Al-Jabar: Jurnal Pendidikan Matematika
Volume 13, Number 1, 2022, Pages 199 – 209
http://ejournal.radenintan.ac.id/index.php/al-jabar/index

The analysis of junior high school students' mathematical literacy: Field study in Bandar Lampung

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Artikel Information
Submitted March 24, 2022
Revised June 17, 2022
Accepted June 21, 2022

Keywords
Mathematical Literacy;
Junior High School Students;
Public and Private School.

Abstract

Mathematical literacy is a person's ability to formulate, apply and interpret mathematics in various contexts, including the ability to reason systematically and use concepts, procedures, and facts to describe, explain or predict an event. Therefore, mathematical literacy is essential in everyday life. This article analyzed the mathematical literacy of junior high school students in Bandar Lampung. Data were collected by giving mathematical literacy questions to junior high school students. The data were analyzed descriptive–quantitatively. The research population is 14–15 years junior high school students in Bandar Lampung City. The research sample was selected using a stratified sampling technique to get students from several favorable and unfavorable public and private junior high schools. The research instrument was a test on the mathematical literacy of junior high school students. The results showed that junior high school students in Bandar Lampung were generally able to solve mathematical literacy problems whose information was clearly available, solve problems procedurally, and use basic algorithms, formulas, procedures, or conventions involving integers. However, they have yet to solve problems that involve constraints or make assumptions. They have not been able to select and integrate different representations, including symbolic ones, relate them directly to aspects of real–world situations and have not been able to solve problems related to everyday life that they rarely encounter.

INTRODUCTION

Mathematical literacy is one of the components measured in the Program for International Student Assessment (PISA), which is a study conducted by the Organization for Economic Cooperation and Development (OECD) that asses the members' educational systems (Kastberg et al., 2016; Berberoğlu, 2005). The PISA reports on student performance affected not only the formation of educational policies in the countries but also the competencies required by PISA in the national curriculum (Breakspear, 2012). The Minister of Education and Culture of Indonesia (2016–2019), Muhadjir Efendi, considers PISA an international education standard in Indonesia (Rohmad, 2020). Furthermore, the Minister of Education and Culture of Indonesia. Nadiem Makarim, also stated that the policy direction for the implementation of the national exam conducted in 2021 refers to assessment instruments at the international level, such as PISA. Correspondingly, in 2017, the government, through the Indonesian Ministry of Education and Culture, launched a national literacy program. One of the dimensions of national literacy is mathematical literacy (Ibrahim et. al., 2017).

Minister of Education and Culture Regulation Number 20 of 2016 concerning Graduate Competency Standards (SMK) at the junior high school level explains that elementary and

How to cite Nurhanurwati, N., Caswita, C., Bharata. H., & Widyastuti, W. (2022). The analysis of junior high school students' mathematical literacy: Field study in Bandar Lampung. *Al-Jabar: Pendidikan Matematika*, *13*(1), 199-209.
E-ISSN 2540-7562
Published by Mathematics Education Department, UIN Raden Intan Lampung

secondary school graduates must have simple factual, conceptual, procedural, and metacognitive knowledge (Alawiyah, 2017). It also emerges the demands for the expected achievements of junior high school graduates, which supported the achievement of students' mathematical literacy. Several terms are related to mathematical literacy, for instance, numeracy or quantitative literacy (Boldstad 2020). The term numeracy is better known in the U.K., Australia, and New Zealand, while the terms mathematical literacy and quantitative literacy are better known in the United States (Geiger, et al, 2015). The meaning of mathematical literacy varies widely, ranging from mastery of basic arithmetic skills to interpretation related to problem–solving in real life. In Indonesia, it is better known as numeracy literacy (Han, et al. 2016).

The concept of mathematical literacy is currently developing into numeric literacy, which relates to a person's ability to formulate, apply and interpret mathematics in various contexts, including the ability to reason systematically and use concepts, procedures, and facts to describe, explain or predict an event (Afriyanti, 2018; Yore et al., 2007). Numeration can be defined as the ability to apply number concepts and arithmetic operations skills in everyday life (for example, at home, work, and participation in community life and as citizens) and the ability to interpret quantitative information around us. Someone with mathematical literacy knows and uses efficient methods and evaluates the results obtained (Goos et al., 2014). Therefore, mathematical literacy is vital in everyday life.

