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#5729 Summary

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ABSTRACT

Mathematical literacy is the ability to formulate, implement, and interpret problems related to everyday life. The Minimum Competency Assessment (AKM) is an Indonesian program that assesses students' basic competencies, particularly mathematical literacy. This research reveals the characteristics of students' mathematical literacy when solving AKM problems. The study was conducted at a junior high school in Surakarta, Indonesia. The research stages included giving AKM problems, observing students' problem-solving processes through think-aloud methods, conducting interviews for confirmation, reducing data, coding data, analyzing data, and drawing conclusions. The data used included students' answers, observation sheets, and interview transcripts. In the formulation process, students identified problems in various ways. They began by marking or scribbling on the question sheet, rereading the questions, and adding notes as a form of understanding. During the implementation process, students formulated problem-solving strategies and performed calculations. In the interpretation process, students drew conclusions without recalculating. Most students experienced difficulties in understanding problems during the formulation process, which impacted subsequent problem-solving steps and led to a domino effect of errors

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1. INTRODUCTION

In the era of globalization and rapid technological advancement, comprehending and utilizing information has become one of the critical skills required to address the challenges of the 21st century (Griffin, McGaw, & Care, 2012; Scott, 2015; Tan, 2021). Beyond merely understanding numbers and formulas, mathematical literacy encompasses the ability to apply mathematical concepts in everyday life, solve data-based problems, and make informed decisions based on mathematical analysis, thereby necessitating critical and logical thinking skills when addressing problems (Muhaimin & Kholid, 2023; OECD, 2021; Stacey, 2015).. Therefore, this skill is crucial for students to master and should be included in the mathematics curriculum. Students with good mathematical literacy tend to be more critical and confident in solving complex mathematical problems (Nisa & Arliani, 2023). This underscores the importance of mathematical literacy in everyday life and education for students.

However, the reality is that mathematical literacy among students in Indonesia still needs to improve. A survey conducted by the Organization for Economic Co-operation and Development (OECD) through the Programme for International Student Assessment (PISA) in 2018 revealed that Indonesia ranked 71st out of 77 in reading literacy, mathematical literacy, and scientific literacy, with a mathematical literacy score of 379 (Schleicher, 2018). Numerous studies have shown that Indonesian students' mathematical literacy still needs to improve. Research by Jailani et al. (2020) revealed that one of the causes of low mathematical literacy among junior high school students is difficulty identifying contextual problems. Previous research by Dewantara et al. (2015) showed similar findings, indicating that students struggle to apply mathematical formulas in solving mathematical problems. Another finding by Fauzi & Chano (2022) indicated that weak mathematical literacy also occurs among elementary school students who need help to solve contextual problems and can only apply formulas limited to algorithms already taught and listed in textbooks.

The low mathematical literacy among Indonesian students calls for solutions from various sectors, particularly education. Understanding and improving students' mathematical literacy is not only the responsibility of educators but also a national priority that requires serious attention (Genc & Erbas, 2019; Umbara & Suryadi, 2019). The Indonesian government has made efforts to provide support by implementing the Minimum Competency Assessment (AKM) as a replacement for the National Examination (UN) since 2020 (Ministry of Education, 2020; Pusmendik, 2022). The AKM is an assessment program designed to determine students' basic abilities and improve the quality of education in Indonesia, thus requiring competencies in language and mathematical literacy to measure basic abilities (Handayani, Perdana, & Ukhlumudin, 2021). Based on the AKM concept, its goal is to understand students' potential and abilities and improve the quality of education in Indonesia (Ministry of Education, 2020; Pusmendik, 2022). This aligns with Cahyanovianty (2021) view that the purpose of AKM is to identify and assess students' language and mathematical literacy competencies. Therefore, the AKM is considered a solution to the low mathematical literacy of Indonesian students.

Despite this solution, the AKM only evaluates the outcome based on the obtained score, whether good or bad, without an in-depth investigation of students' problem-solving abilities (Kemendikbudristek, 2022; Rohmah, Sutama, Hidayati, Fauziati, & Rahmawati, 2022). If the result is good, does the student have good mathematical literacy, or were they merely lucky? If wrong, what caused the difficulty in solving the problem? The AKM needs to provide more specific insights, thus necessitating this research to reveal the detailed characteristics of students' mathematical literacy in solving AKM problems. Therefore, this study aims to identify the characteristics of students' mathematical literacy. These characteristics are students' responses when solving AKM problems, including difficulties and other unique aspects that indicate their mathematical literacy.

This research presents another perspective in the realm of existing mathematical literacy studies. Although many research works have explored aspects of mathematical literacy, most rely on PISA problems as their primary instrument (Dewantara et al., 2015; Hayati, 2019; Khoirudin, Styawati, & Nursyahida, 2017; Ozkale & Ozdemir Erdogan, 2022; Thien, 2016; Wijaya, 2016). However, they have yet to explore mathematical literacy using the AKM problem approach. This indicates a new area of exploration in mathematical literacy. While PISA is widely recognized and used in global research (OECD, 2023), AKM problems may offer a different and more contextual perspective in understanding how students comprehend and use mathematics daily. Therefore, delving deeper into mathematical literacy through the AKM lens can provide additional insights and enrich academic discussions.

