Mathematical writing ability based on Stacie Leffler’s theory

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Abstract. Mathematical writing is one communication tool that always used by students especially when they trying to solve a problem. It becomes one of the student's necessities to make it easier to find the right answer. It also trains students to solve problems coherently, completely, and clearly. Mathematical writing ability is important for students in Junior High School because it to know how they write the mathematical sentences in problem-solving. Teachers also need it to know how far their students can convey an answer through mathematical writing. The students' mathematical writing ability will be measured on a particular dimension. The research method used is qualitative with the students of Junior High School as subjects. Based on the data analysis is found that on the dimension of accuracy, students are able to write answers and respond to the questions minim accuracy. On the terminology, students not use mathematical terms. In mathematical explanations, students' explanations are minim and not thorough. It because that their written explanation is too short and minim sentences.

1. Introduction
Mathematical writing is one of the written mathematical communication aspects. Mathematical writing classes becomes more widespread, students will develop the ability to approach problems in ways they may have never seen before [1]. Additionally, it is one of the methods for students to be able to meet Common Core practice standards (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010) that students can build appropriate arguments, criticize people's mathematical reasoning others, explain how to solve problems, use definitions and clear vocabulary, and communicate appropriately to others [2]. Mathematical writing is a skill that uses practice in writing and experience in learning mathematics [3]. In line with that, it is one way to convey mathematical ideas or ideas in the form of problem-solving, problem formation, connection, understanding, and reasoning [4]. It can be the use of tables, drawings, diagrams, or other mathematical symbols that he stated in writing about a mathematical problem-solving [5].

Through writing, students may reflect what they have done and thought, find out the point of problems, and develop their capability to combine mathematical language with daily language in order to see connection mathematics in daily life [6]. Mathematical writing can support changes in beliefs about mathematical abilities [7]. It also increases understanding of mathematics learning material [8] and the use of writing in solving mathematical problems [9].

Mathematical writing consists of more than words. It also involves symbols and images. Students who are successful at mathematics are able to understand and manipulate mathematical languages, and also apply mathematical meanings to the symbols, images, and words [10]. A written explanation
would be applied for a better understanding of the students who confused with a spoken explanation [6]. Students are expected to not only solve the problem through writing but also to explain the process and recall the steps they used to determine their answer [11].

Ability to explain problem-solving appropriately by using language and mathematical terms very much needed in solving problems in writing. Some of these aspects are one indicator of the assessment of mathematical problem-solving in writing. These aspects can be used to assess a student's mathematical writing ability based on the level of accuracy, the ability to use mathematical terms, and mathematical explanations. The assessment aspect of mathematical writing in this research based on Stacie Lefler theory are accuracy, terminology, and explanation of mathematical thinking [12]. The assessment aspect based on the rubric is actually applied to journal writing. But in this study, aspects of the assessment will be applied to problem-solving. Writing journals and writing problem-solving are some of the strategies used for the purpose to help further develop metacognitive abilities in students [13].

Table 1. Rubric to assess the mathematical writing ability based on Stacie Lefler

| Assessment aspect                     | 1                          | 2                          | 3                          | 4                          |
|---------------------------------------|----------------------------|----------------------------|----------------------------|----------------------------|
| Accuracy                              | The response is not accurate | Minimal accuracy            | Main ideas are accurate, but some minor inaccuracies | Response was accurate      |
| Terminology                           | No use of terminology       | Attempted, but not used correctly or minimal use of terminology | Some use of terminology or a few errors in terminology | Terminology used and used correctly |
| Explanation of mathematical thinking  | Did not cover problem topic | The explanation is minimal and very confusing | Explanation was not thorough or lacked clarity | Explanation was thorough, clear, and easy to understand |

Table 1 becomes a standard for assessing mathematical writing abilities in this study. The assessment aspect is also used in previous research but without displaying the rubric used. In this study shows that the subject of geometric proving cannot convey an argument systematically and logically. While the subject of algebraic presents arguments that are not clear, insufficient and incomplete [14]. Post-test results on linear algebra show that students make a few mistakes in using symbols/mathematical terms, but most students are able to read tables/graphs/diagrams in accordance with the commands in the problem given. Students began to get used to making mathematical models even though there were still some mistakes in completing the algorithm [15].

2. Methods
This research is qualitative research. This research was conducted at one of the Junior High School in Magetan city, East Java. The research subject randomly that 29 students of 9th grade of SMPN 1 Plaosan, Magetan. Tests and interviews method are used as data collection techniques. The tests were used for mathematical writing ability based on Stacie Lefer's theory, and the interviews were used to know the student's explain what they were written in the answer sheet. There are four procedures in this research. First, the problem in a test was given to all students in a math class in two times to be completed. Second, the results of the answers for the first and second tests will obtain valid data with
the triangulation method where the data becomes the reference for the interview stage, interviews were conducted with two students who wrote the right answers according to the test. Third, analyzed the data that has been reduced and presented. The last, made a conclusion.

3. Result and Discussion
The results of the mathematical writing test showed that of 29 students who given tests, only two students writing the complete solution and 27 students not complete their solution. So, the researcher selected two of 29 students with the complete answer as the research subject to have an interview. The following description is the result of the study consisting of the general description of students' ability in mathematical writing, and the data description of the mathematical writing ability based on Stacie Lefler’s theory.

