Investigating mathematical literacy, mathematical reasoning skill, and self esteem of a public high school

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Abstract. This study aims at describing mathematical literacy skill, mathematical reasoning skill, self esteem and the relationship of them. Participants of the research were 37 tenth-grade students randomly selected from a public high school. Data collected through mathematical literacy skill test, mathematical reasoning skill test, and self esteem questioner. The result shows that the average skill of students in making the conclusions of an argument has the lowest average among other reasoning indicators other than in generalizing mathematical problems, finding patterns in a mathematical phenomenon, giving reasons for strategy selection, and formulating an alleged or mathematical strategy. While in self esteem, although the category is quite good but still found indicators that has a bad category that is evaluation of skill. The relationship between mathematical literacy and reasoning skill of students was at low criteria and the relationship between mathematical literacy and self esteem of students was at the lowest criteria.

1. Introduction

Indonesia is one of the countries that often get gold medals in the field of mathematics Olympiad. It show that Indonesian students have mathematical skills that are not inferior to other countries. Education in Indonesia has also progressed, it is supported by learning that use of assessments for classroom improvement, has parental service on secondary school committees, teacher do observations of secondary school lessons to everyday life, and use of answer explanation in secondary mathematics [1]. However, the academic achievement and innovation in learning is not in accordance with the research results of Program for International Student Assessment (PISA) in 2015 which stated that over 50% of Indonesian fifteen year olds do not master basic skills in mathematics and raising performance in shows that Indonesian students are performing some three years behind the Organization for Economic Cooperation and Development (OECD) average [2]. In addition, based on a survey conducted by OECD in 2015 using the test PISA states that Indonesia's mathematics achievement is ranked 69 out of 76 countries that follow PISA with a flat score 386.

One of the aspects studied in the survey is the low level of Indonesian mathematical literacy. Whereas mathematical literacy is one that can describe analyse and communicate ideas as student pose and interpret solutions to mathematical problems in a variety of contexts that can keep track of one's cognitive processes. Mathematical literacy can assist student to formulate, employ, interpret
mathematics, and make well founded judgments and decisions needed by constructive, engaged and reflective citizens [3]. Mathematical literacy includes reasoning mathematically and using mathematical concepts, procedures, facts and tools to describe, explain and predict phenomena and mathematics literacy in collaborative learning, where reasoning skills could correspond to higher level tasks, such as analyzing[4]. Based on the characterize of mathematical literacy, reasoning skill is one of the skill of mathematical standard that must be mastered in mathematical literacy. The mathematical reasoning is the skill of learners to give reasons and prove the outcome of their thinking using time and manner or procedure appropriately [5]. Learners can optimize their reasoning skill by constructing arguments in learners themselves, such as (1) whether the strategi used is working or not, (2) whether the strategy is generally applicable to other problems, and (3) when the strategy can be used efficiently [8]. The indicators of mathematical reasoning skill such as make allegations, prove allegations, generalize allegations, and use the results of the alleged generalization [6]. That steps can make learners believe and explain that the answer according to the model used correctly [7].

In addition to being influenced by mathematical reasoning skill, mathematical literacy implies a knowledge base and the confidence competence to apply students knowledge in the practical world [8]. This will affect the personality in self constructing or self relating system of self motivation and self regulation based on self evaluation and emotional experience or we can call it by self esteem [9]. Self esteem is a basic human need that can affect the motivation, behavior, life satisfaction, and well being of the individual [10]. Self esteem is included in the category of self concept. When the student has self esteem, the student can have an understanding of himself and will be the solution of all the individual problems. But there is still a little school learning that assessedes about self esteem, whereas self esteem is an important part in self regulation [11]. In some studies there is strong evidence of self esteem can predict person success [12]. The results of studies provide strong evidence that self-esteem is predictive of a person’s success and well being in important life domains, even after taking into account prior levels of self esteem and success [13]. Student with low self esteem has negative self perceptions, feeling useless, and feeling poorly compared to others [14] because student can not make strong initiative, self regulation strategies weakness, and student can not be evaluator [15].

Various indicators of self esteem can support of mathematical literacy indicators such as making mathematical models, determining mathematical solutions, interprete or evaluate solutions. Based on the description, it is required research to determine the investigating of mathematical literacy, mathematical reasoning skill, and self esteem students and the relationship of them. It is expected that this research will provide information about mathematical literacy skill, mathematical reasoning skill, and self esteem in public high school student. So it is hoped that this research can find out which indicators make low mathematical literacy skill according to PISA and the correlation between mathematical literacy with mathematical reasoning and the relationship between mathematical literacy with self esteem as the cause of low mathematical literacy, then to improve teacher teaching quality and become one of solution to improve education in public high school.

