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Mathematical Literacy Of Auditory Learner: Study On Junior High School Students

Nais Qonita Salsabila[1], Sri Subanti[2], Budi Usodo[3]

[1,3] Department of Mathematics Education, Universitas Sebelas Maret, Surakarta, Indonesia

[2] Department of Mathematics, Universitas Sebelas Maret, Surakarta, Indonesia

Abstract – Mathematical literacy refers to a person's ability to use mathematics in different situations, such as applying and interpreting mathematical concepts and using facts and procedures to explain or predict events. There are seven fundamental abilities involved in mathematical literacy, including: (a) communication, (b) mathematising, (c) representation, (d) reasoning and argument, (e) devising problem-solving strategies, (f) using symbolic, formal, and technical language and operations, and (g) using mathematical tools. This study is a descriptive research with a qualitative approach that aims to describe and explain the mathematical literacy abilities of junior high school students with an auditory learning style. The research subjects were eighth-grade students from Islamic Junior High School (MTsN) 1 Surakarta. Based on the results and discussions, it can be concluded that students with an auditory learning style possess the following mathematical literacy abilities: (a) communication, (b) mathematising, (c) representation, (d) reasoning and argument, (e) devising problem-solving strategies, (f) using symbolic, formal, and technical language and operations, and (g) using mathematical tools. Each of these abilities will be explained in detail in the following discussion.

Keywords – mathematical literacy, auditory learner, junior high school.

I. INTRODUCTION

In the modern era, learning mathematics goes beyond memorizing formulas and performing calculations. Students are expected to possess logical and critical reasoning skills that enable them to solve problems related to everyday life. These problems can be personal, social, work-related, or scientific in nature, and many of them require the application of mathematical concepts. A firm grasp of mathematics can equip students with the tools to solve these problems effectively. The question then arises as to what kind of mathematical abilities are necessary for solving everyday problems. Specifically, what mathematical competencies must 15-year-old children acquire through schooling or specialized training to prepare them for their future careers or for continuing their education at the tertiary level? This situation makes mathematical literacy the primary focus of the Programme for International Student Assessment (PISA).

Mathematical literacy refers to an individual's capacity to apply mathematical concepts in different contexts, interpret mathematical information, and use concepts, procedures, and facts to explain, describe or predict phenomena or events (OECD, 2013). It helps people recognize mathematics's significance in the world and make informed judgments and decisions as citizens (OECD, 2010). While understanding mathematical concepts is crucial, the capacity to employ mathematical literacy to address issues encountered in daily life is even more critical.

According to the Organization for Economic Co-operation and Development (OECD, 2017), mathematical literacy involves seven basic abilities. These abilities include communication; mathematizing; representation; reasoning and argument; devising strategies for solving problems; using symbolic, formal, and technical language and operations; and using mathematical tools. Communication involves connecting real objects, pictures, and diagrams into mathematical ideas, explaining ideas, situations, and mathematical relations orally or in writing with real objects, images, graphs, and algebra. Additionally, it entails stating day-to-day events in mathematical language or symbols, listening, discussing, and writing about mathematics, reading

Corresponding Author: Nais Qonita Salsabila

with understanding or presentation of written mathematics, making conjectures, constructing arguments, formulating definitions and generalizations, and explaining and creating mathematics questions that have occurred. Mathematizing is the ability to change problems presented in everyday language into the form of mathematical language by doing variable examples and writing mathematical models based on what is known in the problem correctly (Abidin, Mulyati & Yunansah, 2018). Furthermore, representation involves the ability to choose, interpret, translate, and use various descriptions to capture the meaning of the questions, and reasoning and argument involve a process of logical thinking to investigate and relate the elements in the problem to obtain a valid conclusion, proof, justification, and solution to the problem. Additionally, devising strategies for solving problems involves designing or choosing mathematical plans and strategies for solving problems raised in real-world contexts. Moreover, using symbolic, formal, and technical language and operations involves using operational language and symbolic, formal, and technical language, including understanding, interpreting, manipulating, and using symbolic expressions such as arithmetic operations, which are based on rules, rules, as well as formal definitions of using algorithms to solve problems. Finally, using mathematical tools involves knowledge and the ability to use various tools that can help with mathematical activities, as well as knowing the limitations of these tools.

Students' literacy abilities vary and can be influenced by their learning styles. De Porter & Hernacki (2002) identified three learning styles: visual, auditory, and kinesthetic. The auditory learning style involves learning by listening and using hearing and audio to achieve success in learning. It can be further divided into external and internal auditory learning styles. Students with an auditory learning style exhibit several characteristics, such as liking to talk to themselves while working, being easily distracted by noise, moving their lips and saying the words in a book when reading, preferring to read aloud and listen, quickly repeating and imitating tones, bars, and timbres, finding it challenging to write but being good at telling stories, speaking in patterned rhythms, usually being fluent readers, preferring music to art, learning by listening and remembering what is discussed rather than what is seen, liking to talk, discuss and explain things at length, having problems with jobs that involve visualization, such as cutting the parts to fit each other, being better at spelling out loud than writing it and preferring oral jokes to reading comics. Given the above explanation, this article aims to analyze junior high school students' mathematical literacy, focusing on the auditory learning style.