Related to context, to develop mathematical literacy, students must work on open–ended problems and use real–world contexts such as mathematical modeling (Kaiser and Willander, 2005). Open–ended problems and mathematical modeling require high–level knowledge and skills and the teacher's willingness to explore and respond to student thinking. Teachers' understanding of how to apply mathematics in contexts outside of school is an essential factor in providing students with the learning experiences needed to adapt the knowledge they learn in school to the world (Popovic & Lederman, 2015). However, in everyday mathematics learning, the teacher involves very few modeling activities (Blum & Ferri, 2009). Open–ended problems are also rarely used by teachers because teachers will find it difficult if students provide other responses that are different from what the teacher expects. As a result, students are less able to solve the problems of everyday life beyond the material learned at school. PISA results for Indonesian students' competency in 2018 were as poor as in the previous three–year period. Indonesian students' performance scores in mathematics were consistently below the international average score (379 < 489 = the international average score) (Schleicher, 2019). In general, these results indicate that the mathematical literacy of students in Indonesia is low.

Many researchers are concerned with developing students' mathematical literacy ability by producing a set of PISA–like mathematics tasks. Oktiningrum et al. (2016) found that the tasks with Indonesia's natural and cultural heritage as a context potentially impact activating the indicators of each Fundamental Mathematical Capabilities. Umbara & Suryadi (2019) found that 60% of teachers lack knowledge of mathematical literacy, and only 2.47% of teachers understand the aspects of mathematical literacy assessment in the PISA. Other research focus on implementation of some learning methods. Malasari et al. (2020) researched to optimize the enhancement of students' mathematical literacy proficiency due to the implementation of the inquiry cooperation model and revealed that there is no significant difference in the increase of mathematical literacy proficiency in experimental classes in terms of the basic mathematical

proficiency. Another research found no significant differences in students' mathematical literacy between those who received the problem–based learning and direct instruction based on the school's location. Also, there is no interaction effect between the model of learning by school location factors to the increase in students' mathematical literacy (Firdaus, et al., 2017). Kadaritna et al. (2020) conducted research to describe the mathematical literacy abilities of elementary and junior high school students in Lampung Tengah Regency in terms of gender. They found that elementary and junior high schools are still in the low category, and female students have higher mathematical literacy abilities than male students. Some of these studies highlight the importance of examining the student's shortcomings in solving mathematical literacy problems more deeply. However, an in–depth analysis of this mathematical literacy ability has not been found. This study aims to analyze students' mathematical literacy in Lampung Province, especially in Bandar Lampung City.

METHODS

This research is a quantitative descriptive study conducted in junior high school in Bandar Lampung, both in public and private junior high schools. Data were collected by giving mathematical literacy instruments to junior high school students. The data obtained were described, presented, and then analyzed by comparing the students' mathematical literacy. The research population is junior high school students aged 14–15 years (the age of students who take the PISA test) in Bandar Lampung.

The research sample was 129 students, selected by stratified sampling to get students from several public and private junior high schools. School selection is also based on the school's accreditation rating, an average number of applicants, and average national exam scores to determine preferred and disliked school groups. To measure students' mathematical literacy, the research instrument used was a mathematics literacy test for junior high school students whose indicators refer to mathematical processes related to mathematical literacy. Measurement of the internal consistency of the test instrument in this study was carried out with expert justification. Internal consistency in the documentation involving many respondents is necessary so that the data obtained can truly describe the actual conditions. In other words, the results must be consistent, although it was conducted at different times and included respondents from different social backgrounds.

RESULTS AND DISCUSSION

Data on students' mathematical literacy in each public and private junior high school are presented as follows.

1. Analysis of Students' Mathematical Literacy in Favorable Public Junior High School

The results of the analysis of students' answers to mathematical literacy problems at favorable public junior high schools are presented in Table 1.