2. Method
Participants of the research were 37 tenth-grade students randomly selected from a public high school. In collecting the data, the researcher involved two kinds of method. Those are doing the test and questionnaire. Data collected through mathematical literacy skill test, mathematical reasoning skill test, and self esteem questioner. The instrument used comes from previous research that has been tested for validity and reliability. The method is done by analyzing of students written test and questionnaire. The steps taken in analyzing the data in this study, which are (1) checking the results of the mathematical literacy skill and mathematical reasoning skill tests description in solving the problem (right answer, correct but incomplete, incorrect, no answer) and self esteem questionaire (always, often, sometimes, rarely, never), (2) analyzing the results of questionnaires and tests based on established indicators, (3) matching the scores obtained according to criteria using a scale, (4) analyzing the level of relationship between mathematical literacy and mathematical reasoning skill as well as between mathematical literacy and self esteem, and (5) analyzing more deeply in descriptively.
3. Result and Discussion

In this study, the researcher collects information based on the results of research derived from mathematical literacy and mathematical reasoning as well as self-esteem questionnaires. From Table 1 it can be seen that the result of students work are five questions (Q1-Q5) mathematical reasoning skill and four questions (Q6-Q9) of mathematical literacy skills. The percentage of students who answered correctly but was incomplete on both the mathematical literacy test and mathematical reasoning skill were greatest compared to other types of student responses. While the percentage of students who answered correctly is much higher than the students who do not answer or incorrect answer. This shows that many students have been able to solve the problem of mathematical literacy and mathematical reasoning skill but they don’t know how to finish the answer.

Table 1. Answer result of diagnostic test.

| Kind of Answer       | Reasoning Skill | Mathematical Literacy |
|----------------------|-----------------|-----------------------|
|                      | Q1  | Q2  | Q3  | Q4  | Q5  | Amount| Q6 | Q7 | Q8 | Q9 | Amount|
| Correct (C)          | f   | 17  | 9   | 5   | 1   | 2    | 34 | 12 | 3  | 9  | 13   | 37   |
|                      | %   | 45,9| 24,3| 13,5| 2,7 | 5,4  | 18,3| 32,4| 8,1| 24,3| 35,1 | 25,0 |
| Correct But Incomplete (CBI) | f   | 10  | 20  | 21  | 14  | 9    | 74 | 22 | 27 | 12 | 8    | 69   |
|                      | %   | 27,1| 54,1| 56,7| 37,8| 24,3 | 40 | 59,4| 72,9| 32,4| 21,6 | 46,6 |
| Incorrect (I)        | f   | 8   | 5   | 5   | 8   | 7    | 33 | 2   | 6  | 3  | 5    | 16   |
|                      | %   | 21,6| 13,5| 13,5| 21,6| 18,9 | 17,3| 5,4 | 16,2| 8,1 | 13,5 | 10,8 |
| No Answer (NA)       | f   | 2   | 3   | 6   | 14  | 19   | 44 | 1   | 1  | 13 | 11   | 26   |
|                      | %   | 5,4 | 8,1 | 16,2| 37,8| 51,3 | 23 | 2,7 | 2,7| 35,1| 29,7 | 14,1 |

Next, determining the criteria in the mathematical literacy and mathematical reasoning skill. Based on the value of mathematics National Exam in a public high school year 2016/2017, the average value of mathematics National Exam ($\bar{x}$) is 71.03 and the standard deviation (s) is 7.61. These average and standard deviation values are used as a reference in determining criteria based on the Ebel and Frisbie formulas [16]. The data in Table 2 shows descriptions of mathematical literacy and mathematical reasoning skill data, it shows that mathematical literacy and mathematical reasoning skill of public high school students are low criteria.

Table 2. Criteria of mathematical literacy and reasoning skill.

| Interval       | Criteria | Mean Descriptive |
|----------------|----------|------------------|
| $x \geq 78,34$ | High     | Mathematical Literacy Criteria |
| $63,72 \leq x < 78,34$ | Average | Low |
| $x \leq 62,45$ | Low      | 46,35 |

Furthermore, to find out indicators which make the results of mathematical literacy and mathematical reasoning skill low, it showed presented the average of each indicator in Table 3. Based on the analysis of student answers, the authors found that many students have been able to determine the information needed to complete question of some mixed information required. However, students still have difficulty to make models in right general. Figure 1 shows one of the answers of a student who had difficulty in making mathematical models. Students are given word problem that contain finding way to make the wood to balance when given the number of blocks, balls, and different cubes, but student should make mathematical model from that situation first. Many of the students are difficult to mathematized that situation, they don’t write mathematical symbols so they prefer to use words sentences and drawings in modeling the mathematical problems. If student can make mathematics
model correctly, it can help students in solving problems [17]. The problem can be solved if solver has adequate skills to perform the required mathematical algorithms. Student should describe and construct situation in the current word problems formed and differentiate between relevant and irrelevant information [18].