2. METHODS

The researcher employs qualitative research with a phenomenological design to deeply analyze mathematical literacy. Creswell (2015) emphasizes that phenomenology focuses on interpreting the meaning of individuals' experiences within the context of their life worlds. Therefore, through this study, the researcher aims to provide a deeper insight into how mathematical literacy is understood and experienced by students in the classroom and how it can be applied, specifically to uncover the characteristics of students' mathematical literacy by engaging and understanding their individual experiences.

The research subjects selected are eighth-grade junior high school students considered relevant and unique in the context of the mathematical literacy being studied. At around 15, junior high school corresponds to the age group assessed in the PISA evaluation globally (OECD, 2021). The selected junior high school in Surakarta is recognized for its excellent reputation. Thus, the selection of subjects from this school is expected to represent students' mathematical literacy at the junior high school level.

The subject selection technique uses snowball sampling until a saturation point is reached (Reserved, Url, & Uri, 2020). In snowball sampling, the researcher starts by identifying one or more individuals who have relevant information or experience related to the research objectives. The researcher also seeks recommendations from teachers when selecting subjects, which is expected to provide deeper or different information. This approach allows the researcher to access a group of subjects that might be difficult to reach through conventional subject selection techniques. In this research context, the researcher decided to select five students as research subjects based on initial information and recommendations from initial students. The selection of these five students is based on data saturation and the consideration of the diversity of their experiences and backgrounds in mathematics learning, thus expected to provide a holistic and in-depth picture of mathematical literacy. The snowball sampling technique employed by the researcher is clearly outlined in Table 1.

Table 1. Snowball sampling technique

Research Subjects	**Mathematical literacy process**		
	Formulation	**Implementation**	**Interpretation**
1	F1	IM1	IN1
2	F1	IM1	IN2
3	F3	IM3	IN1
4	F1	IM3	IN2
5	F1	IM1	IN2

Code description:

F1	:	First subject response in the formulation process
F3	:	Third subject's response to the formulation process
IM1	:	First subject's response to the implementation process
IM4	:	Fourth subject's response to the implementation process
IN1	:	First subject response in the formulation process
IN2	:	Second subject's response to the formulation process

Table 1 shows the codes of the subjects' responses. Identical codes between subjects indicate a similarity in responses among the subjects. These response codes will be discussed in-depth in the findings and discussion section.

In this study, the researcher acts as the primary instrument in data collection and utilizes various tools to obtain more comprehensive information regarding students' mathematical literacy. These instruments include a mathematical literacy test instrument and non-test instruments such as guidelines for conducting in-depth interviews and special sheets for observations during the research process. The test used refers to AKM problems focused on the algebra domain. More specifically, the problems cover the subdomains of ratio and percentage, which are essential components of mathematical literacy at the junior high school level. These problems have been revised to ensure they are genuinely relevant to the research objectives and can accurately measure students' competencies. The test instrument is depicted in Figure 1.

Question translation:
Angelia needs three different clothes models for her holiday; she has an IDR of 125,000.00. There are several clothing models from Kroger, Nick Jr., and Walgreens online stores. These shops provide five types of vouchers that can be used. However, vouchers have conditions, namely that each voucher can only be used for one transaction. So which model of clothes should Angelina choose? Explain!

Figure 1. Mathematical literacy test instrument

The researcher employs the think-aloud technique in data collection to obtain comprehensive and in-depth research data from students. According to Macias et al. (2018), think-aloud is a method of data collection that involves verbalizing everything the research subjects are thinking about concerning the test or problem they are working on during the process. This study observes and records various responses from students during the problem-solving process and conducts interviews to confirm these responses. Therefore, the researcher uses tests, interviews, and observations during the think-aloud process.

The validity of the data in this study hinges on the snowball sampling technique, which uses five research subjects, applying source triangulation to test the validity of the data obtained. This involves comparing data collected from all five subjects (Creswell, 2015). The collected data is then compiled for further processing. Once the data is gathered, the researcher enters the data reduction phase. In this phase, irrelevant or redundant data is filtered out, while vital information is highlighted. This reduction focuses the analysis on the most significant data, eliminating information that might be unimportant or obscure the interpretation. After the reduction, the following process is coding, then presenting the data in a more systematic and easily understandable format. At this stage, the reduced data is organized into tables, charts, or narratives, making it easier for the researcher to identify patterns, relationships, or trends within the data. This presentation is crucial for analyzing the data more effectively and efficiently. Finally, after completing all the above stages, the researcher proceeds to the conclusion-drawing phase.

3. FINDINGS

To determine various subject responses, researchers conducted an analysis based on the mathematical literacy process, formulation, implementation and interpretation. This mathematical literacy process is important to understand how subjects respond, process and understand the mathematical concepts proposed in mathematical problems (AKM). In the formulation stage, researchers observe how subjects deconstruct and understand a given problem, as well as how they formulate strategies to solve it. Next, in the implementation stage, the researcher evaluates how the subject applies the strategy they have formulated to find a solution to the problem. This stage is important because it shows the subject's ability to apply the mathematical concepts and techniques they have mastered. Finally, at the interpretation stage, researchers examine how subjects understand and analyze the results they obtain, how they explain or convey their ideas to others, and whether these results make sense. Through these three stages, researchers can get a holistic picture of the subject's mathematical literacy abilities and how they construct the given problem.

3.1. Formulation process

Based on Table 1, code F1 is the highest response shown based on the five research subjects, the response of subject 1 during the formulation process. This formulation process begins when the subject is given a problem (AKM), in this process the subject can be seen identifying the problem by writing down the question given (Figure 2). Apart from that, it appears that the subject repeatedly read the questions given up to three times, this condition coincided with scribbling on the question sheet.

