Analysis of Students' Mathematical Literacy Skills Reviewed from Problem Solving Skills

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ABSTRACT

This study aims to describe students' mathematical literacy skills reviewed from problem-solving skills in solving AKM-shaped questions. The method of this research is a qualitative descriptive study. This study was conducted in class 10 MAN 3 Jakarta Pusat and took 251 students as participants. Data collection in this study was carried out by conducting problem-solving tests, mathematical literacy tests, and interviews. Based on mathematics literacy achievement levels, students are grouped into 4 levels, namely, requiring special intervention, basic, professional, and advanced. While problem-solving skills are grouped into 3 categories, namely low, medium, and high. The results showed that most students, regardless of problem-solving skills category, were at "needing special intervention" level in mathematical literacy achievement. However, no students in the low problem-solving skills category reached the advanced level in mathematical literacy. Students often ignore the "looking back" step in problem solving. In fact, ignoring this step causes many students to make mistakes in the final results, including students with higher problem-solving skills. These findings highlight the need for teacher intervention in mathematics instruction to enhance students' accuracy and effectiveness in problem-solving.

Keywords : Mathematical Literacy, Problem-Solving Skills

INTRODUCTION

Mathematical literacy is one of the skills needed by someone in the 21st century. With mathematical literacy skills, students can apply mathematical logic in the real world, so that they are able to make decisions based on logical reasons. In addition, mathematical literacy skills can also help students in connecting and using relevant mathematical content when they solve problems. This is in line with the opinion of Sari (2015) who stated that mathematical literacy skills are related to students' ability to apply mathematics when solving problems they face in real life. OECD (2018) stated that mathematical literacy helps students understand the role of mathematics in the real world. Therefore, the Ministry of Education and Culture (2016) stipulates that mathematics education at the high school/equivalent level aims for students to have mathematical literacy skills.

PISA (*Programme for International Student Assessment*) is one of the assessments that tests students' mathematical literacy skills. According to the PISA results from 2000 to 2018, the average mathematics score of Indonesian students was below the OECD average score. From the OECD (2019), the 2018 PISA results showed that Indonesia scored 379 out of an average of 489 in mathematics. This means that the mathematical literacy skills of Indonesian students are still far behind those of countries that participated in PISA. Meanwhile, in the 2022 PISA results in mathematics, Indonesia scored 367, only down 13 points from the OECD's average score of 21 points. Even though the score decreased, Indonesia's ranking actually improved. In mathematics, Indonesia rose 5 ranks (OECD, 2023b).

In order to improve students' literacy skills, including mathematical literacy, the Indonesian government held a Minimum Competency Assessment (AKM) to measure their literacy skills. By knowing students' abilities, it allows the government, schools, and teachers to improve students' mathematical literacy skills. AKM is an assessment designed to measure the basic skills needed by students to be able to optimize themselves and contribute to society. One of the basic skills in question is mathematical literacy. The results of the 2022 AKM for Indonesian students at the high school/equivalent level show that Indonesian students are included in the category below the minimum competency in the field of mathematical literacy. Minimum competency is the minimum competency that students must have in order to be useful and productive in real life (Kemendikbudristek, 2022) .

The 2022 Education Report Card shows that less than 50% of Indonesian students are able to achieve minimum competency in mathematical literacy. In other words, students are at the "basic" achievement level, which means that students have mastered basic mathematical skills, such as basic calculations in the form of direct equations, basic concepts of geometry and statistics, and solving simple routine mathematical problems. Meanwhile, the AKM results of high school/equivalent students in DKI Jakarta are above the national AKM results throughout Indonesia. As a result, most students in DKI Jakarta have achieved minimum competency with a "competent" achievement level in the field of mathematical literacy and are able to apply the mathematical concepts they have in broader situations. However, efforts are needed to encourage more students to reach the "proficient" level (Kemendikbudristek, 2022).