![Figure 1. Student answer on making mathematics model.](image)

If students have difficulty in making the model then it will affect the way students in determining the solution from the problem and it can make students wrong in choosing a formula or concept that will be used in solving the problem. In addition the students also still have difficulty in interpreting and evaluating the results they have gained. It is seen from students who can solve the problem correctly but students do not know how to evaluate the results of their answers. It can be a student's weakness because the most important to mathematical literacy require shifts in an individual’s thinking likes applying abstract concepts of quantity or print related skills [19]. On the other hand, we find that determine important information from word problems has the highest average. It shows that students student can mention what are known and asked from the questions and student have been able to distinguish information that will be used and information that is not used in solving the problem. Problem selection by taking a mathematics related class during class positively influences candidates and be suggested in improving the mathematical literacy skill [20]. So based on Table 3 it can be seen that the average indicator of mathematical literacy skill has low category which is making mathematical models indicator, making mathematical solution, and interpreting or evaluating the solution, while for important information has average criteria.

| Interval                                      | Mean  | Criteria |
|-----------------------------------------------|-------|----------|
| Determine Important Information From Word Problems | 72.29 | Average  |
| Make Mathematical Models                      | 49.32 | Low      |
| Determine Mathematical Solutions               | 62.16 | Low      |
| Interprete Or Evaluate Solutions               | 54.05 | Low      |

As for the average each mathematical reasoning indicator is also not much different from the mathematical literacy skill. Based on the investigating of students’ answers, we found that many students were able to find patterns in a mathematical phenomenon. But there are still many students who have difficulty in formulating an allegation or a mathematical strategy that will be used. Constructing, evaluating, or understanding mathematic is the most difficult thinking activity for high school students [21]. Though argument drawing conclusions with the act of understanding as a mental experience by linking the related experience is one of illustrates the mathematical reasoning skill [22].
Figure 2. Student answer on making conclusion of an argument.

The authors analyze it because students are oriented to solve the problem so that the strategies and expectations expected by researchers are still answered by the students by solving the problem. In addition, based on Table 4, the average indicator on making the conclusions of the argument has the lowest average. Figure 2 show the student answers, the authors analyze that there are still many students who are difficult to make the conclusions of an argument statement. Student are given several contexts of the problem to make conclusions then with the conclusion that students can solve other problems. But from the student answer, it can conclude that student incorrectly represent some problems presented so that students are wrong in making conclusions. This is due to the low skill of students to link the allegations or strategies used and the reasons for using the strategy. So based on the data in Table 4 only finding patterns in a mathematical phenomenon that has the average criteria, while formulating a conjecture, making reason of election strategy, generalizing mathematical problem, and making conclusion of argument has low criteria.

Table 4. The result of reasoning skill indicator.

| Interval                              | Mean  | Criteria |
|---------------------------------------|-------|----------|
| Finding Patterns in A Mathematical Phenomenon | 66,21 | Average  |
| Formulating an Alleged or Mathematical Strategy | 31,08 | Low      |
| Giving Reasons for Strategy Selection | 59,45 | Low      |
| Generalizing Mathematical Problems    | 51,35 | Low      |
| Making Conclusion Of An Argument     | 23,64 | Low      |

In this study, the self esteem questionnaire provided consisted of 32 items divided into positive statements and negative statements. Self esteem is measured using five alternative answers that are always, often, occasionally, rarely, and never. The score interval refers to the criteria in Table 5. The average of the self esteem score result is 107, 13. So it can be concluded that the category of self esteem is quite good. It means that student can feel about themselves as a person overall judgment of themselves, associate with stronger initiative, and more adaptive self regulation strategies. It implies into the basic human needs that can affect the motivation, behavior, life satisfaction, and welfare of the individual [23] whereas self-esteem entails evaluating oneself positively and often involves the need to be special and above average [24]. Table 6 shows the average for each indicator of self esteem and based on the Table 5 it show that there are many students who have not reached good criteria.
Table 5. Criteria of self esteem.