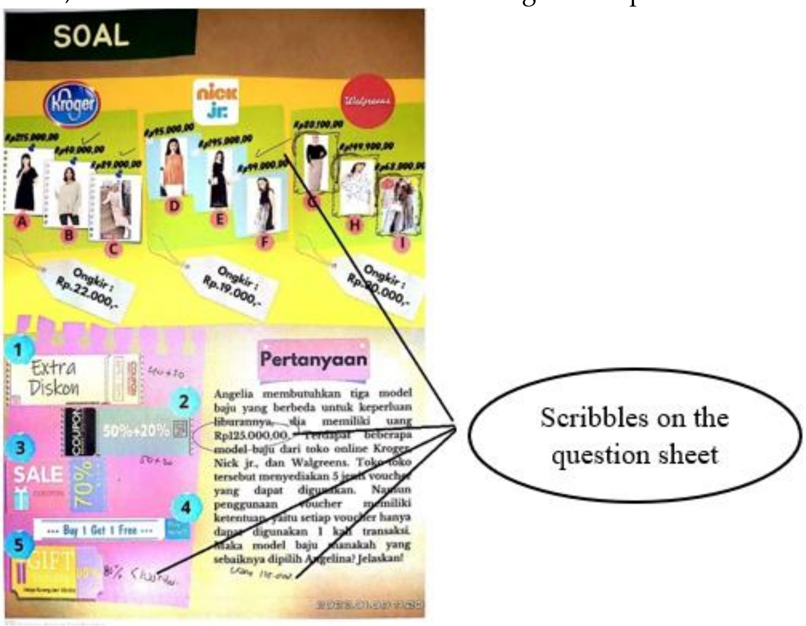


Figure 2. Subject question sheet (FI)

In Figure 2, the subject can be seen scribbling certain parts of the question, the price, discount and initial deposit. based on these conditions, researchers confirmed through interviews.

Researcher (R) : *why did you scribble on your question sheet?*
Subject (S) : *to note important data to make it easier for me to understand the problem*
R : *why did you read the questions several times?*
S : *because I have difficulty understanding the questions*

The interview text highlights the importance of the problem identification strategy carried out by the subject. By scribbling or marking on the question sheet, the subject seems to be giving a visual clue, which makes it easier to recognize key elements or important information in the question. It also helps them to separate relevant information from irrelevant, thereby focusing their attention on important aspects of the problem at hand. In addition, reading the questions repeatedly provides an opportunity for the subject to understand more deeply the nuances and context of the problem. Each repeated reading allows subjects to explore the question from a different perspective, identify potential obstacles, and sharpen their understanding of what the question is actually asking.

When the problem identification process is complete, the next response shown by the subject is to write down the data or information. This is done by the subject to ensure that all important information has been obtained sufficiently before they start working on the questions. By writing data or information explicitly on the answer sheet, the subject makes it easier for him to refer back to the information when needed, without having to go back to check the original question. Based on Figure 3 that the subject wrote the data or information about the question directly on the answer sheet.

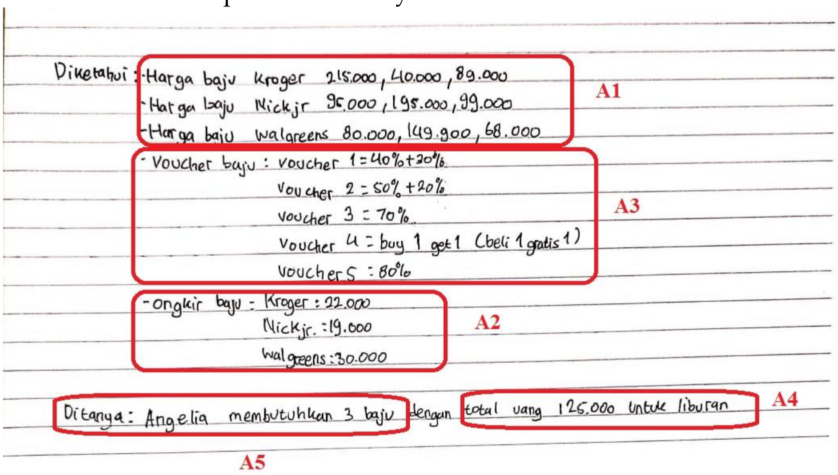


Figure 3. Subject answer sheet (F1) in the data writing process

Figure 3 shows that the data written consists of known data and questionable data. The known data is the price of clothes in each shop (A1), postage prices (A2), and clothes vouchers (A3). Then the data asked is three clothes that must be chosen with the available money (A4). These data are written directly by the subject on the answer sheet. This condition was confirmed by researchers.

R : *Why did you write the question information directly on your answer sheet?*

S : *To make it easier for me without having to look back at the information on the questions or other sheets.*

The interview indicated that writing information on the question sheet made it easier for the subject to solve the problem without having to reopen the question or another sheet, this was also to consider the efficiency level in solving the problem. By minimizing the need to return to the source, subjects can move more quickly through the problem-solving steps, increasing their chances of reaching the correct solution in less time. Thus, the interviews underscore the importance of proactive strategies in problem-solving and how simple steps such as writing down information can significantly impact the final outcome and efficiency of the process.