The poor results of AKM and PISA indicate that students' basic mathematical abilities in solving real-world problems are still low. Sulfayanti (2023) found that one of factors influencing students' low mathematical literacy is their basic mathematical ability. According to OECD (2023a) there are eight basic mathematical abilities that provide a comprehensive foundation for students to develop their mathematical literacy abilities, one of which is problem-solving skills. Suminar and Rahman (2022) argue that problem-solving abilities require students not only to remember formulas and concepts, but also to analyze mathematical problems and find solutions. Students can use their problem-solving abilities to solve problems they face in the real world. This is closely related to mathematical literacy, because mathematical literacy is the ability to use mathematics to solve problems in the real world. In line with Wildani, Triyana, and Mahmudah (2020) who stated that someone with good mathematical literacy skills will be able to formulate, apply, and interpret mathematics in various contexts.

In the PISA 2022 framework, mathematical literacy is associated with two components, one of which is problem solving. OECD (2021) states that mathematical literacy plays an important role in the use of mathematics to solve real-world problems. According to NCTM (2000), problem solving is one of the basic mathematical skills that students must master. In fact, Lester Jr. (2003) stated that problem solving is the core of mathematics. This is because all mathematical activities require problem solving. Maghfiroh, Amin, Ibrahim, and Hartatik (2021) explain that problem solving requires students to not only memorize mathematical formulas and concepts but also be able to use mathematics to solve problems they face in real life. Since problem solving is important for mathematics, PISA 2022 developed assessment items that can reflect students' problem-solving skills.

Several previous studies have described students' mathematical literacy skills, such as research conducted by Sirait, et al. (2016); Tai and Lin (2015); and Zainiyah and Marsigit (2018) explained mathematical literacy skills in terms of students' problem-solving abilities. Furthermore, in the study by Sirait et al. (2016) only focused on the aspects of reasoning and communication, but the components of mathematical literacy should not only cover these two aspects. Pusat Asesmen dan Pembelajaran (2020) determined 3 levels of AKM cognitive in the field of mathematical literacy, namely understanding, application, and reasoning. Research conducted by Tai and Lin (2015) and Zainiyah and Marsigit (2018) did not use mathematical literacy test instruments to measure students' mathematical literacy skills. They used PISA 2012 data in Taiwan to measure students' mathematical literacy skills. Meanwhile, Zainiyah and Marsigit (2018) used problem-solving questions to measure students' literacy skills.

Therefore, the researcher is interested in conducting a study entitled "Analysis of Students' Mathematical Literacy Skills Reviewed from Problem Solving Skills". This study aims to describe students' mathematical literacy skills reviewed from problem solving skills in solving AKM-shaped questions. In addition, this study also describes the process of students solving mathematical literacy questions using problem solving steps.

METHOD

The research method used is

descriptive research with a qualitative approach. This research was conducted in class 10 MAN 3 Jakarta Pusat with 251 students as research participants. The research was conducted from April to June 2024. Data collection was carried out by conducting problem-solving tests, mathematical literacy tests, and interviews. The research instruments used in this study were problem-solving ability test questions, mathematical literacy ability test questions in the form of AKM, and interview guidelines. Both test questions are in the form of written descriptions. The problem-solving test aims to measure students' problem-solving abilities. From the results of the problem-solving ability test, students are grouped into 3 categories, namely low, medium, and high. This grouping uses the Somakim (2010) criteria which are based on the average score ($\bar{x}$) and standard deviation (SD) as follows.

Table 1 Criteria for Grouping Problem Solving Abilities

Category	Description
High	$PSA \geq \bar{x} + SD$
Medium	$\bar{x} - SD \leq PSA < \bar{x} + SD$
Low	$PSA \leq \bar{x} - SD$

Meanwhile, the mathematical literacy test aims to determine the level of achievement of mathematical literacy, namely proficient, competent, basic, and need special intervention. The indicators for grouping mathematical literacy abilities are adapted from the levels of achievement of mathematical literacy owned by (Pusmendik, 2022) as in Table 2 below.

