Students mathematical literacy in solving wetlands contextual problems

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Abstract. The research describes the students' mathematical literacy in solving wetlands contextual problems. This study employed a descriptive qualitative method. The subjects were 87 students in Mathematical Learning for Junior High School course of Mathematics Education Study Program at Universitas Lambung Mangkurat in the 2019/2020 academic year. The students were tested with ten items of wetlands contextual problems. The analysis of those data used descriptive statistics including mean, standard deviation, maximum and minimum score, and total score. The research finding reveals that the mean score of students' mathematical literacy was 18.55 (medium category). Individually, there were five students in very high, 14 students in high, 31 students in medium, 35 students in low, and two students in the very low category. In addition, the students are weak in the formulating process. Based on the result, students’ habituation in solving contextual wetland problems needs to be continuously pursued to improve students' mathematical literacy ability.

1. Introduction
The skills to obtain open networks, gain new concepts and have the competence to reach high work standards are needed in the current era of globalization [1]. The society that is needed today is not solely those who can understand specific knowledge. Currently, people are required to make optimal use of their experience to be smarter and more critical in receiving and processing information. This is very important to support the solving of complex problems.

The ability of solving complex problems is expected to be developed in education through the subjects taught in schools. One of the fields of knowledge taught in school is mathematics. In the process of learning mathematics, literacy is one of the abilities that students must have. Mathematical literacy has an essential role in helping students solve problems related to the application of mathematics in daily life [2]. Mathematical literacy is the ability of students to formulate, use and interpret mathematics in various contexts. This includes mathematical reasoning and using mathematical concepts, procedures, facts and tools to describe, explain and predict phenomena. This helps a person recognize the role of mathematics in life and make rational and logical judgments and decisions that are needed by citizens who are constructive, actively engaged and reflective [3].

The Ministry of Education and Culture formulates that the 21st-century learning paradigm emphasizes the ability of students to find out from various sources, formulate problems, think analytically and collaborate in solving problems [4]. Based on this statement, current education is expected to be able to develop students to think creatively, flexibly, solve problems, collaborative and
innovative skills needed to succeed in work and life [5]. Education is expected to be able to equip students with the ability to apply their knowledge in everyday life. On the other hand, there is a research study revealing that teachers have difficulty solving problems in real-life contexts [6].

Currently, there are international organizations that assess students’ mathematical literacy skills, one of which is PISA (Program for International Student Assessment). The focus of PISA is to emphasize student skills and competencies that are obtained from school and can be used in everyday life and various situations [7]. Mathematical literacy is said to be good if it can analyze, reason, and communicate knowledge and mathematical skills effectively, and can solve and interpret mathematical solutions.

PISA has assessed mathematical literacy since 2000. In fact, the performance of 18-year-old Indonesian students on PISA is still low. PISA reported that Indonesia’s ranking in 2009 was 61 out of 65 participants, ranked 61 out of 65 participating countries in 2012, ranked 61 out of 70 participating countries in 2015, and ranked 72 out of 78 participating countries in 2018 [7–9]. This happens because they are not familiar with these contextual problems [10]. As a result, they find it challenging to solve items and often make mistakes when solving context-based mathematical literacy problems [11,12]. Seeing these facts, the mathematical literacy skills of students in Indonesia still need to be improved. The results of students' mathematical literacy are indeed a reflection material for the learning process of mathematics in the classroom. Mainly to see the extent of the availability of the material in the learning resources available in schools, namely mathematics subject textbooks, teachers as educators teach students who reach literacy coverage so that students mathematical literacy can improve.

Preparing prospective teachers who can improve student literacy skills needs to begin with mapping and analyzing the ability of the prospective teacher. The characteristics of mathematical literacy skills in solving PISA problems are described by [13], based on the high, medium and low mathematical dispositions expressed by [14], based on their mathematical abilities described by [14,15], and based on their initial mathematical abilities described by [16]. On the other hand, the way Mathematics Education students solve PISA problems was investigated by [17]. In another study, the mathematics literacy ability of mathematics education students in terms of process components showed low results revealed by [18]. In fact, some of these studies show that students' mathematical literacy skills are in a low category. However, this study still uses PISA questions as its instrument. Therefore, it is necessary to investigate mathematical literacy for students in solving problems with the context in their environment.

However, mathematics education students as prospective teachers need to be able to prepare students to have good mathematical literacy. In line with ULM's vision, the realization of ULM as a leading and competitive university in the field of the wetland environment, students also need to resolve and criticize discourses related to wetlands in the South Kalimantan Region and its surroundings. Therefore, this study aims to describe students' mathematical literacy in solving wetland contextual problems.