After writing down the data or information about the problem, it can be seen that the subject not only passively receives the information but is also active in processing it to reach a solution. The selection of a formula as the next step shows the subject's understanding of the mathematical concepts involved in the problem. By explicitly writing the formula, the subject provides a framework for himself, ensuring that the next steps are based on a sound mathematical approach. Figure 4, which displays the subject's answer, shows details of the formula used, as well as how the subject applies it to the data that was recorded previously.

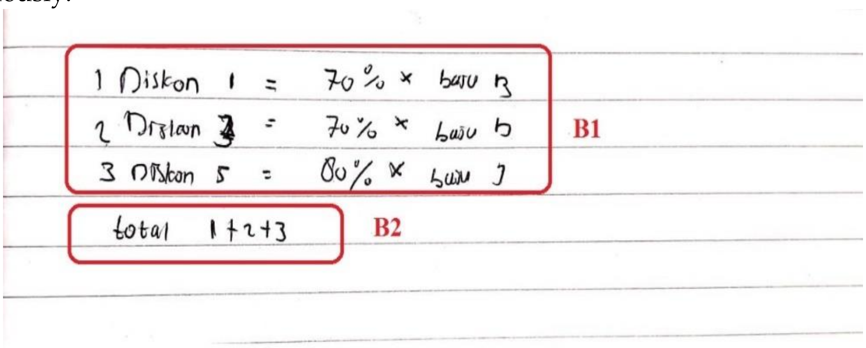


Figure 4. Subject answer sheet (F1) in the strategy development process

The formula written in Figure 4 shows the discount calculation formula (B1) and total discount (B2). The writing of this formula is not without reason, so confirmation is needed for this condition through interviews with the subject.

R : *Why did you write that formula?*

S : *To plan strategies for solving problems*

The subject's response to writing this formula was based on designing how to solve the problem. Subjects seemed aware that solving mathematical problems often requires a structured approach. By writing the formula first, the subject creates a frame of reference to help them carry out the following steps more systematically and organized.

The process of writing problem data and formulas by the subjects above (Figure 3 and Figure 4) reflects the transformation process of a concrete situation or problem that exists in reality into a more abstract mathematical representation. It represents an attempt to understand and define a complex problem from everyday life into mathematical language, which allows for more systematic analysis and solutions.

Another finding in the subject with code F3, in the formulation process, showed a response that the subject did not identify the questions by scribbling on the question sheet or reading the questions repeatedly. On the question sheet, there is also no complete writing of the data or question information (Figure 5), this is different from the F1 code, which identifies by marking information on the question sheet and reading it repeatedly, besides also writing all the data or question information on the answer sheet.

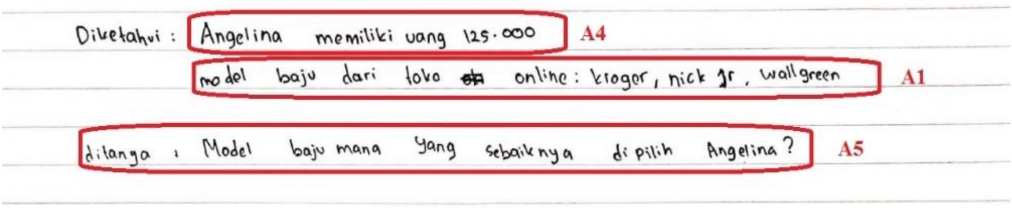


Figure 5. Subject answer sheet (F3)

Code F3 only writes the clothing model from each shop (A1), the initial money (A4), and the data requested (A5). These data are also incomplete in terms of completeness components. However, F3 showed the same response as F1 when designing a problem solving strategy, namely writing down the formula used to solve mathematical problems (AKM).

3.2. Implementation Process

This implementation is a concrete manifestation of the ideas and plans processed and formulated in the formulation process, providing an accurate picture of how these plans are implemented in practice. Based on Table 1, we can observe that the implementation process with IM1 code dominates, even more than with other possible codes. Response code IM1, the subject begins the step by rewriting the question data, but this data is more specific based on what is required in the formula written in the formulation process. The subject answer sheet is clearly shown in Figure 6.