II. METHODOLOGY

This study employs a qualitative approach to describe the literacy abilities of junior high school students with an auditory learning style. The research aims to provide a detailed explanation of the literacy abilities of students in this category. The subjects of this study were class VIII students from Islamic Junior High School (MTsN) 1 Surakarta, selected based on the results of a learning style questionnaire. Data was collected from two sources: the results of students' mathematical literacy tests and interviews with the students. A written test was used to measure the students' mathematical literacy skills, and interviews were conducted to support the data gathered from the reported test results. During the interviews, students were asked how they approached the questions in the written test.

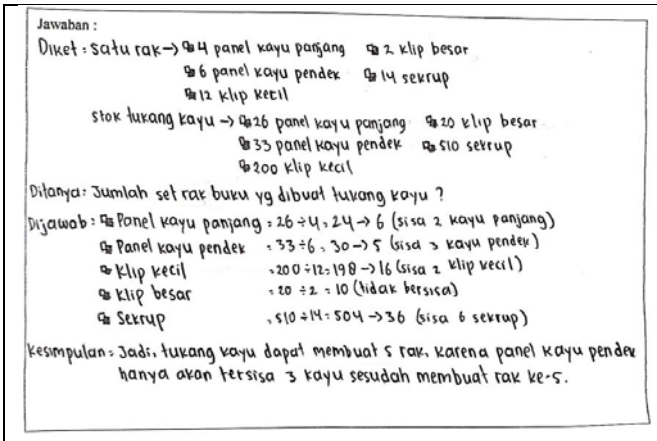
The data collected through the tests and interviews will be analyzed, and the findings will be used to describe the students' mathematical literacy skills according to the seven indicators of mathematical literacy skills. The indicators used in this study are as follows:

Mathematical Literacy Skill	Indicators
Communication	1. Students are capable of connecting real-life objects, pictures, and diagrams to mathematical concepts. 2. Students can effectively communicate mathematical ideas, situations, and relationships verbally and in writing, using real-life objects, pictures, graphs, and algebraic equations. 3. Students can express everyday events in mathematical language or symbols, participate in mathematical discussions, and write about mathematics. 4. Students can read mathematical material with comprehension and present mathematical ideas in writing. 5. Students can formulate arguments, definitions, and generalizations, as well as explain and ask questions about mathematical concepts.

Mathematical Literacy Skill	Indicators
Mathematising	1. Students can convert real-life problems into mathematical language by providing variable examples. 2. Students can write accurate mathematical models based on given information.
Representation	Students can select, interpret, translate, and use various visual representations, such as graphs, tables, pictures, diagrams, and formulas, to comprehend the meaning of mathematical questions.
Reasoning and Argument	1. Students can answer mathematical questions accurately 2. Students can draw appropriate conclusions based on their problem-solving results.
Devising Strategies for Solving Problems	1. Students can determine the appropriate problem-solving strategy. 2. Students can correctly execute the steps of problem-solving.
Using Symbolic, Formal and Technical Langauge and Operations	1. Students can apply mathematical operations, such as addition, subtraction, multiplication, and division, to solve problems. 2. Students can use proper language when working on mathematical questions.
Using Mathematical Tools	1. Students can use operational, symbolic, formal, and technical language in mathematical problem-solving. 2. Students can understand, interpret, manipulate, and apply symbolic expressions, such as arithmetic operations, according to rules and formal definitions, using algorithms to solve mathematical problems.

III. Results And Discussions

This study was conducted in Class VIII Science 5 at MTsN 1 Surakarta, which consisted of 27 students. The research was carried out in two stages: written tests that assessed literacy skills and interviews. The purpose of the study was to examine the auditory learning style abilities of the students by analyzing the results of the written tests and interviews of problem number 1 and 2 from the subject.



Given Information: one shelf → 4 long wood, 2 large clips, 6 short wood, 14 screws, and 12 small clips.
Carpenter's stick → 26 long wood, 20 large clips, 33 short wood, 510 screws, and 200 small clips
Asked: How many sets of bookshelves did the carpenter make?
The answer is : long wood = 26:4 = 6 (2 long wood left)
Wood = 33:6= 5 (3 wood left)
Small clips = 200:12 = 198 (2 small clips remain)
Screws = 510:14 = 36 (6 screws left)
Conclusion: A carpenter can make a maximum of 5 shelves because the raw materials need to be included, and only 3 pieces of wood are left after making the 5th shelf.