Table 2 Indicators of Mathematical Literacy Ability Grouping

Achievement Level	Indicator
Need Special Intervention	Students are able to solve simple routine problems but only partially with limited mastery of mathematical concepts and calculation skills. Students only master limited mathematical concepts and are unable to solve simple routine problems.
Basic	Students have basic mathematical skills, namely basic calculations in the form of direct equations, basic concepts related to statistics and geometry, and solving routine and simple mathematical problems.
Competent	Students are able to apply their mathematical concepts to more varied problem contexts.
Proficient	Students are able to solve non-routine and complex problems based on the mathematical concepts and skills they have mastered.

From the results of the mathematical literacy test, researchers conducted interviews with 6 students consisting of each level of mathematical literacy achievement. The interview was intended to explore the process of students completing the mathematical literacy test using problem-solving steps. The data obtained were then analyzed using the data analysis stages according to Creswell (2014) , namely (1) organizing and preparing data, (2) coding data, (3) analyzing data, and (4) representing the information obtained.

RESULT AND DISCUSSION

In this study, researchers grouped students based on their problem-solving abilities and their mathematical literacy achievement levels. Based on problem-solving abilities, students were categorized into 3 groups, namely low, medium, and high. Meanwhile, according to the level of mathematical literacy achievement, students were grouped into 4 levels, namely need special intervention, basic, competent, and proficient. Of the 251 students who participated in the study, the majority of students were only able to reach the "need special intervention" level in mathematical literacy achievement. This means that students tend to be able to solve routine and simple problems, although only partially. The following is a table showing the number of students at each level of Mathematical Literacy Ability (MLA) achievement based on their Problem Solving Ability (PSA).

Table 3 Students' Mathematical Literacy Abilities Based on Problem Solving Abilities

PSA	MLA				TOTAL
	Need Special Intervention	**Basic**	**Competent**	**Proficient**	
Low	19	4	2	0	25
Medium	101	31	53	7	192
High	10	4	14	6	34
TOTAL	130	39	69	13	251

Most students in the low and medium problem-solving ability categories were only able to reach the "need special intervention" level in mathematical literacy achievement. Moreover, no students from the low problem-solving ability category were able to reach the "proficient" level in mathematical literacy achievement. This means that no students in this category were able to solve complex and non-routine problems. In the medium problem-solving ability category, quite a few students were able to reach the "proficient" level in mathematical literacy achievement. This is similar to the high problem-solving ability category, where 41.18% of students in this category were able to reach the "proficient" level in mathematical literacy. This means that they are able to solve simple and routine problems as well as problems related to real life. The results of this study are in line with the research of Muslimah and Pujiastuti (2020) which explains that students with the medium mathematical ability category were able to reach level 3 and students with the high mathematical ability category were able to reach level 4 in mathematical literacy. Level 4 shows that students are able to manipulate models effectively, determine and synthesize various representations, and relate them to everyday life.

Furthermore, the researcher interviewed several research participants from various categories of problem-solving ability and mathematical literacy ability to find out more about their process of solving mathematical literacy problems. The results of the answer sheets and interviews of the six research subjects were analyzed based on the problem-solving steps. Table 4 explains the process of solving mathematical literacy problems using problem-solving

steps.

Table 4 Solving Mathematical Literacy Problems with Problem Solving Steps

No	Research Subject	Problem-Solving Steps			
		Understanding the Problem	**Devising a Plan**	**Carrying Out the Plan**	**Looking Back**
1	RPIK248	Difficulty identifying information and questions	Unable to plan strategy	Unable to continue the completion process	Didn't look back
2	TPIK28	Determine the information and questions in reverse	Planning the strategy used appropriately	Using the wrong formula and not in accordance with the chosen strategy	Not rechecking the calculation process
3	SD245	Determine information and questions accurately	Planning the strategy used appropriately	The student used the wrong formula. However, after checking it again, the student was able to correct it.	Checking the calculation process
4	SC87	Determine information and questions accurately	Planning the strategy used appropriately	Using the right chosen strategy	Didn't look back
5	TC93	Determine information and questions accurately	Planning the strategy used appropriately	Using the right chosen strategy	Didn't look back
6	SM205	Determine information and questions accurately	Selecting the manual calculation method	Using the chosen strategy	Didn't look back