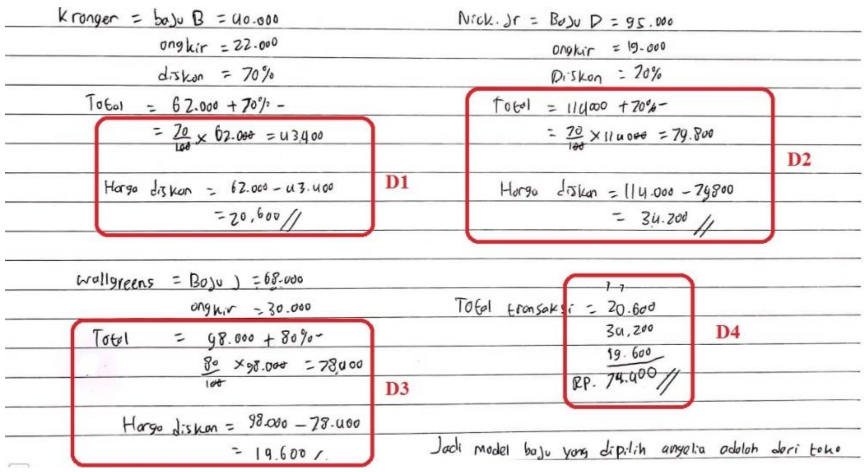


Figure 6. Subject answer sheet (IM1) in the implementation process

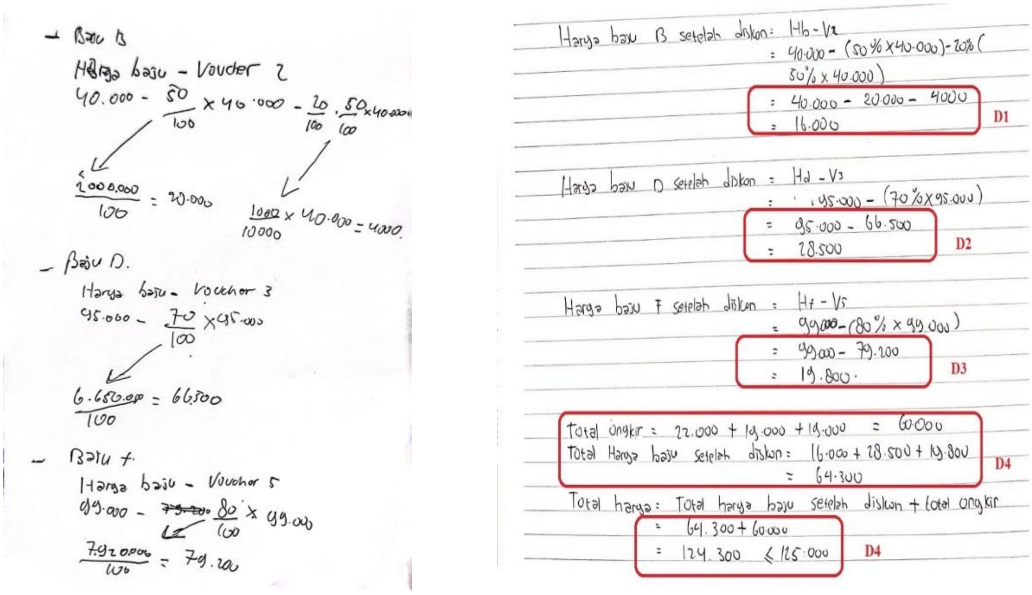
Figure 6 illustrates that the subject performs computations in the form of calculations on his answer sheet. From what we can see in the image, the subject carefully researches the price of each shirt in various stores after considering the discounts given. The goal is clear, the subject wants to ensure that the total cost of the clothes he chooses does not exceed the initial amount of money. The calculation details, as shown by codes D1, D2, and D3, show the price search process after discounts, while code D4 represents the step of adding up all these prices. What is interesting about this observation is the approach the subject took in executing his calculations. Instead of using a scratch sheet as a starting place for carrying out initial calculations or sketches, the subject confidently immediately wrote the results of his calculations on the answer sheet. This may indicate that the subject has high confidence in his mathematical abilities or that the subject prefers to rely on his memory. Through interviews, researchers confirmed this.

R : *Why do you do calculations directly on the answer sheet?*

S : *I am used to doing calculations like this so that problem solving is done quickly*

From the interview it is clear that the subject performs calculations directly on the answer sheet so that it is fast, apart from that, with high self-confidence and a deep understanding of the material, the subject feels he is more efficient and effective in applying the concepts that the subject has mastered. This self-confidence is not without reason, the subject stated that through various training and experiences in the past that strengthened his ability to face similar problems. By practicing calculations directly on the answer sheet, the subject eliminates the need for intermediate steps or transitions, which might slow down the thought process or even be a source of confusion. This allows the subject to fully focus on the question and answer it at his or her desired pace without being distracted.

In contrast to code IM1, other findings in code IM3 reflect a more careful and systematic strategy. Subject 3 and subject 4, when using this approach, seemed to appreciate the importance of a draft or initial draft before putting their answers on the answer sheet. This may indicate that they are more likely to minimize the risk of error or that they need to visualize their calculations more clearly before feeling confident in their final answer. The scribble sheets used by subjects 3 and 4 are necessary for them to organize their thoughts, verify, and ensure that each calculation step is correct before writing it on the answer sheet. The subject's scratch sheet and answer sheet are clearly shown in Figure 7.



(a) (b)

Figure 7. Scribble sheet (a) and answer sheet (b) subject to code IM3

Figure 7 clearly shows the voucher discount calculations carried out by the subject on the scratch sheet. These scratch sheets allow subjects to easily modify, correct, or repeat calculations without crossing out or changing the official answer sheet. As the interview progressed, this subject said, "This is done as an effort to increase calculation accuracy and minimize errors." This method may take longer than the direct method on IM1. However, for the subject, this additional time, the benefits outweigh the investment in terms of accuracy and certainty gained.

3.3. Interpretation Process

After the formulation and implementation process, the following process is interpretation. In this process, researchers see how the subject responds when the answers obtained in the computational calculation process can be reprocessed to become a conclusion to answer the question in the problem. This process produces various response codes from the five subjects. Of these two codes, IN2 is the majority of the IN1 codes. Both codes give rise to the same response, namely using their reasoning abilities to conclude the calculations obtained, but the two codes have different ways of deducing the answer.

In the initial interpretation process, subjects with response code IN2 showed the process of inferring answers. The subject not only carried out a simple evaluation of the results of his calculations but also carried out in-depth reflection to ensure that the resulting answer had a context appropriate to the question given. The subject carefully compares every detail of the answer with the information provided in the question, assessing the relevance and validity of the answer based on the data and parameters provided. From this process, the subject looks back at the answers he received and then at the data in the question. The results of this interpretation are presented in Figure 8.

