The Lost Process of Mathematical Literacy on Excellent Students at MAN 2 Kudus

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Abstract. Data showed that Indonesian mathematical literacy from 2006 to 2015 was always below the PISA average score. Previous research showed that student on Regular Science Program in MAN 2 Kudus has a better level of mathematical literacy than students on Excellent Science Program. This is a case study on Excellent Science Program MAN 2 Kudus as the subject of the research, 27 students. Data was taken with adjusted PISA tests and interviews then analyzed by Miles and Huberman method. The results showed that 36% of students at the Regular Science Program and 41% of students at the Excellent Science Program had literacy level below level 1. An in-depth study of the mathematical literacy process in the Excellent Science Program shows that 11% of students did not understand the problem. Of the 89% of students who understand the problem, 42% of them cannot translate the context into mathematical form, 29% of students only reach the Formulate process, 4% of students reach the Employ and Interpret process, and 21% of students reach the Evaluate process. Thus, to improve mathematical literacy, understanding contextual problems and improving skills in formulating problems into mathematical languages or models must be strengthened.

1. Introduction

Civilization has developed increasingly rapidly, starting with the era of the industrial revolution which brought about disrupted technology. Learning no longer can only be seen as a transfer of knowledge, but about how students make and develop their knowledge. Learning outcomes are no longer seen as scores or credit, sent more to mastery of competencies. In mathematics learning, one of the competencies as a learning outcome is mathematical literacy skills. Mathematical literacy that connects mathematics learned in the classroom with various kinds of real-world lessons [1]. Mathematical literacy shows what students see and what they can do with mathematics. High or low level of mathematical literacy shows an individual's ability to reason mathematics and use mathematics in various contexts, using abilities that are needed in life. - well prepared to meet future challenges.

Data on the measurement of mathematical literacy by PISA for Indonesian students themselves still show unsatisfactory results, where the average math literacy score is below the average.
Apart from the score, PISA also categorizes literacy skills into level 1 to level 6. In terms of levels, the PISA results show that mathematical literacy is the lowest compared to science literacy and reading literacy. This can be seen in the following graph.

The data above shows that an in-depth study of mathematical literacy is needed so that students can improve their mathematical literacy. The study of efforts to improve mathematical literacy has been carried out for various levels, for example with the Problem Based Learning learning model [7], Creative Problem Solving [8], or the Indonesian Mathematics Realistic approach combined with Edmodo implementation [9]. And although PISA is intended for junior high school students, the study of mathematical literacy is also conducted at the Senior High School level. Shava, for example, did a research to find didactical practice to improve students’ mathematical literacy in high school [10]; and Sari, et.al who studied about mathematical literacy abilities of high school students in Yogyakarta which is show that the abilities are in a very low category [11]. In her research, Sera, et.al analyzed quantitatively the achievements and literacy processes carried out by 15 high school students. Different with that, this research would describe and explore qualitatively the mathematical literacy process experienced by students from the best Senior High School in Kudus, MAN 2 Kudus. Our
previous study in MAN 2 Kudus showed that students in the Regular Science Program have a better level than students in the Excellent Science program, as shown in Table 1 below.

**Table 1. Level of Mathematical Literacy of MAN 2 Kudus Students**

| Program               | Below Level 1 | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Level 6 |
|-----------------------|---------------|---------|---------|---------|---------|---------|---------|
| Regular Science       | 36%           | 8%      | 17%     | 17%     | 17%     | 6%      | 0%      |
| Excellent Science     | 41%           | 15%     | 22%     | 4%      | 11%     | 0%      | 7%      |
| Social Science        | 88%           | 8%      | 5%      | 0%      | 0%      | 0%      | 0%      |
| Total                 | 57%           | 10%     | 14%     | 7%      | 9%      | 2%      | 2%      |

The table above shows that the majority of students are at levels below 1, and in the Excellent Science Program, more than 50% of students cannot reach level 2, and only 2 students or as many as 3% of students reach level 6. Excellent class students have failed to achieve the performance of mathematical literacy better than Regular Science or the Social Science Program. The comparison of level distribution for Regular, Excellent and Social Science programs is described in Figure 3.

![Figure 3. The level distribution of mathematical literacy for Regular Science Program (IPA R), Excellent Science Program (IPA U), and Social Science Program (IPS).](image-url)

The graph above shows that the achievement of Regular Science is better than the achievement of the level of the Excellent Science Program, where about 40% of students in the Regular Science Program are at levels 4, 5, and 6, while for the Excellent Science Program is less. So further studies then are conducted to reveal on what process students in the Superior class cannot reach the highest level of mathematical literacy.

