

Improving mathematical literacy of problem solving at the 5th grade of primary students

Umi Zainiyah¹, Marsigit²

¹Department of Primary Education, Graduate School, Yogyakarta State University, Indonesia

²Graduate School, Yogyakarta State University, Indonesia

Article Info

Article history:

Received Oct 23, 2018

Revised Nov 08, 2018

Accepted Nov 22, 2018

Keywords:

Mathematical literacy
Mathematical problem solving
ability

ABSTRACT

This quantitative descriptive study aims to describe the Mathematical Literacy of Grade 5 of Primary Students regarding their mathematical problem-solving abilities. The samples of this study were 35 5th-grade-students at Muhammadiyah Condongcatut Elementary School in academic year 2017/2018. The data were collected through observations and tests with five questions containing indicators of mathematical literacy regarding mathematical problem-solving abilities; two experts have validated the test instruments. Moreover, the test estimated Cronbach's alpha of 0.749 proved reliability. The data analysis in this study was carried out descriptively based on the average score, the standard deviation, the maximum score, the minimum score, the total score, and the percentage correct answer. The results showed that the mathematical literacy of the 5th-grade students at SD Muhammadiyah Condongcatut was generally at the high category (indicated by the problem-solving abilities). Students have been able to understand a problem, to use logic to describe the solution to a problem, and to choose the most appropriate solution to solve a problem.

*Copyright © 2019 Institute of Advanced Engineering and Science.
All rights reserved.*

Corresponding Author:

Umi Zainiyah,
Department of Primary Education,
Graduate School Yogyakarta State University,
Colombo Street No 1, Karangmalang, Depok, Sleman, Yogyakarta, Indonesia.
Email: umi.zainiyah2016@student.uny.ac.id

1. INTRODUCTION

Nowadays, literacy is crucial for humans' live [1]. The mathematical literacy context is different from the mathematical-context [2]. Mathematics can be applied in various settings whereas mathematical literacy can be used to analyze each meaning quantitatively. The domain of mathematics depends on the ability to understand rules, procedures and mathematical concepts that are increasingly abstract; it is different from mathematical literacy [3]. Mathematical literacy aims to foster students with an ability to become active citizens participating in the present and future events because mathematically literate citizens possess an awareness of dynamic changes occurred and the need of long-life learning [4].

Mathematical literacy is the ability to interpret, formulate and utilize mathematics in various contexts including the use of concepts, procedures, and facts in mathematics that can develop the knowledge and confidence to think critically, logically and mathematically in interpreting and analyzing and solving problems of a day-to-day phenomenon to prepare individuals to face the challenges of life [5-10]. Generally, literacy has four aspects, namely reading, writing, speaking, and listening [11], however, this study focuses on reading and writing mathematical models. Mathematical reading is an active process requiring unique and specialized skills to understand the meaning of mathematical language, especially in solving word problems and interpreting systematic graphs, signs, and mathematical symbols [12]. The ability in Mathematical

reading might help students to understand the meaning contained in a passage and increase the students' opportunity to critically learn and think thus they become capable long-life independent learners.

Another aspect is writing which is a combination of several early reading skills involving several simultaneously functioned cognitive and physical processes [11, 13]. Mathematical writing is an individual activity in composing ideas through language in writing form using mathematical symbols so that targeted readers can understand it.

Mathematical literacy, as a stand-alone literacy, has three aspects: interpret, formulate, and employ [10]. Moreover, in its implementation in mathematical learning, mathematical literacy has five standard processes, namely Problem Solving, Reasoning and Proof, Communication, Connections, and Representation [14]. It means mathematical literacy has a connection with the ability to apply mathematics to overcome daily problems.

One of the standard mathematical learning processes is problem-solving or the Individual's ability, in high-level cognitive aspects that require more basic skills, to find a possible solution to achieve unknown goals or challenging-to-be achieved goals [15, 16]. The ability in problem-solving might facilitate students to understand mathematics involving processes of designing, evaluating, and implementing strategies [17, 18]. The problem-solving-ability does not only rely on standard-relevant knowledge but also information that might help students to choose or determine the right answer by guessing the possible right answers by using some relevant strategies [19, 20]. Students are not only required to get the correct conclusion but also to use strategies to obtain the final results or outcomes. The final results are crucial, but what is more significant is the process in drawing the conclusion, because it fosters students' ability in recognizing or determining their thinking-process patterns in learning.