Figure 1. The result of problem number 1.

In Figure 1, the written test results showed that the subject could identify the mathematical aspects of a problem in a real-world context and recognize the variables involved in the problem. Moreover, the subject could accurately answer the questions related to the problem and draw correct and precise conclusions. Additionally, the subject could design and implement effective strategies to solve the problem and execute the steps correctly. the subject demonstrated the ability to use mathematical operations such as division to solve the given problem. Furthermore, the subject showed proficiency in recognizing mathematical concepts, facts, and procedures related to the given problem.

Researcher : Can you please explain what information is contained in the problem?

Subject : So you know that to make one shelf, you need 4 long wood panels, 6 short wood panels, 12 small clips, 2 big clips, and 14 screws. Then the carpenter's stock was 26 long wood panels, 33 short wood panels, 200 small clips, 20 large clips, and 510 screws. And what is being asked is the number of sets of bookcases a carpenter can make.

Researcher : Then how do you solve the number problem?

Subject : The method for each material, such as long wood panels, short wood panels, small clips, large clips, and screws, is divided by the materials needed to make 1 wooden shelf. For long wood panels, the stock is 26 divided by 4, the result is 6, and the result is 2. For short wood panels, the stock is 33 divided by 6, and the result is 5. The result is 3; for the small clip, the stock is 200 divided by 12, the result is 16; the result is 2; for the large clip, the stock is 20 divided by 2, and the result is 10; screw the stock 510 divided by 14 is 36 and the remainder is 6.

Researcher : Why do you divide the stock of materials with those needed to make shelves?

Subject : To find out how many shelves I can make a set of materials, ma'am.

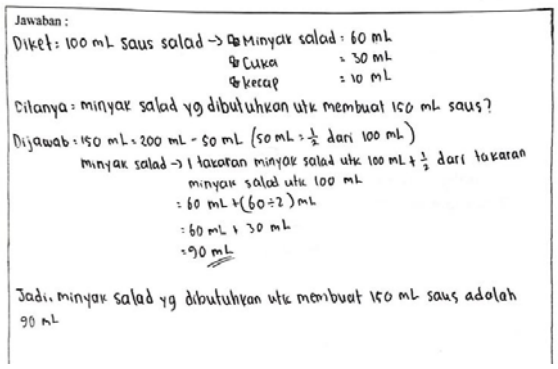
Researcher : Okay, continue.

Subject : So the carpenter can make 5 shelves because the short wood panels only have 3 wood left after making the 5th shelf

Researcher : Why can't your conclusion only be 5, and what does it mean that there are only 3 wood panels left after making the 5th shelf?

Subject : Yes, the carpenter can only make 5 wooden shelves because there needs to be more material to make the 6th wooden shelf. The point is that to make the 6th wooden shelf, you need 6 panels of short wood, while you only need 3 short wood left after making the 5th shelf so that later you don't need scarce lumber, so you can't make 6 sets of shelves.

Based on the interview results, it is evident that the subject can explain the information presented in the problem, answer the questions posed in the problem, and clearly articulate the steps taken to arrive at their solutions. Additionally, the subject is proficient in explaining the concepts behind the problems and can provide well-reasoned arguments and logical reasoning in their completion steps.


Jawaban :
Diket: 100 mL saus salad → Minyak salad : 60 mL
Cuka : 30 mL
kecap : 10 mL
Ditanya: minyak salad yg dibutuhkan utk membuat 150 mL saus?
Dijawab: 150 mL = 200 mL - 50 mL (50 mL = $\frac{1}{2}$ dari 100 mL)
minyak salad → 1 takaran minyak salad utk 100 mL + $\frac{1}{2}$ dari takaran minyak salad utk 100 mL
= 60 mL + (60 ÷ 2) mL
= 60 mL + 30 mL
= 90 mL
Jadi, minyak salad yg dibutuhkan utk membuat 150 mL saus adalah 90 mL

Given Information: 100 ml of salad dressing → salad oil: 60 ml, Vinegar: 30 ml, Soy sauce: 10 ml.

Asked: the salad oil needed to make 150ml of dressing?

Answer: 150ml = 200ml – 50ml (50ml = ½ of 100.l)

Salad oil → 1 measure of salad oil for 100 ml + ½ of salad oil measure for 100ml

	Salad oil: 60ml + 30ml= 90 ml So the salad oil needed to make 150ml of dressing is 90ml.

Figure 2. The result of problem number 2.

Regarding the written test and interview for question number 2 (Figure 2), the subject displays mathematical literacy in Communication, Representation, Reasoning and Argument, Devising Strategies for Solving Problems, Using Symbolic, Formal, and Technical Language, and Operations. The subject can comprehend the information presented in the problem and solve the problem accurately. They can correctly utilize formulas and equations and provide logical steps for their solutions.