Table 1. Number of Students' Responses and Answers in Favorable Public Junior High School

Question Number	The Number of Students' Response		Type of Answer		Further Information
	Answered	Not Answered	Correct	Incorrect	
1	29	0	29	0	All students answer the questions correctly
2	29	0	29	0	All students answer the questions correctly
3	29	0	8	21	Students directly divide the floor area with an area of 1 piece of ceramic. Students make mistakes when determining the operation of dividing the floor area by the number of tiles in the box. Many students answered 4 or 5 boxes of ceramics. Some students answered the result was 41 boxes.
4	29	0	20	9	Students make mistakes in determining the final result by looking for the climbing start time
5	26	3	0	29	Many students choose answer choice A, that is 7500
6	28	1	15	13	Students error in calculating the year. They only finish up to 96 years without adding 2021 to 96 years.

The following diagram compares the correct and incorrect answers for each question from the Favorable Public Junior High School in Bandar Lampung.

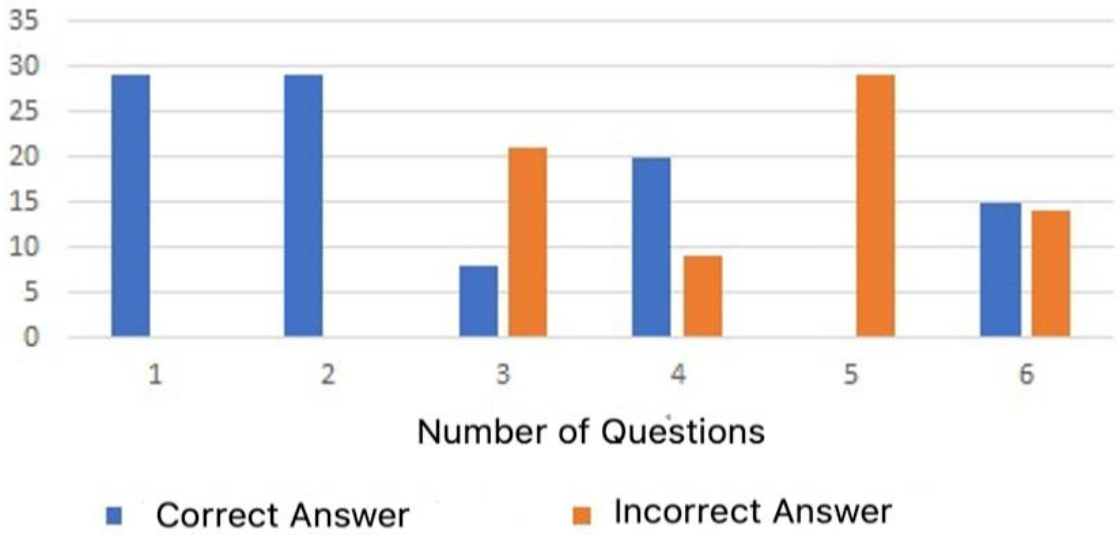

Figure 1. Bar Chart Comparison of Correct and Incorrect Answers in Favorable Public Junior High School

2. Analysis of Students' Mathematical Literacy in Unfavorable Public Junior High School

The results of the analysis of students' answers to mathematical literacy problems at unfavorable public junior high schools are presented in Table 2.

Table 2. Number of Students' Responses and Answers in Unfavorable Public Junior High School

Question Number	The Number of Students' Response		Type of Answer		Further Information
	Answered	Not Answered	Correct	Incorrect	
1	30	0	24	6	Not analyze the number of days
2	30	0	26	4	Misconceptions about multiplication and addition operations
3	30	0	25	5	Don't pay attention to units of meters to centimeters
4	30	0	30	0	All students answered correctly
5	28	2	28	2	All students who answered revealed the correct mathematical procedure
6	28	2	0	30	Using number pattern operations, including the current year

The following diagram compares the correct and incorrect answers for each question from the Unfavorable Public Junior High School in Bandar Lampung.