The main objective of learning mathematics is that students have the ability to solving various problems [21]. Problem-solving is not only the goal of mathematics learning, but also a means to achieve certain goals [14]. Moreover, the ability in problem-solving is an inseparable integral part of mathematics learning. Thus, modern education should be able to educate and prepare students to become individuals with problem-solving ability. [22, 23]. The problem-solving ability has four indicators as measurements: understanding problems, formulating mathematical models, applying relevant solution strategies, and checking processes and results [15, 24].

The fact that Indonesian students take a position in 50 of 55 countries in the mathematical literacy, based on TIMSS 2015, indicates that Indonesia is still in a low category [25]. It leads to the necessity of reviewing Indonesia mathematical literacy to determine the reason behind such a case. Mathematical literacy in mathematics learning is a standard ability required to be mastered by students to develop and improve their competency in other more-advanced mathematical skills. The individuals' ability to communicate and explain the phenomena they faced utilizing mathematical concepts is significantly preferred in mathematical literacy. By adopting the previous research conducted by TIMSS, this study aims to analyze the mathematical literacy of the 5th grade of primary school students viewed from the mathematical problem-solving abilities of students at SD Muhammadiyah Condongcatu.

2. RESEARCH METHOD

This research is a quantitative descriptive study with focus analysis is the problem-solving ability in mathematical literacy of grade 5 students. Mathematical literacy is analyzed based on the results of the students' test scores. Furthermore, the results are then categorized into five categories: very high, high, medium, low, and very low. Such categorization is based on the normative standard deviation reference as shown in Table 1 [26].

Table 1. Mathematical Literacy Categories

Score Interval	Categories
$\mu + 1,5\sigma < X$	Very High
$\mu + 0,5\sigma < X \leq \mu + 1,5\sigma$	High
$\mu - 0,5\sigma < X \leq \mu + 0,5\sigma$	Medium
$\mu - 1,5\sigma < X \leq \mu - 0,5\sigma$	Low
$X \leq \mu - 1,5\sigma$	Very Low

This research was conducted on March 5, 2018, to May 28, 2018, at SD Muhammadiyah Condongcatu in the second semester of the academic year 2017/2018. The participants were 35 of 5th-grade students and chosen for their high score based on *Kriteria Ketuntasan Minimal (KKM)* (Minimum completion Criteria) compared to four other parallel classes in the same grade at SD Muhammadiyah

Condongcatu. Such decision aims to determine whether or not the students considered with a high level of mathematical literacy by the school are genuinely have a high mathematical literacy skill. The primary data are obtained from observations in their class during mathematics learning, and mathematical-literacy-based tests including indicators of mathematical problem-solving abilities whereas photographic documentation are used as secondary data.

The observation guidelines and grids on math literacy test questions are used as the methods and instruments of data collection. Since the researchers were only 'sit-in' classroom during mathematics learning was conducted, the observation method used in this study is passive participation observation. There were five core activities (5M) observed during the observation activity namely observing, asking, gathering information, communicating, and presenting results. Moreover, test instruments used in this study were mathematical literacy tests containing five essay questions involving indicators of mathematical literacy focusing on mathematical problem-solving abilities. The time allocation given to finish the test was 70 minutes (adjusting the students' math-class hours). The topic materials given are those have been discussed by students and their teacher in the classroom, namely (1) number; (2) patterns, functions, and algebra; (3) space and shape/geometry; (4) measurement; and (5) data handling [27]. The question grid of math literacy test questions is presented in Table 2.

Table 2. Mathematical Literacy Test Question Grids

Mathematical literacy aspects	Indicator of mathematical problem-solving abilities	Material				
		Numbers, operations, and relationships	Number, function, and algebra	Space and shape/Geometry	Measurement	Data handling
<i>Interpret</i>	Identifying known and asked items	3				2
<i>Formulate</i>	Developing mathematical models		1			
<i>Employ</i>	Implementing strategies to solve various mathematical problems			5	4	

The related documents used in this study include school profiles and achievements achieved by students at SD Muhammadiyah Condongcatu. For validation purposes, the contents of the instrument were consulted with two experts who are postgraduate lecturers in the mathematics education study program at Universitas Negeri Yogyakarta. The next step was analyzing factors by using SPSS 17.0. The results of factor analysis indicate that the test instrument used in this study is valid to be used as a research instrument. Moreover, the reliability estimation results 0.749 also demonstrates that the test instruments are reliable.