3.1. Mathematical writing of the first subject
In this section will be explained about the mathematical writing ability of the first subject seen from the subject answer paper based on rubric Stacie Lefler.

Figure 1 shows that the first subject illustrates the problem, writing the summary in accordance with the information in the problem, writing down the known information, writing down the solution to find a solution to the problem, writing an explanation of how the subject solving the problem. In the aspect of accuracy, the first subject writes all the answers to the problem correctly. This is shown by the illustration of the problem in point (a) which is described with two rectangles and given simple information to explain the parts of the picture. Point (b) indicates that the first subject writes the code for information that was known. The code is written differently based on a shortening from the information sentences in the problem. At point (c) there is a part of problem-solving, that is known information, something asked and how to find the solution. It can be seen from the answer sheet that the first subject calculates and solve the problem correctly so that the right answer is obtained. A brief explanation of problem-solving is written correctly at point (d), but it is still not clear because this first subject does not explain what formula is used to find answers. The first subject correctly writes the answers to each point, but there is still a slight lack of explanation for problem-solving. So it can be said that this subject is right in writing the problem solving, but there is still a slight inaccuracy, namely at point (d) is not appropriate in explaining problem-solving.

In the aspect of terminology, the first subject does not write complicated mathematical terms. The term used is only simple words that are easily understood by the reader, both at points (a), (b), (c), and
(d). The words used are the same words as the problem given. So, this subject not uses the mathematical terms in his answer sheet.

On the explanation mathematical thinking aspect, this subject presents a brief explanation seen in point (d). Only a few explanations were written and did not cover the whole of the problem-solving steps. In point d there is only an explanation of how the subject finds a solution to the problem but does not explain what formula is used to solve the problem. So, in this aspect, the subject does not explain thoroughly about the solution to the problem.

3.2. Mathematical writing of the second subject
In this section will be explained about the mathematical writing ability of the second subject seen from the subject answer paper based on rubric Stacie Lefler.

Figure 2 shows that the second subject illustrates the problem through an image, gives a code to differentiates each information in the problem, solving the problem, and explains the solution to the problem briefly. In the accuracy aspect, this second subject can illustrate the problem in an image consisting of two rectangles. In the picture, there is information written in each part of the picture. This is shown by the subject at point (a). Different things are shown in points (b), (c), and (d) where this subject cannot write code, how to find a solution, and also an explanation of the overall problem solving correctly. At point (b), the subject only writes the code for two information that is known in the problem without writing additional information that can be found through understanding the problem. This causes miscalculation when finding a solution to problems in point (c). The subject cannot find the right answer because the subject does not know the formula or the right way to find a solution. Likewise with point (d) where the subject cannot explain exactly how he solved the problem starting from the formula used to the correct way to find a solution. So it can be said that this subject is very few in showing the right answer because of the three points of the question namely points (b), (c), and (d), the subject writes a very inaccuracy answer. So, the second subject is said to be minim accuracy in writing the answer.

It can be seen in Figure 2 that this subject does not use complicated mathematical terms. In points (a), (b), (c), and (d) the subject does not at all shown that he wrote a mathematical term to solve the
problem. Even to write an explanation on point (d), the subject only uses everyday sentences and languages. Then it can be said that the second subject did not use complicated mathematical terms.

For a mathematical explanation aspect, it can be seen clearly in point (d). This subject only writes briefly about how he found the problem solution. But the explanation written by this subject cannot be said to be short and easy to understand. This happens because the written explanation is too simple and makes the reader more confused. Therefore, in this aspect, the second subject writes a little mathematical explanation and what has been written is very confusing for the reader.

From the explanation of the results of the analysis of the answer sheet, it can be seen that for each research subject has a different mathematical writing ability. The first subject wrote the main idea in the right solution, but some other things were still not right. Subjects do not use complicated mathematical terms. Also, the subject writes an explanation was not thorough or lacked clarity. It is also known that the second subject wrote about the problem in a minimal accuracy. The subject also does not use complicated mathematical terms. As well, the subject wrote minim explanation and was very confusing. Students think that is no need to write a complete description of formulas or symbols in mathematical language, so students are accustomed to solving the problem with not completing written mathematical term and assuming the work is correct [4]. So, from the data analysis obtained results that are almost the same as previous studies that the subject of geometric proving cannot convey an argument systematically and logically while the subject of algebraic presents arguments that are not clear, insufficient and incomplete because in this study also includes material about geometry and algebra although only a little [14]. This result is also in accordance with the results of the post-test which shows that students make fewer mistakes in using mathematical symbols/terms in linear algebra [15].

4. Conclusion
The conclusions obtained from the results of the study are that for both first and second student not uses the mathematical terms. The first student writes accurate main idea but some minor inaccuracies, and the second student writes minim accuracy in problem-solving. The first student writes an explanation was not thorough or lacked clarity and the second student write minim explanation and was very confusing. It is expected for mathematics teachers, to pay more attention and improve students' mathematical writing ability.

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