RPIK248 students are one of the students with low problem-solving skills and are only able to reach the "need special intervention" level in mathematical literacy achievement. These students are included in the "need special intervention" level because they are unable to solve simple and routine problems and other problems that have a higher level of difficulty. From the student's answer sheet, it can be seen that RPIK248 students do not work on simple and routine problems, instead they immediately work on problems related to everyday life that have a higher level of difficulty. This is because students have difficulty in determining information and questions from simple and routine problems. This means that students do not understand the problem of the problem and are unable to pass the first step in solving the problem. This statement is supported by Timutius, Apriliani, and Bernard (2018) who state that students who cannot identify known information and questions from the problem mean that students are unable to understand the problem well. This can cause students to have difficulty in the next step and be unable to solve the problems given.

Figure 1RPIK248 Answer Sheet

The interview results showed that students were able to easily state information and questions from problems related to everyday life. However, students found it difficult to explain the meaning of the problem. RPIK248 students only knew that the problem being worked on was about quadratic equations, but they did not know how to solve it. This means that students do not understand the problem given because they are unable to connect the problem with mathematical content, so they have difficulty in determining a strategy to solve the problem. Ahsan, Hartoyo, and Halini (2023) and Buyung and Sumarli (2021) stated that students' difficulty in determining appropriate problem-solving strategies can be caused by students' lack of ability to understand the problem.

TPIK28 students are students with high problem-solving abilities who are only able to reach the level of "needs special intervention" in mathematical literacy achievement. These students are also unable to solve problems at the lowest level of difficulty, namely simple and routine problems and other problems with a higher level of difficulty on the mathematical literacy test. The results of the students' answers show that the students did not write down information and questions in the questions. Students immediately solved the problem using the formula $Sn = ar^{n-1}$ which is the formula for calculating the nth term (Un) in a geometric sequence. In fact, the question of the problem is the sum of the first n terms (Sn) of the geometric sequence. This causes students to solve the problem incorrectly. The following is a picture of the student's answer sheet.

Figure 2TPIK28 Answer Sheet

When interviewed, students were able to determine information and questions from the given questions even though they were wrong, by stating the

questions as information about the questions. After that, students determined the strategy correctly and carried out the calculation process. In the calculation process, students used the wrong formula, so they got the wrong final result. TPIK28 students did not carry out the last step of problem solving, which was rechecking. They did not check the calculation process so they got the wrong final result. Setyawan and Siswono (2020) stated that the rechecking step in the problem-solving process is sometimes not carried out by students so that it can cause errors in the final result, procedural errors, and conceptual errors. This shows the importance of carrying out the "looking back" stage in the problem-solving process.

SD245 students have moderate problem-solving skills and are able to reach the "basic" level in mathematical literacy achievement. This means that students are able to solve simple and routine problems only. From the student's answer sheet, it can be seen that students determine the information and questions in the problem before solving the problem. Students are able to determine the information in the problem correctly, although students do not write down the results of r that they calculate using $r = U_2 / U_1$. However, in the question section, students only write "the first 6 terms", the question should be "the sum of the first 6 terms" or S_6. After that, students choose to use the Sn formula in the geometric series and write it on the answer sheet. Furthermore, students calculate using the formula that has been chosen correctly. However, students do not write down the final conclusion from solving the problem. The image below is the result of the answers of SD245.

