Academic Publisher.

Garfield, J., & Ben-Zvi, D., 2008. *Developing students' statistical reasoning: connecting research and teaching practice*. Germany: Springer.

Gal, I., 2002. Adults' statistical literacy: Meanings, components, responsibilities. *International statistical review*, Vol. 70 No. 1. pp. 1-25.

Wade, B. & Goodfellow, M., 2009. Confronting statistical literacy in the undergraduate social science curriculum, Sociological Viewpoints, Pennsylvania.

Garfield, J., Hogg, B., Schau, C., & Whittinghill, D., 2002. First couerses in statistical science: The status of educational reform efforts. *Journal of statistics education. 10(2)*.

Hafiyusholeh, M., 2015. Literasi Statistik dan Urgensinya Bagi Siswa. *Wahana*. 64(1), 1–8.

Mooney, E. S., 2002. A framework for characterizing middle school students' statistical thinking. *Mathematical Thinking and Learning*. 4, 23-64.

Miles, M.B. & Huberman, A.M. 1994. *Qualitative data analysis: an expanded sourcebook* (2nd. Ed). London: Sage.

National Research Council, 2001. *Adding it up: Helping children learn mathematics*. Washington, D.C.: National Academy Press.