2. **Method**

The descriptive qualitative method is selected in this research due to the following considerations: (1) this research is an effort to describe mathematical literacy of students in solving wetland contextual problems; (2) this research is more inductive, meaning that the researcher tries to explain the results of the study based on data, which is open to further research. The test was administered to 87 students in Pembelajaran Matematika SMP/MTs (Mathematical Learning for Junior High School) course of the Mathematics Education Study Program, Universitas Lambung Mangkurat. The participants were taken from students who took this course because the mathematical literacy assessed by PISA was aimed at students aged around 15 years or students at the junior high school level. There were 66 female students (75.9%) and 21 males (24.1%) with the range of their age is from 18 years and 0 months to 20 years and seven months. The data was collected through a test. The test items released from PISA 2006 to 2012 were modified and used in the studies. The modification is related to the use of wetland context. There were ten wetland contextual problems to be completed in 120 minutes. Moreover, the items were spread across the three broad clusters of competencies (Formulating, Employing, and Interpreting) and the four
content subdomains (Quantity, Space & Shape, Change & Relationships, and Uncertainty) identified by PISA. Details of the test items are given in Table 1.

**Table 1. Description of the wetland contextual problems**

| Item Name                               | Subdomain                      | Process          |
|-----------------------------------------|--------------------------------|------------------|
| Pertandingan Sepak Bola (Soccer)        | Quantity                       | Formulating      |
| Kota Banjarmasin (1) (Banjarmasin)      | Uncertainty and Data           | Formulating      |
| Soto Banjar (Soto Banjar)               | Quantity                       | Employing        |
| Menara Pandang (Pandang Tower)          | Quantity                       | Employing        |
| Pasar Terapung (Floating Market)        | Change and Relationship        | Employing        |
| Masjid Sultan Suriansyah (Sultan Suriansyah Mosque) | Space and Shape | Employing |
| Lahan Rawa Kalimantan Selatan (Swampland of South Borneo) | Uncertainty and Data | Employing |
| Bus Rapid Transit (City Bus)            | Uncertainty and Data           | Employing        |
| Tajau (Tajau)                           | Quantity                       | Interpreting     |
| Kota Banjarmasin (2) (Banjarmasin)      | Uncertainty and Data           | Interpreting     |

Figure 1 presents the problem of Kota Banjarmasin, which shows a map of Banjarmasin. When studying in class, students often determine the area of the two-dimensional shape in regular forms. Meanwhile, for the area of the map, students usually only memorized the information that was already available. Therefore, it would be interesting if students were challenged to determine the area of Banjarmasin by themselves based on a map as an example of two-dimensional shape in irregular form.

The analysis of those data used descriptive statistics including mean, standard deviation, maximum and minimum score, and total score. Students' mathematical literacy is categorized using the normative reference of the standard deviation as in Table 2.

**Figure 1. Example of wetland contextual problem**
Table 2. Normative Reference of The Standard Deviation.

| Score Interval          | Category       |
|-------------------------|----------------|
| $M_i + 1.5SD_i < X \leq M_i + 3SD_i$ | Very high |
| $M_i + 0.5SD_i < X \leq M_i + 1.5SD_i$ | High       |
| $M_i - 0.5SD_i < X \leq M_i + 0.5SD_i$ | Medium     |
| $M_i - 1.5SD_i < X \leq M_i - 0.5SD_i$ | Low        |
| $M_i - 3SD_i < X \leq M_i - 1.5SD_i$ | Very Low   |

where $M_i = \frac{1}{2}(\text{ideal max. score} + \text{ideal min. score})$ is the ideal mean score,

$SD_i = \frac{1}{6}(\text{ideal max. the score})$ is an ideal standard deviation, and $X$ is empiric score [19].

The data in this study were tested for normality using the SPSS version 16 with a significance level of $\alpha = 0.05$. The hypothesis used is $H_0$: The data are normally distributed and $H_1$: The data are not normally distributed. The test criterion for $H_0$ is accepted if the significance value is more than $\alpha$, while $H_0$ is rejected if the significance value is less than $\alpha$.

3. Result and discussion

The results of the study categorized participants based on their level of mathematical literacy in solving wetlands contextual problems, including very high, high, medium, low, and very low. The test scores were tested for normality using the One-Sample Kolmogorov-Smirnov Test. The results of the normality test scores for students' mathematical literacy showed that the score is normally distributed.

3.1. Overview of the Students’ Result

The presentation of the results begins with a recapitulation of the scores for the achievement of students' mathematical literacy. This achievement score includes the ideal maximum and minimum score, the maximum and minimum score obtained, and the mean score achieved by students. The recapitulation is presented in Table 3.