Figure 3 SD245 Answer Sheet

According to the interview results, the student was able to solve simple and routine problems using complete problem-solving steps. First, the SD245 student correctly determined the information and questions in the problem. He understood that the problem faced was related to the sum of the first n terms. Therefore, second, the student determined the strategy used to solve the problem. Third, he implemented the chosen strategy. However, he forgot the formula for the chosen strategy, so he made a mistake in the calculation process. Furthermore, in the fourth step, the student rechecked the calculation process and realized that he had used the formula incorrectly. After that, the student recalculated using the correct formula. This shows the importance of the rechecking step in the problem-solving step. The student avoided

incorrect   final   results   because   he   rechecked his work

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Figure 4 SC87 Answer Sheet on Simple and Routine Questions

Student SC87 has moderate problem-solving skills and is able to reach a proficient level in mathematical literacy achievement. This student wrote information and questions on both solved problems. In problem 1 (simple and routine problem) the student wrote the question as n_6 which means the 6th term, the student should have written S_6 which means the sum of the first 6 terms as the question. However, the student understands that the question of the problem is the sum of the first 6 terms. This can be seen from the way the student solves the problem by adding the first to the sixth terms of the geometric series. It can also be seen that the student uses a manual method in calculating the sum of the first 6 terms, by determining the 4th to the 6th terms first. The student's method of determining the 4th to the 6th terms is also manually by multiplying the previous term by 3 which is the ratio of the series. The student does not use the formula for the nth term (U_n) and the sum of the first n terms (S_n) in the geometric series. This means that the student does not remember the formula, but he understands the concept of the geometric series itself, so he is able to solve the problem correctly. According to Setiani, Roza, and Maimunah (2022), understanding concepts is the basic provision for achieving problem-solving skills, so that problems in any form can be solved without having to memorize formulas.

Figure 5 SC87 Answer Sheet on Questions Related to Daily Life

In question 2 (questions related to daily life), students are able to determine the information and questions in the question correctly. Then, students determine the strategy used to solve the question. From the interview results, the strategy chosen by students is to look at the difference in the height of the profit bar chart from each business sector each month so that students can predict the business sector that provides stable profits in the following months. Students choose the construction services sector which provides stable profits, because it has a slight difference in height in profits each month. This shows that students are able to evaluate more complex data based on data displays and descriptive statistical summaries. However , in both questions, students did not do the "looking back" stage.

TC93 students have high problem-solving skills and are able to reach a proficient level in mathematical literacy achievement. In simple and routine problems, students are able to determine information and questions from the problem correctly. To calculate the sum of the first 6 terms, students add the first term to the sixth term. This method is a manual method and does not use the formula for the sum of the first n terms (Sn) of a geometric series. However, students are wrong in the results of adding the first six terms. The final result that students get is 2.908, where the final result should be 2.912. When interviewed, students admitted that they did not recheck the calculation process that was carried out, which caused errors in the final result. This means that students master the concept of geometric sequences and series, even though students are wrong in the calculation process.

Figure 6 TC93 Answer Sheet on Simple and Routine Questions

In questions related to daily life, student TC93 did not write down information and questions from the questions. However, when interviewed, the student was able to mention information and questions from the questions. The strategy used by the student was to choose a bar chart that had a slight difference in height each month. After that, the student determined the business field "Construction Services" which would have stable profits in the following month. On the answer sheet, the student did not write down the detailed reasons for choosing the business field, but the student was able to explain the reasons in the interview session. The student did not do the re-examination process.
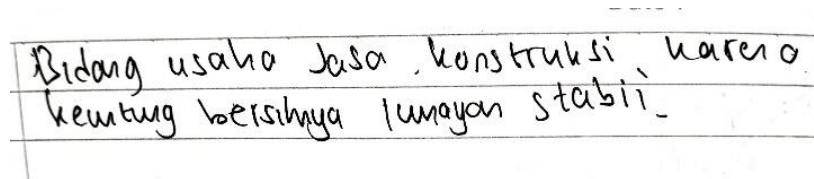