3. RESULTS AND ANALYSIS

Based on the observations, regardless of the participants' level in mathematical literacy, several students are struggling in interpreting the problem in the mathematical literacy test. It might be because they are not familiar with the mathematical literacy problem adopted PISA questions; they are more familiar with closed characteristics test items. Related to time allocation, 70 minutes given are seemly sufficient time to answer five given questions. It means that each student solved one problem on average within 14 minutes. The percentage of the number of 5th-grade students in each category based on the test results is presented in Figure 1.

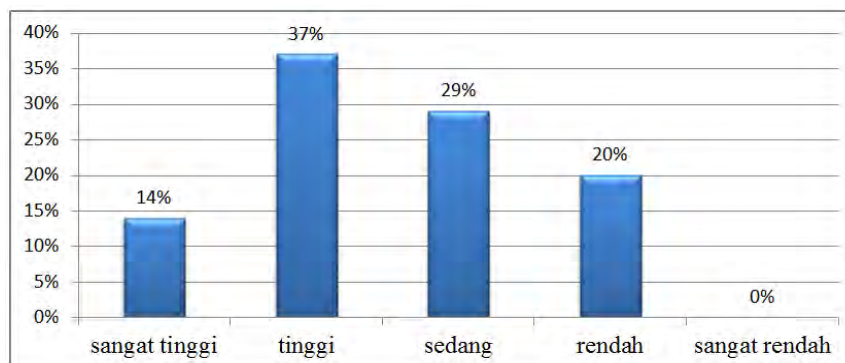


Figure 1. The percentage of the number of 5th-grade students in each category based on the test results

There are only 5 of 35 students (14%) are in the very high category whereas, the majority of students (37%) are in the high category. Moreover, 29% of students are categorized in the moderate students whereas, and the other 20% are in the low group. The average score (8.77) indicates that the students' mathematical literacy skills are in the high category. Furthermore, the data in Figure 2 shown the percentage of the number of 5th-grade students based on the test results on each indicator.

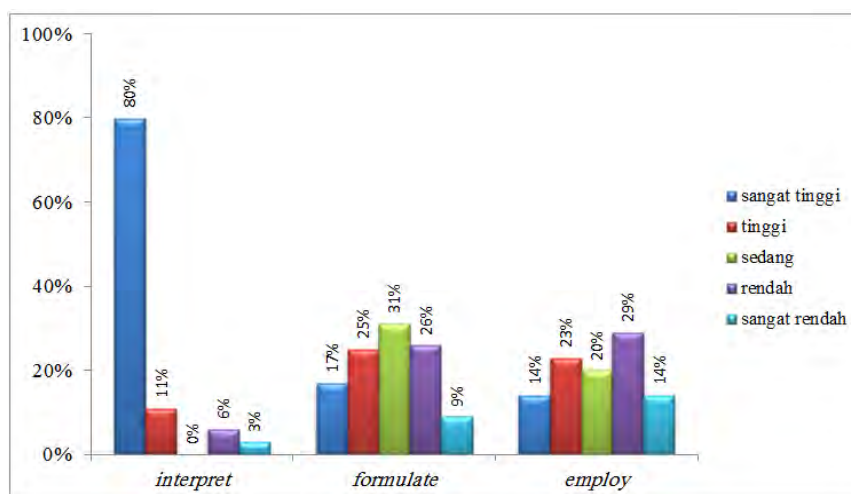


Figure 2. The percentage of the number 5th-grade students based on the test results on each indicator

The diagram shows that each indicator is in the very high, medium, and low category. On the 'interpret' indicator, the majority of students (80%) are in the very high category whereas 11% of students are in the high category. Moreover, 6% of students are categorized in the low category, and 3% of them are in the very low category. In the 'formulate' indicator, there are only 17% of students are categorized as very high skill students whereas 25% of them are in the high category. Furthermore, the majority of students (31%) are in the moderate category whereas 26% of them are in a low category. There are only 9% of students are categorized as the very low students. Move to the 'employ' indicators, and there are only 14% of students are in the very high category whereas 23% of them are in the high category. 20% of participants are classified as moderates whereas the majority of them (29%) as the low. Besides, the remaining 14% of students are included in the very low category.

It can be concluded that the higher the ability category of students, the higher their tendency to answer questions correctly and vice versa. Such result aligns with a study conducted by Mistiani [28] that found the higher the ability of the participants to more chances they correctly answer the test items; in the very high category, the majority of students correctly answer questions. It shows that students in this category do not experience significant difficulties in solving the given questions.