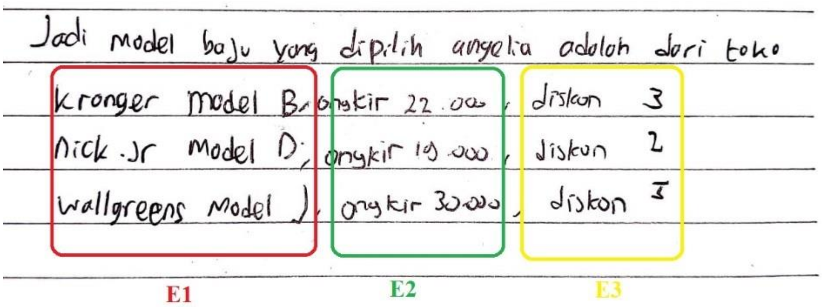


Figure 8. Subject answer sheet (IN2) in the interpretation process

Based on Figure 8, subjects can write down their answer conclusions, starting from the clothes chosen (E1), shipping costs (E2), and discount vouchers chosen (E3), even though they do not do the calculations again. Through interviews, researchers confirmed this condition.

R : *Why don't you check the calculations before concluding the answer?*

S : *To shorten the time, because the processing time is short, I do not have enough time to do the calculations again*

The interview quoted above indicates that poor time management will result in less-than-optimal work steps being taken. In contrast, as seen in IN1's response, efficient time management allows subjects to allocate sufficient time to each aspect of the problem. In this case, subjects with an IN1 response can not only solve the problem, but also have the freedom to review their calculations before deducing an answer.

4. DISCUSSION

We have described various subject responses in solving AKM problems in the findings section; in each step of the mathematical literacy process, we received different feedback (formulation, implementation, and interpretation). In formulating initial findings, the subject identifies the problem by Muhaimin & Kholid (2023) revealed that mathematical literacy is the ability to solve problems related to everyday problems so that in solving mathematical problems, the first step is to identify the problem first. This opinion is also supported by Laamena & Laurens (2021) that mathematical literacy's first ability is analyzing or identifying problems. Identify problems that arise by scribbling on the question sheet and rereading the questions repeatedly. This scribble is the subject's attempt to visualize or map information that is considered necessary (Venkat, 2010), making it easier for the subject to solve the problem so that they do not see the problem continuously during the process of solving the problem. Likewise, reading the questions repeatedly helps the subject understand the problems in the questions. Various findings from other research also say that students often read questions repeatedly to understand the problem (Anwar & Rahmawati, 2017; Robinson & Kevoe-Feldman, 2010; Therrien & Hughes, 2008). Another finding (F3) that we understood was that the subject needed to recognize issues the way F1 did (did not mark or scribble on the response sheet and did not repeatedly read the questions). According to Schoenfeld (1988), students with good understanding only need to read the problem once, and they will understand the meaning of the problem in the questions.

The next ability that emerges is writing down the data obtained; this data is the known data, and the data asked about in the question. In this case, two different responses are writing information or data thoroughly and systematically (F1) and only writing some information or data on the answer sheet (F3). Remember that mathematical literacy is the ability to solve everyday problems (Ministry of Education, 2020; OECD, 2019), so the forms of questions given are usually related to everyday life (Gatabi, Stacey, & Gooya, 2012). Therefore, we need to understand and record relevant data well. Sometimes, the data presented in a problem may contain additional information not needed to solve the problem (Najafabadi et al., 2015). Therefore, the ability to sort and focus on critical data is essential. In addition, it is important to record data clearly and systematically (English, 2015). This will help us in the thinking process and help us solve problems later. Sometimes, errors in recording data can result in errors in completion. According to Sundayana & Parani (2023), The student's initial error in solving the problem was due to incomplete data or information obtained based on the problem, and this condition will affect the subsequent process where incomplete data may make the written formula and solution strategy incorrect and result in incorrect answers being obtained. So, accuracy in this process is essential. In mathematical literacy, this ability functions to solve problems and is also valuable for students' daily lives (Genc & Erbas, 2019). For example, when we shop, make a budget, or even when talking about statistics and data in real life. Identifying, recording, and sorting data correctly will help us make more precise decisions based on accurate information.

The response to the formulation process we found next was the ability to develop problem-solving strategies; all codes (F1, F3) in the formulation process showed this response. Developing this strategy takes the form of formulating a formula that will be used to solve the problem faced and planning the steps that must be taken to solve the problem. This process requires critical and analytical thinking (Bali, Capano, & Ramesh, 2019). The ability to develop problem-solving strategies is an essential aspect of mathematical literacy. This is because mathematical literacy is the ability to carry out simple mathematical operations and the ability to analyze, interpret, and use mathematics in various real situations (Ministry of Education, 2020; OECD, 2019). With a clear strategy, one may find it easier to find efficient and effective solutions (Basadur, 2004). Many problems, especially in mathematics, require specific problem-solving strategies (Gupta & Mishra, 2021; Muhaimin, Dasar, & Kusumah, 2023). Therefore, having the right strategy will speed up the problem-solving process and increase the accuracy of answers. However, we found the subject's error in determining the formula to solve the problem. Of course, the solution strategy will also be inappropriate in this condition. According to Cho & Nagle (2017), the need for an in-depth understanding of basic mathematical concepts makes students choose the wrong formula. Therefore, the results may be different from what was expected. This statement is in line with the findings we obtained, which stated that the subjects needed to understand the material about discounts well, which resulted in errors in formulating strategies, which impacted the calculation results.