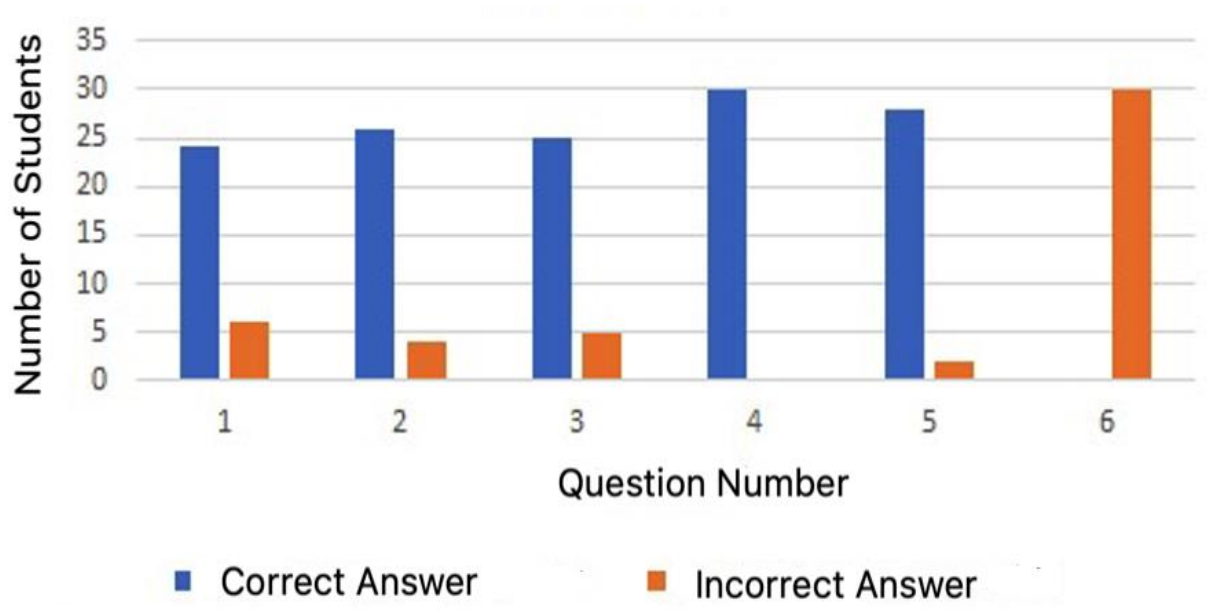

Figure 2. Bar Chart Comparison of Correct and Incorrect Answers in Unfavorable Public Junior High School

3. Analysis of Students' Mathematical literacy in Favorable Private Junior High School

The results of the analysis of students' answers to mathematical literacy problems at favorable private junior high schools are presented in Table 3.

Table 3. Number of Students' Responses and Answers in Favorable Private Junior High School

Question Number	The Number of Students' Response		Type of Answer		Further Information
	Answered	Not Answered	Correct	Incorrect	
1	40	0	32	8	Students incorrect in determining the time from March 12th – March 21st, 2021, 21 – 12 = 9 days
2	40	0	40	0	All students answered correctly
3	38	2	26	14	Students' errors in converting units of 900 cm^2, they changed it to 0.9 m^2
4	40	0	26	14	Students' errors in subtracting time 16.00 and 07.30, and some only count the time increase.
5	40	0	40	0	All students answered correctly
6	37	3	17	23	Students use the wrong concept to solve the problem. They use the concept of sequence so that the result is 2118

The following diagram compares the correct and incorrect answers for each question from the Favorable Private Junior High School in Bandar Lampung.