Based on the previous explanations, it can be concluded that geometry material is quite challenging material for elementary school students. It is because the majority of students in the low to very high categories gave incorrect answers incorrectly. Besides, they might find difficulties in geometry because most students have not understood the concepts of geometry. It can be seen their behavior in incorrectly mismatching the formula of geometries; a number of students often use a broad formula to measure mobile problems or vice versa. Following is some conclusions drawn based on the students' answers in their answer sheets.

3.1. Question no. 1 for 'formulate' indicator in patterns and algebras

The data from students' answer sheets for the question number 1 indicate that there are some difficulties encountered by students in solving questions, including: (1) students have not been able to understand the problem thus, the answers given are irrelevant, (2) students do not follow the directions provided in the question, hence some of them do not use the correct patterns; Question no. 1 asked students to find the number of white tiles using a pattern (in this case is square) not only using information that the number of blue tiles is 36 tiles which leads some of them to assume that 36 blue tiles can be formed into a rectangle.

3.2. Question no. 2 for 'interpret' indicator in statistical and opportunities

The students' answer sheets for question number 2 show that there are some difficulties encountered by students in solving questions, including: (1) students have not been able to understand the problem thus the answers given are irrelevant. (2) Students did not follow the direction or information provided in the question thus that some students did not sum up all the book sales every month. The students were asked the total sales of books each month, yet students discarded the information needed. However, students are right in calculating total book sales in January and March but are wrong in estimating total book sales in February.

3.3. Question no. 3 for 'employ' indicator in numbers

The data from students' answer sheets for question number 1 indicate that there are some difficulties encountered by students in solving questions, including: (1) students have not been able to understand the problem thus, that the answers given are irrelevant to the questions, (2) students did not follow the information or direction provided in the question, thus some students guessed each number of chicken legs and goats' feet with a total of 88 feet regardless of the number of goats and chickens (30). Learners were asked to find the number of goats and chickens using information that there are 30 chickens and goats with a total number of feet are 88. Some students only pay attention to the total legs of chickens and goats and ignore the number of chickens and goats in the cage.

3.4. Question no. 4 for 'employ' indicator in measurement

The students' answer sheets for question number 4 indicate that there are some difficulties encountered by students in solving questions, including: (1) students have not been able to understand the problem thus the answers given are irrelevant to the question, (2) students did not follow the information provided in the question, so that some students were tricked by the weight of kerosene sold. Learners were asked to find the weight of the barrel without kerosene, yet most students divided the weight of kerosene into barrels to two.

3.5. Question no. 5 for 'formulate' indicator in geometry

The students' answer sheets for question number 5 indicate that there are some difficulties encountered by students in solving questions, including: (1) students have not been able to understand the problem, so the answers given are irrelevant to the question, (2) students did not follow the information provided in the question, so that some students did not compare one area to another. The problem was to find the maximum area of the existing tour, but students discarded the information needed; they did not compare the area thus the information of whether or not the area produced by the students was the maximum area is hardly be determined.

4. CONCLUSION

Mathematical Literacy of Grade 5 at SD Muhammadiyah Condongcatutur is indicated in the high category. It is determined by their ability to solve mathematical problems that included in the high category. Students have been able to understand problems and answered the questions regarding given and needed information by using logic to formulate and describe the problem models, choose the most appropriate solution to solve the issues, and draw the possible solutions guesses and verify the possible solutions.

ACKNOWLEDGEMENTS

Special thanks to SD Muhammadiyah Condongcatutur, especially the Principal, the Vice-principal for curriculum, 5th graders and teachers who have directly supported the implementation of this research and the realization of this article.

REFERENCES

- [1] UNESCO, *Education for all: Literacy for life*. Paris: UNESCO Publishing, 2005.
- [2] D. Hughes-Hallet, "Achieving numeracy: The challenge of implementation," in *Mathematics and Democracy: The Case for Quantitative Literacy*, Princeton, NJ: National Council on Education and the Disciplines, 2001, pp. 93-98.
- [3] S. Bansilal, B. Goba, L. Webb, A. James and A. Khuzwayo, "Tracing the impact: A case of a professional development programme in mathematical literacy," *Africa Education Review*, vol. 9, no. 1, pp. 106-120, 2012.
- [4] C. Arslan and G. Yavuz, "A study on mathematical literacy self-efficacy beliefs of prospective teachers," *Procedia – Social and Behavioral Sciences*, vol. 46, pp. 5622-5625, 2012.
- [5] National Council of Teacher of Mathematics, *Curriculum and evaluation standards for school mathematics*. Reston, VA: NCTM, 1989.