In writing down data and developing strategies when solving problems, we also found that students carried out data transformations, such as changing contextual data or information into mathematical language data. Mathematical problems designed to test or explore the depth of students' mathematical literacy must have several elements or components, one of which is that the problem must have a specific context (Almarashdi & Jarrah, 2022; Stacey, 2011). This context provides background or story to the problem and serves as a source of information that students need to find a solution. AKM is a mathematical problem with a context within the problem (Cahyani & Susanah, 2022; Ministry of Education, 2020; Muhaimin et al., 2023). This requires students' ability to change data or information based on the problem presented into mathematical form. Additionally, Muhaimin & Kholid (2023) stated that although conceptual understanding in recognizing problem patterns, identifying relationships between existing variables, and understanding basic mathematical concepts are essential, all of this will be worthwhile if students can transform information into relevant mathematical language. This transformation ability is essential for students to apply their knowledge in solving problems in everyday life.

The following process in mathematical literacy after the formulation process is implementation. In this process, all codes show the same response, implementing the planned problem-solving strategy and, in this case, carrying out computational calculations. This stage is where basic mathematical skills, such as arithmetic, algebra, and geometry, are often applied (Kholid et al., 2022). In PISA, this stage also involves skills in using mathematical tools, such as calculators or special software, if necessary (OECD, 2019, 2021). However, for researchers, the questions used simple numbers and wanted to see how students apply their numeracy skills in depth, so using mathematical tools is not permitted in this process. The difference in response we found between IM1 and IM3 lies in how they calculate. IM1 is doing calculations directly on the answer sheet, and IM3 is not doing calculations directly on the answer sheet but instead doing calculations on another sheet (scribble sheet) before writing the answer on the answer sheet. Our findings in Table 1 show that most responses were in IM1. According to Foshay & Kirkley (1998), working directly on the answer sheet is more efficient in solving problems. PISA also states that the time given to work on questions is short (OECD, 2019, 2021). In this case, it confirms our findings that subjects perform calculations directly on the answer sheet to be efficient. It is important to note that both IM1 and IM3 codes have advantages and disadvantages. While IM1 may be faster and more efficient for subjects with high confidence and a deep understanding of the material, IM3 may be better suited for those needing additional clarification or who tend to make mistakes when rushed. In an educational context, these findings emphasize the importance of introducing various calculation strategies to students. It also underscores the need to provide flexibility in learning approaches, recognizing that each student is unique in processing information and solving problems.

The discussion on the formulation process mentioned that mistakes made at the beginning of problem-solving will impact the process afterward. Imagine if the foundation of a building is not solid or inappropriate, the building is at risk of collapsing when faced with pressure. As with solving mathematical problems, if the basic understanding or strategy used is not appropriate at the formulation stage, then in subsequent stages, the chance of getting the correct answer becomes smaller (Schafer, M., & Brown, 2006). This condition is confirmed in the implementation process in Figure 6 and Figure 7. This visualization shows how initial errors that appear at the formulation stage affect the results at the implementation stage. The findings we obtained are, in fact, in line with the research results by Huu Tong & Phu Loc (2017) and Astutik & Purwasih (2023), which also shows that the majority of incorrect answers obtained were caused by previous steps needing to be corrected. It is, therefore, important for educators to ensure solid understanding from the start to have a greater chance of success in the later stages.

The findings of this research show the importance of the interpretation stage in the mathematical literacy process. This interpretation process involves not only understanding mathematical concepts but also reasoning skills that enable the subject to reflect on the results of his work and draw appropriate conclusions (Machaba, 2018). Our findings show that the response code in this process shows students' reasoning abilities in concluding answers. This is seen in how subjects with response code IN2 process their answers. From IN2's response, subjects are more likely to rely on their conceptual understanding and the context of the problem to conclude rather than sticking to the calculation results. Strong confidence in their ability to understand and solve problems prevents students from recalculating before concluding (Bénabou & Tirole, 2002). However, this also reveals a potential risk: the lack of verification that may be required in specific contexts to ensure the correctness of answers. Executive skills such as time management also influence the lack of verification in the interpretation process; the longer the time spent on the previous process, the less time is spent at this stage (Broyden, 1965). Then, errors in the formulation process impact the implementation process and, finally, the interpretation process. Interestingly, despite errors, the subjects seemed confident in their understanding even though they were wrong. This error is not surprising because many students sometimes misunderstand certain concepts without realizing it (diSessa, 2002). This phenomenon is a "cognitive error," in which a person believes something to be true even though the facts differ (Miller, Holcombe, & Latham, 2020). In the learning context, this phenomenon underlines the importance of constructive feedback and double-checking in the learning process. This ensures that students' understanding is not only deep but also accurate. The existence of cognitive bias reminds educators to always emphasize to students the importance of reflection, re-examination, and the willingness to accept and process criticism or correction.