However, the subject needs help discerning which information is pertinent to the problem and which is not. As a result, the subject includes all available information in the written responses. Additionally, although the subject can produce correct completion steps, their written work could be more consistent. For instance, the subject writes the formula 150 ml = 200 ml – 50 ml, but in the subsequent step, they write 100 ml + ½ x 100 ml. Despite these inconsistencies, the subject arrives at the correct conclusion.

Researcher : What information is contained in question number 2? Please explain

Subject : So number 3 knows the recipe for 100 ml of sauce. The ingredients are 60 ml of salad oil, 30 ml of vinegar, and 10 ml of soy sauce. How many milliliters of salad oil Anna needs to make 150 ml of sauce is asked.

Researcher : OK, please explain how you solve the problem.

Subject : First, write down everything you know, such as 60 ml of salad oil, 30 ml of vinegar, and 10 ml of soy sauce. Then write down what is asked in the problem. After that, look for how many ml of salad oil are needed to make the dressing. So, 150 ml is from 100 ml plus 50 ml, and 50 ml is ½ of 100 ml, so for 150 ml of salad oil, it is the same as one measure of salad oil for 100 ml plus ½ of the measure of salad oil for 100 ml. So, 60 ml plus 60 divided by 2 equals 60 ml plus 30 ml equals 90 ml. So the salad oil needed to make 150 ml of dressing is 90 ml.

Researcher : Can you explain? Don't you mean that you wrote 150 ml equals 200 ml - 50 ml, even though your answer was 100 ml plus 50 ml?

Subject : At first, I wanted to find it that way, but it turned out to be easier to use 100 ml plus 50 ml.

Based on the interview results, it is evident that the subject possesses the ability to explain mathematical results and conclusions in a reasonable manner. Additionally, the subject can provide detailed explanations of the completion processes used to obtain these results. Furthermore, the subject is able to argue mathematically and draw accurate conclusions. The subject also clarified any inconsistencies on their answer sheet, stating that they initially intended to use a different method but found an easier one. The subject's explanations and reasoning were reasonable and well-supported.

The written test and interview for question number 2 showed that the subject possesses various mathematical skills, including mathematical literacy, mathematizing, reasoning and argument, devising strategies for problem-solving, using symbolic, formal, and technical language and operations. These findings are consistent with a study by Sari & Wijaya (2017), which found that 3.81% of students demonstrated very high mathematical literacy skills in understanding problems, and 8.00% demonstrated high skills. For turning questions into mathematical models (mathematizing), 0.25% of students demonstrated very high skills, and 9.23% demonstrated high skills. In the problem-solving process, 0.37% of students demonstrated very high skills, while 2.46% demonstrated high skills, which is consistent with devising strategies for problem-solving and using mathematical

tools. Finally, 1.85% of students demonstrated high mathematical literacy abilities in the interpretation process, which is equivalent to representation, reasoning, and argument.

Another study by Syawahid & Putrawangsa (2017) found that students with an auditory learning style were capable of identifying information within problems, answering questions in familiar contexts, sorting relevant information, and working with basic algorithms, formulas, and procedures. These students were also able to execute procedures accurately, solve problems using simple strategies, communicate their interpretations and reasoning, and provide explanations supported by arguments.

IV. Conclusion

Based on the results and discussion above, it can be concluded that students with an auditory learning style have literacy skills:

1. Communication: The ability to communicate ideas, situations, and mathematical relations orally, using appropriate indicators to explain concepts. This includes developing arguments, formulating definitions and generalizations, and explaining the complete problem-solving process.
2. Mathematizing: The ability to write a mathematical model based on the information provided in a problem. This involves correctly applying mathematical principles to create a model that accurately represents the situation presented.
3. Representations: The ability to select and interpret formulas and equations and to use them to solve problems. This includes manipulating and using equations correctly to arrive at the correct solution.
4. Reasoning and Argument: The ability to answer questions accurately and make appropriate conclusions based on problem-solving results. This includes applying critical thinking skills and logical reasoning to arrive at valid conclusions.
5. Devising Strategies for Solving Problems: The ability to determine the most effective strategy for solving a problem and to carry out the necessary steps coherently and correctly. This involves analyzing the problem and identifying the most appropriate approach for solving it.
6. Using Symbolic, Formal, and Technical Language and Operations: The ability to use mathematical operations such as addition, subtraction, multiplication, and division correctly in problem-solving. This also includes using appropriate language and terminology when working on problems and correctly applying mathematical concepts.
7. Using Mathematical Tools: The ability to understand, interpret, manipulate, and use symbolic expressions, such as arithmetic operations, to solve problems. This includes applying mathematical rules, definitions, and algorithms to find the correct solution.

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