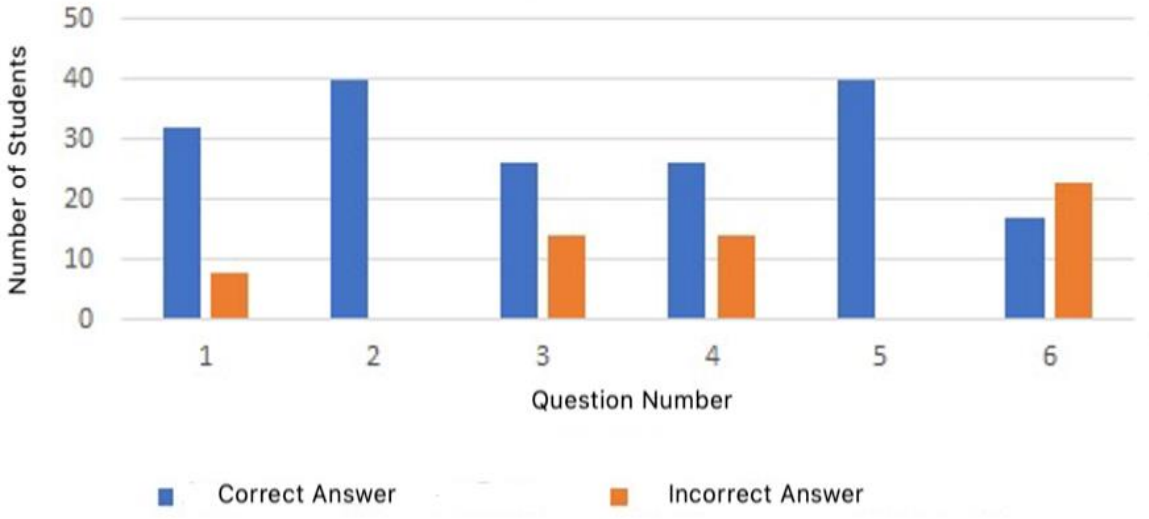

Figure 3. Bar Chart Comparison of Correct and Incorrect Answers in Favorable Private Junior High School

4. The Analysis of Students' Mathematical literacy at Unfavorable Private Junior High School

The results of the analysis of students' answers to mathematical literacy problems at unfavorable private junior high schools are presented in Table 4.

Table 4. Number of Students' Responses and Answers in Unfavorable Private Junior High School

Question Number	The Number of Students' Response		Type of Answer		Further Information
	Answered	Not Answered	Correct	Incorrect	
1	30	0	19	11	Students miscalculated the number of days resulting in errors in calculating the average visitor every day
2	30	0	20	10	Students are wrong in determining the comparisons, so it caused the error in doing calculations amount of cloth needed
3	29	1	10	20	Students are wrong in dividing and do not equalize the unit of measurement between the area of the ceramic and the floor
4	26	4	6	24	Students do not understand the problem well, so they calculate the travel time by dividing the distance traveled by the speed
5	30	0	30	0	All students answered correctly
6	29	1	2	28	Students perform calculations using arithmetic formulas (Un = a + (n–1) b) so that n = 96.6 (rounded to 97) and the result is 2021 + 97 = 2117

The following diagram compares the correct and incorrect answers for each question from the unfavorable Private Junior High School in Bandar Lampung.

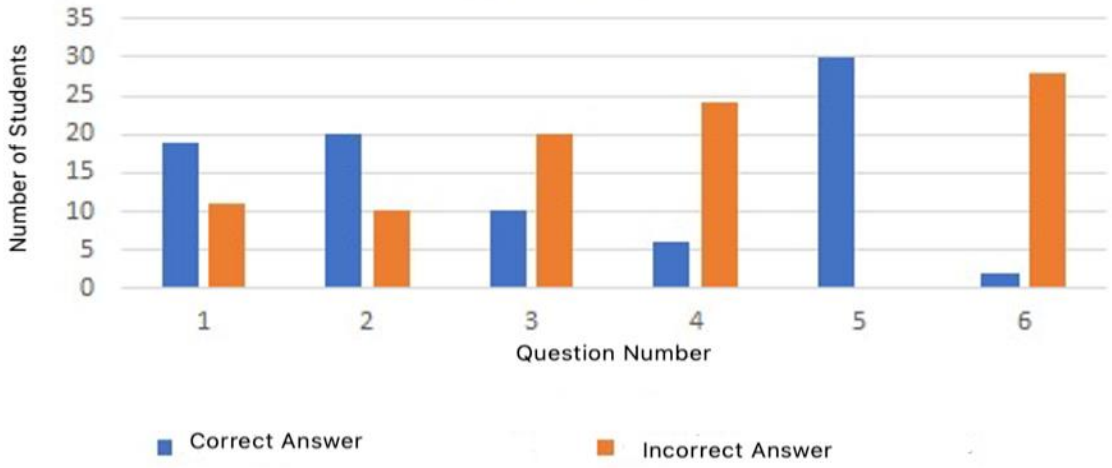

Figure 4. Bar Chart Comparison of Correct and Incorrect Answers in Unfavorable Private Junior High School

To show the comparison of the correct answers, the percentage of correct answers for each question from each school is presented in Table 5.