Figure 7 TC93 Answer Sheet on Questions Related to Daily Life

SM205 students are included in the moderate problem-solving ability group and are able to reach an advanced level in mathematical literacy achievement. Students are able to reach the highest level in mathematical literacy achievement, where they are able to solve simple and routine problems, problems related to everyday life, and complex and non-routine problems. Students begin the problem-solving process by determining the information and questions in the problem, then they determine the strategy used. In simple and routine problems, students choose to use the formula for the sum of the first n terms (S_n) in a geometric series. Furthermore, students solve problems using the chosen strategy until they obtain the final result correctly. Then, students also write the final conclusion correctly, but students do not do the "looking back" stage in solving this problem. This stage is an indicator of the "look back and learn" stage in the IDEAL problem-solving strategy. The IDEAL problem-solving strategy was introduced by Bransford and Stein which is an acronym for Ideal problem, Define goal, Explore possible strategies, Anticipate outcomes and act, and Look back and learn. Regarding the look back and learn stage, the results' study from Mardiyyah, Hidayat, and Dewi (2024) are in line with this study that students write conclusions but do not look back the results of the work that has been done.

Figure 8 SM205 Answer Sheet on Simple and Routine Questions

SM205 students try to solve problems related to everyday life, but the results obtained are not accurate. This is because students choose the wrong strategy to use. However, when interviewed, students realize that they chose the wrong strategy and know the strategy that should be used to solve the problem. In complex and non-routine problems, students also start the problem-solving process by determining the information and questions in the problem, then they determine the strategy to use. Students choose to calculate manually. This is because students understand that the problem forms a number pattern, but they do not know the formula or strategy that should be used to solve the problem. Students solve the problem by calculating the size of the frame and the number of beads following the number pattern formed until they get the final result asked by the problem. Although the final result obtained is correct, students do not do the last step in solving the problem, namely looking back.

Figure 9 SM205 Answer Sheet on Complex and Non-Routine Questions

Of the six students interviewed, only one student rechecked his/her answer. The other five students skipped the last step in the problem-solving step. It is undeniable that the rechecking step is a determining stage in problem solving (Normalasari, Rachmawati, and Wiyanto, 2022; Wahyu, Wibowo, & Kurniawan, 2019). By looking back, students can prove that the final results obtained are correct and can teach students to be more careful and careful in solving problems. Furthermore, Herlita, Sugiatno, and Dian (2018) explained that the rechecking step is not only to check the correctness of the final results obtained, but can also look for alternative strategies in solving the problems faced. Unfortunately, in this study, only 1 out of 6 students carried out the rechecking stage. In fact, there was 1 student who got the wrong final result because he did not recheck the calculation process he did.

The interview process also showed that the problem-solving steps, especially re-checking, are often overlooked. In fact, ignoring this step causes many students to make mistakes in the final results obtained, including students with higher problem-solving abilities. This emphasizes the importance of the step of re-checking to ensure the accuracy of the final results, improve students' understanding of mathematical problem solving, and motivate them to explore alternative strategies. These results are in line with previous literature that emphasizes the role of re-checking as an important step in the problem-solving process and suggests the need for teacher intervention in mathematics learning to make students more careful and effective. These results can also be a reminder that double-checking skills need to be drilled explicitly in the learning process. Therefore, it is important for teachers to reflect and re-evaluate their answers in relation to solving the problems being studied. Moreover, teachers should design learning experiences that enhance students' comprehension of problem statements and strategy selection.

CONCLUSION

Based on the results of the study conducted at MAN 3 Central Jakarta in grade 10, it can be concluded that most students, regardless of the problem-solving ability category, are at a low level of mathematical literacy achievement, namely "need special intervention". Of the 251 students analyzed, no students in the low problem-solving ability category reached the "proficient" level in mathematical literacy achievement. Meanwhile, students with moderate and high problem-solving abilities still have some who are able to reach the "competent" level in mathematical literacy achievement. Some students have difficulty understanding information and questions in simple problems, so they fail to determine the first step in solving the problem. In addition, although some students with higher abilities show a good understanding of the concept, they do not re-check the calculation results which causes errors. In fact, students who reach the "proficient" level who are able to solve various types of problems with the correct stages, often miss the important step of re-checking the final results obtained.

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