| Interval Score                      | Category       | Criteria   |
|------------------------------------|----------------|------------|
| $x > Mi + 1.8 Sbi$                 | $x > 134$      | Very Good  |
| $Mi + 0.6Sbi < x \leq Mi + 1.8Sbi$| $109 < x \leq 134$ | Good       |
| $Mi - 0.6Sbi < x \leq Mi - 0.6Sbi$| $83 < x \leq 109$ | Quite Good |
| $Mi - 1.8Sbi < x \leq Mi - 0.6Sbi$| $57 < x \leq 83$ | Not Good   |
| $x \leq Mi - 1.8Sbi$              | $x \leq 57$    | Bad        |

Based on the Table 6, it can be concluded that the indicator of evaluation of skill has the lowest average, while for evaluation of abilities, acceptance, self love, worthiness, self confidence, self respect have almost the same average. If student can improve their self esteem, student can monitor individuals’ status in intra group competition for dominance, resources and mates, and concern with motivating people to maintain a minimum level of acceptance from others [25]. This is different from the self respect and evaluation of characteristic indicators which have the high average. Students have a reservoir of good feelings and strong beliefs about their capabilities that they have stored up and can draw upon as they persevere toward identity verification when that is difficult [26]. It means student can associate with stronger initiative and more adaptive self regulation strategies, but it is not proportional to the average of formulating an alleged or mathematical strategy that fall into the low category.

Analysis to obtain a description of the mathematical literacy, mathematical reasoning skill, and self esteem. The next step is to determine the relationship between the mathematical literacy skill with mathematical reasoning skill and the relationship between mathematical literacy skill and self esteem. Analysis of the relationship level by looking at the value of $r$ output Product Moment Pearson. Based on the product $r$ output Product Moment Pearson, the correlation ($r$) for the relationship between mathematical literacy and mathematical reasoning skill is 0.298 so it is included in the low relation criteria. This result differs from the initial hypothesis that there is a relationship between mathematical literacy and mathematical reasoning skill because mathematical reasoning skill is one part of mathematical skill activity. Although based on the results of representative studies of low correlation criteria between mathematical literacy and mathematical reasoning skills, it can be noted the relationship between their indicators. Finding patterns in a mathematical phenomenon results in mathematical reasoning skills related to the determining important information from word problems on mathematical literacy skills. Both indicators also state the highest average value. When student can find the information needed, student can find the pattern in mathematics phenomenon.

Table 6. Average of each self esteem indicator.

| Indicator | Evaluation of skill | Evaluation of abilities | Acceptance | Self love | Worthiness | Self confidence | Self respect | Evaluation of Characteristic |
|-----------|---------------------|-------------------------|------------|-----------|------------|-----------------|-------------|-----------------------------|
| Mean (%)  | 2.91                | 3.04                    | 3.46       | 3.48      | 3.11       | 3.04            | 4           | 3.72                        |
|           | 58.37               | 60.81                   | 69.32      | 69.79     | 62.29      | 60.97           | 80          | 74.45                       |

While the relationship between mathematical literacy and self esteem has correlation value ($r$) - 0.182 so included in the relationship is very low. The negative sign represents a left-leaning reverse linear relationship. There are three possibilities when looking for the connectedness of a variable with self esteem: 1) assess explicit self esteem may fail to capture self-views of which people are unaware, even if people are aware of a given self view, 2) might fail to express it due to self presentational pressures that tempt them to inflate their self evaluations, perhaps due to the foregoing limitations, researchers have failed to uncover strong and 3) consistent support for the predictive validity of measures of explicit self esteem [27]. This correlation result is different from the research from Jordan (2013), that student has experience negative outcomes, may be common response for low self esteem, but when they experience positive outcomes, they fare better self esteem [28]. But in this result,
students who have good self esteem do not show good results of mathematical literacy. However, although based on the results of research representations of low relation criteria between mathematical literacy and self esteem, can be considered the relationship between indicators. As a result evaluate solutions indicator of mathematical literacy related with evaluation of skill of self esteem. This is because if the student can evaluate the ability they have, then the students will be able to easily evaluate the solution that has been made. This shows the linear relationship between the two indicators of mathematical literacy and self esteem.

4. Conclusion
Based on the results of research and discussion can be concluded that the mathematical literacy and mathematical reasoning skills has low category and self esteem in the category quite good. This result is in accordance with the OECD survey which states that mathematical literacy Indonesia is still low. The relationship between the mathematical literacy and mathematical reasoning has a low correlation. While the relationship between the mathematical literacy with self esteem has a very low correlation. The lowest average of mathematical literacy skills is the making mathematics model whereas the highest average is in the determine important information from word problems. The lowest average of mathematical reasoning skill is formulating an alleged mathematical strategy while the highest average is in the determine important information from word problems. The lowest average of evaluating skill is evaluating solutions indicator of mathematical literacy related with evaluating solutions indicator of mathematical literacy related with evaluating skill of self esteem.

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