2. **PISA Mathematical Literacy**

OECD defines mathematical literacy as
Mathematical literacy is an individual's capacity to formulate, employ and interpret mathematics in a variety of contexts. It includes reasoning mathematically and using mathematical concepts, procedures, facts and tools to describe, explain and predict phenomena. It assists individuals to recognize the role that mathematics plays in the world and to make the well-founded judgments and decisions needed by constructive, engaged and reflective citizens [12].

In every PISA mathematical literacy problem, there are three domains, i.e content, context and process. The domain of mathematical content consisting of Quantity, Uncertainty, and Data, Change and relationship, Space and Shape. The context domain relates to the situation where the assessment is carried out, consisting of Personal, Societal, Occupational and Scientific. The process domain explains how students connect the context of problems with mathematics and then solve them. To solve the PISA problem, students need to formulate mathematical problems into mathematical forms, using them to solve problems, interpret the results according to the context, and evaluate the results [12]. From the three domains above, this study will be focused on the process domain because this is the domain related to the construction of student knowledge and skill of mathematics.

The process of mathematical literacy can be described in the following flow.

![Diagram](image)

**Figure 4. Mathematical Literacy Process**

3. Data and Discussion

The study was conducted at MAN 2 Kudus, Central Java, Indonesia. This school has the strength of a research-based school and it is one of the best schools in Central Java. There are a lot of achievements both nationally and internationally, such as the special International Award Exhibition of Young Inventor (2014), Finalists of the ASEAN Student Science Project Competition (2016), The Outstanding Teacher in ASEAN, Melayu Day, Yala (2017), The 1st Winner of Developer Augmented Reality game in Southeast Asia, and the Winner of Applicative Game Developer SEAMEO (2017).

This is a case study to explore why the students in the Excellent Science Program have a lower level of mathematical literacy than students in the Regular Science Program as mention in Table 1 and Figure 3. The subjects of the study were the students of grade X from Excellent Science Program. Data was taken using an adjusted PISA test and interviewed. Adjustments to the instrument of the PISA test are carried out by changing the context to suit the child's life and presenting it in Indonesian.
There are six questions in the test given to all of the students. Table 1 shows that the highest gap of the result for the Regular and the Excellent Science Program is for problem number 3, which represents the mathematical literacy level 3. There are 17% of students in the Regular Science program can solve this problem, and only 3% of students in the Excellent Science program can solve it. Problem number 3 is:

![Problem 3](image)

**Figure 5.** Question number 3.

Based on the results of the analysis of the answer sheet and interviews with the students, it was known that only 5 out of 27 students in the Excellent Science Program or as many as 19% were able to go through all the iteration processes to evaluate. There are 3 students did not understand the problem or identify what is asked. 10 students could understand the problem but couldn’t formulate the problem into a mathematical form. There are 7 students could formulate the problem into mathematical forms or models, but failed to connect or use these formulations to solve the problem. One student could reach the employ stage, which means he could use formulas to solve problems, but couldn’t interpret them into context. Another student could interpret it into context but couldn’t evaluate it. The detail of the result is described in Table 2.

| Proses                          | f | %  |
|---------------------------------|---|----|
| Didn't understand the problem   | 3 | 11%|
| Understand the problem          | 24| 89%|
| Can't formulate                 | 10| 42%|
| Formulate                       | 7 | 29%|
| Employ                          | 1 | 4% |
Table 2 shows that 42% of students understand the problem, but they could not formulate the problem into mathematical language. There were 58% of students passed the process of formulating, but only 21% of students could achieve the process of evaluating. It means that the most process that lost from the students of the Excellent program is formulated the problems in context into a mathematical problem.

From Figure 3 above, the process of formulating was the first process in mathematical literacy. So it means that to improve the students’ mathematical literacy, the teacher needs to give some scaffoldings in the learning process to formulate the problems in context into mathematical problems, so they can continue the process of mathematical literacy.

4. Conclusion
Based on the result above, it can be concluded that the difficulty of students in solving problems is to understand the contextual problems and how to make mathematical models of the problems presented. This needs the attention of mathematical educators that students need to get reinforcement in formulating problems into mathematical problems.

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