- [6] OECD, *The PISA 2003 Assessment framework: Mathematics, reading, science and problem solving knowledge and skills*. Paris: OECD Publishing, 2003.
- [7] DoE, *National curriculum statement grades 10-12 (General): Mathematical literacy*. South Africa: Department of Education, 2003.
- [8] A. Zollman, "Learning for STEM literacy: STEM literacy for learning," *School Science and Mathematics*, vol. 112, no. 1, pp. 12-19, 2012.
- [9] Department of Labour and GTZ, *Foundational learning pack: Foundational mathematical literacy*. South Africa: Commissioned by The Department of Labour and GTZ, 2015.
- [10] OECD, *PISA 2015 Assessment and analytical framework: Science, reading, mathematics and financial literacy*. Paris: OECD Publishing, 2016.
- [11] G. Woolley, *Developing literacy in the primary classroom*. New Delhi: SAGE Publications India Pvt Ltd, 2014.
- [12] D. Burton and J. Kappenberg, *Mathematics, the common core, and RTI*. USA: Corwin, 2013.
- [13] D. M. Barone and M. H. Mallette, *Best practices in early literacy instruction*. New York: The Guildford Press, 2013.
- [14] National Council of Teacher of Mathematics, *Principles and standards*. Reston, VA: NCTM, 2000.
- [15] G. Polya, *How to Solve It: A new aspect of mathematical method (Rev. Ed.)*. New Jersey: Princeton University Press, 2004.
- [16] A. B. Bennet, L. J. Burton and L. T. Nelson, *Mathematics for elementary teachers: A conceptual approach*, 9th ed. New York: McGraw-Hill, 2012.
- [17] S. A. Shirali, "George pólya & problem solving ... an appreciation," *Resonance*, pp. 310–322, 2014.
- [18] Peer Review, "Problem solving value rubric," *Peer Review: Emerging Trends and Key Debates in Undergraduate Education*, vol. 18, no. 1/2, pp. 6-7, 2016.
- [19] A. K. Jitendra, E. Szczesniak and A. D. Buchman, "An exploratory validation of curriculum-based mathematical word problem-solving tasks as indicators of mathematics proficiency for third graders," *School Psychology Review*, vol. 34/3, pp. 358-371, 2005.
- [20] A. Mutanen, "About practical problem solving," *Problemos*, vol. 89, pp. 85-94, 2016.
- [21] G. L. Musser, W. F. Burger, and B. E. Peterson, *Mathematics for elementary teachers: A contemporary approach*, 9th ed, USA: John Wiley & Sons, Inc, 2011.
- [22] P. Harnett, *Understanding primary education: Developing professional attributes, knowledge and skills*. New York: Routledge, 2008.
- [23] A. S. Posamentier and S. Krulik, *Problem solving in mathematics grades 3-6*. USA: Corwin, 2009.
- [24] EGAD, *Indicators concordia*. Canada: Concordia University, 2012.
- [25] S. Provasnik, L. Malley, M. Stephens, K. Landeros, R. Perkins, and J. H. Tang, *Highlights from TIMSS and TIMSS Advanced 2015: Mathematics and science achievement of U.S. students in grades 4 and 8 and in Advanced courses at the end of high school in an International context*. Washington: NCES, U.S. Department of Education, 2017.
- [26] S. Azwar, *Psychology Scale Design (in Bahasa)*, Yogyakarta: Pustaka Pelajar, 2016.
- [27] DoBE, *Curriculum and assessment policy statement grades 4-6: Mathematics*. South Africa: Department of Basic Education, 2011.
- [28] W. Mistiani, "Analysis of question items with approaches classical test theory and item response theory (in Bahasa)," *Paedagogia: Jurnal Pendidikan*, vol. 5/1, pp. 122-145, 2016.

BIOGRAPHIES OF AUTHORS



Umi Zainiyah She finished her bachelor's degree in STKIP PGRI Pasuruan at a mathematics education study program in 2015. Currently, the author continues her postgraduate education in Universitas Negeri Yogyakarta since 2016.



Marsigit He finished her bachelor's degree in FKIE IKIP Yogyakarta at a mathematics education study program in 1981. The author continued his postgraduate study at the University of London by taking the Primary Education study program in mathematics concentration and graduating in 1996. Furthermore, the has finished his Ph.D. in Gajah Mada University by taking a mathematics philosophy study program in 2007. Currently, he works as a Lecturer, Professor, and Director at Universitas Negeri Yogyakarta.