Table 3. The recapitulation score of students mathematical literacy

| Aspect                        | Score |
|-------------------------------|-------|
| Ideal maximum score          | 40    |
| Ideal minimum score          | 0     |
| maximum score obtained       | 32    |
| minimum score obtained       | 7     |
| Mean Score                   | 18.55 |

Based on Table 3, it can be seen that the mean score obtained is 18.55. The result indicated that the mean score obtained is less than 50% of the ideal score, that is 40. The range of the scores obtained is 25, so it can be concluded that the score received tends to spread out. Furthermore, the distribution of the average score for each process-content domain on each question theme is presented in Table 4.

Table 4. The recapitulation of mean score based on process and content domain

| Content Process   | Quantity | Change and Relationship | Space and Shape | Uncertainty & Data           |
|-------------------|----------|-------------------------|-----------------|------------------------------|
| Formulating       | Pertandingan                       | (Soccer)        | $Kota Banjarmasin$         |
|                   | Sepak Bola                           | (1,24)          | (Banjarmasin City) (1,23)   |
Max. score: 4; Min. Score: 0

Table 4 showed that the Employing category carried out by students is greater than the other process domains and the lowest was Formulating. When looking at the content domain, the resulting average scores are relatively the same.

Individually, the mapping of students' mathematical literacy is based on the normative reference of the standard deviation, according to Table 2. Based on table 3, the result of \( M_i \) (ideal mean score) = 20 and \( S_{di} \) (ideal standard deviation) = 6.67. The normative reference of the standard deviation in this study is presented in Table 5.

| Category                        | Frequency |
|---------------------------------|-----------|
| 30 < \( X \leq 40 \)           | Very high |
| 23.33 < \( X \leq 30 \)        | High      |
| 16.67 < \( X \leq 23.33 \)     | Medium    |
| 10 < \( X \leq 16.67 \)        | Low       |
| 0 < \( X \leq 10 \)            | Very Low  |

Table 5 shows the five intervals of the normative reference of the standard deviation as the basis for categorizing the mathematical literacy achievements of individual students. These achievements are presented in table 6.

| Category            | Frequency |
|---------------------|-----------|
| Very high           | 5         |
| High                | 14        |
| Medium              | 31        |
| Low                 | 35        |
| Very Low            | 2         |
| Total               | 87        |

Based on Table 6, the results show that the majority of students' mathematical literacy is at the medium and low levels, that is 31 students in the medium category and 35 students in the low category. The number of students increased significantly in the medium and low categories. In addition, only five students (5.7%) were classified in the very high category. It should also be added that the overall mean score obtained was 18.55. According to Table 6, the majority of students are in a low category in terms of mathematical literacy in solving wetland contextual problems.

3.2. Discussion
The sensitivity of solving daily problems using mathematics needs to be used because mathematics is developed to be able to help solve problems. The use of mathematics in solving everyday problems is a form of mathematical literacy. The problem that occurs is that the students' mathematical literacy skills
are classified as low. This shows the same results as research conducted by [14,18,20,21], which shows that students' mathematical literacy skills are low.

One of the efforts to improve mathematical literacy is the need for teachers in schools to familiarize students with developing their mathematical literacy skills. However, it should also be noted that teachers who teach mathematics in schools need to have mathematical literacy. This shows that mathematical literacy is still fragmented and focuses more on procedural fluency [22]. For this reason, this study was conducted to explore information and map the mathematical literacy of prospective mathematics teachers in solving daily problems using mathematics.

In mapping mathematical literacy, the instruments developed to test the subject must be realistic and be lifted from the environment around the subject. In this study, the instruments developed were questions in the context of the wetland environment of South Kalimantan, which could be solved mathematically. The problem as a research instrument pays attention to the domain of the mathematical literacy process domain and the mathematical literacy content domain. By students habitually faced with the problems around them, it is hoped that they can improve their mathematical disposition. Furthermore, the higher mathematical disposition also implies the higher of mathematical literacy ability [20]. Therefore, students' habituation in solving contextual wetland problems needs to be continuously pursued to improve students' mathematical literacy ability.

4. Conclusion
The result of the study shows that the mean score of students' mathematical literacy was 18.55. This means, in general, students are in the middle category of mathematical literacy in solving wetland contextual problems. Individually, there were five students in very high, 14 students in high, 31 students in medium, 35 students in low, and two students in the very low category. In addition, the students are weak in the formulating process. Based on the achievements that have been obtained, the researchers recommend the following suggestions: (1) It is necessary to increase the test time so that the participants can work on the questions given so that the results obtained are maximized; (2) It is better if students are familiarized with problems that assess mathematical literacy in lecturing activities.

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