Table 5. Percentage of Students' Correct Answer

Question Number	Public Junior High School		Private Junior High School		Average (%)
	Favorable (%)	Unfavorable (%)	Favorable (%)	Unfavorable (%)	
1	100.00	80.00	80.00	63.33	80.83
2	100.00	86.67	100.00	66.67	88.34
3	27.59	83.33	65.00	33.33	52.31
4	68.97	100.00	65.00	20.00	63.49
5	0.00	93.33	100.00	100.00	73.33
6	52.72	0.00	42.50	6.67	25.47

More than 50 percent of students' answers to question number 1 in all junior high schools were correct. The errors that occur in students who answer incorrectly are almost the same. Namely, students are wrong in determining the number of days in a certain period. This error is an error in solving word problems in the concept of subtraction (Sepeng & Sigola 2013).

The same situation occurred in question number 2. More than 50 percent of students in all junior high schools answered correctly. Only 11.70 percent of students from the four junior high schools answered incorrectly. The error that occurs is an error in determining the comparison value. Students are wrong in determining the comparison, so they are wrong in calculating the amount of cloth needed.

For the 3rd question about how many cardboard tiles or ceramic tiles are needed to cover the floor, students procedurally calculate the area of the tiles and then divide by the area of the tiles in one cardboard, without considering that the tiles must be cut off at the ends. Students have not been able to imagine using ceramic tiles, which also add magnificence to the floor. It is impossible to connect them, so it will make a tiled floor unsightly. In answering the 4th question, only 20 percent of unfavorable private junior high school students answered correctly. The error occurs because students do not carefully read the questions, so they do not calculate the possibility that when descending, the climber's speed is twice as fast as when climbing. In addition, errors occur when determining the time frame even though the time difference has been obtained. For question number 5, none of the favorable public junior high school students answered correctly.

Meanwhile, there were students in other junior high schools who answered correctly. Errors in junior high school students generally occur because students do not consider that when watching a concert, the audience is crowded. Therefore it is impossible for 1 square meter to only be filled by one audience. Those fact refer to the mathematics literacy skills of junior high school students in applying concepts and procedures superiorly reveal than formulating and interpreting situations/outcomes mathematically. That finding follows Kurniawati & Mahmudi (2019) that applying concepts, facts, and procedures is the highest average among other mathematical literacy indicators. The other indicators are formulating situations mathematically, interpreting mathematical outcomes, and making arguments based on mathematical information or outcomes at medium criteria.

Regarding question number 6, more than 50 percent of students in the four junior high schools indicated wrong answers. Generally, student errors occur in calculating the number of years. Students immediately use arithmetic sequences to calculate the current year as one year. This error is a conceptual error. But some have obtained the number of years that cannot be

translated by calculating the year in question. This type of error is an error of error (Fong, 1993).

Based on the PISA level, most junior high school students in Bandar Lampung can solve problems that involve a familiar context, where all relevant information is already revealed, and the questions are clearly defined (level 1). In addition, some students are also able to use basic algorithms, formulas, procedures, or conventions that involve integers (level 2). A few students can carry out clearly explained procedures, including procedures that require a sequence of decisions. Their interpretations are reasonable enough to serve as the basis for building simple models or selecting and implementing simple problem–solving strategies (level 3). All students have not been able to work effectively with explicit models for complex concrete situations that may involve constraints or assumptions. They have not been able to select and integrate different representations, including symbolic ones, connecting them directly to aspects of real–world situations (Level 4). This research also reveals facts following Malasari et al. (2020) finding of the low percentage of student achievement in solving mathematical literacy level 6. Furthermore, optimization of students' proficiency in mathematical literacy level 1 to level 4 is more appropriate for mathematical literacy proficiency.

CONCLUSIONS

The results showed that junior high school students in Bandar Lampung generally could: a) solve mathematical literacy problems whose information was clearly stated, b) solve problems procedurally, and c) use basic algorithms, formulas, procedures, or conventions involving integers. However, junior high school students in Bandar Lampung have yet to solve problems that involve constraints or make assumptions. They have not been able to select and integrate different representations, including symbolic ones, relate them directly to aspects of real–world situations and have not been able to solve problems related to everyday life that they rarely encounter.

Based on the results, mathematics teachers should carry out learning involving students in solving real–life problems that students may encounter and rarely encounter but exist in this world. So, students' ability to formulate, apply, and reason could be developed by using their thinking to solve problems.

AUTHOR CONTRIBUTIONS STATEMENT

N is the main researcher in this study. This study was designed, conceptualized, and carried out by him. C, HB, and W have been an important part of the whole brainstorming process to write his always important input. They play an important role in data collection and analysis.

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