5. CONCLUSION

This study reveals the diverse responses of subjects in solving contextual mathematical problems (AKM) through mathematical literacy, which includes formulation, implementation, and interpretation. In the formulation stage, subjects identify problems using various approaches. Problem identification begins with marks or notes on the question sheet and re-reading the problem statement to visualize important information. This ability helps in understanding and solving mathematical problems more effectively. The systematic and comprehensive data recording was also observed, indicating the subjects' understanding of relevant information in the problems. Subsequently, the subjects demonstrated the ability to formulate problem-solving strategies, including developing appropriate formulas and planning the necessary steps. The implementation process of these strategies involves computation, with some subjects performing calculations directly on the answer sheet while others use a separate worksheet before writing their answers. The results show that direct approaches may be more efficient, but subjects also demonstrated flexibility in their methods depending on the problem's complexity. The interpretation process reflects the subjects' ability to conclude their work. Some subjects relied on conceptual understanding and the problem context to conclude without redoing calculations. However, there is a potential risk when overconfidence hampers result verification. Initial errors in problem formulation can significantly impact the subsequent stages, including implementation and interpretation. This emphasizes the importance of establishing a solid foundation to ensure success in solving mathematical problems. Overall, this study highlights the complexity of mathematical literacy in everyday problem-solving, underscoring the importance of accurate problem identification, precise data recording, effective problem-solving strategies, and careful interpretation to achieve accurate and meaningful solutions.

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2

BUKTI KONFIRMASI REVIEW DAN HASIL REVIEW PERTAMA

(08 Agustus 2024)

SUMMARY | REVIEW | EDITING

Submission

Authors	Astri Wahyuni, Lukman Hakim Muhaimin, Agus Hendriyanto, Yuliana Tririnika
Title	Exploring Middle School Students' Challenges in Mathematical Literacy: A Study on AKM Problem-Solving
Section	Articles
Editor	Widia Yunita

Peer Review

Round 1

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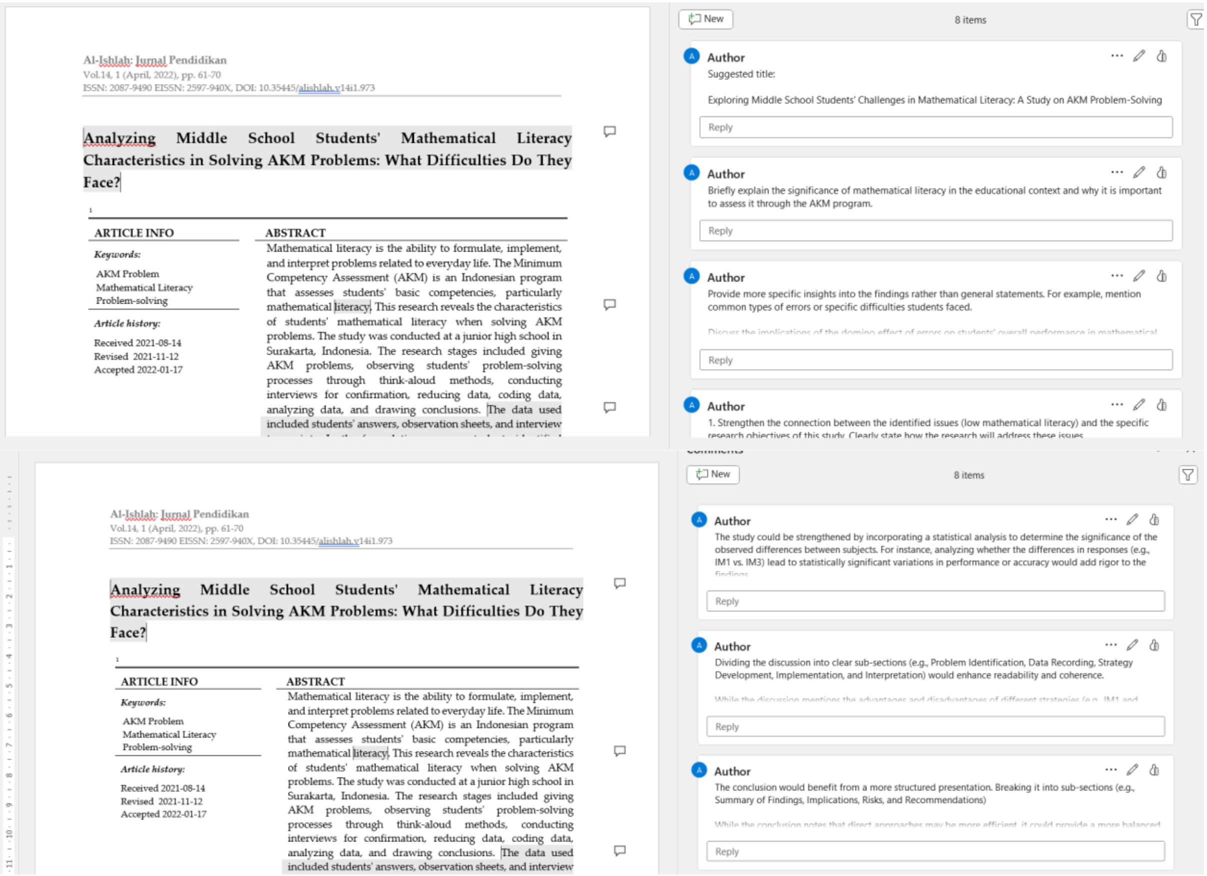
Review



Tabulasi review

Questions and answers

Title: Analyzing Middle School Students' Mathematical Literacy Characteristics in Solving AKM Problems: What Difficulties Do They Face?

Id: 5729/LoA/ALISHLAH/STAI-HW/2024

<table>
<tr><th>Questions</th><th>Answers</th></tr>
<tr><td>Suggested title:

Exploring Middle School Students' Challenges in Mathematical Literacy: A Study on AKM Problem-Solving</td><td>We change the title:

Exploring Middle School Students' Challenges in Mathematical Literacy: A Study on AKM Problem-Solving</td></tr>
<tr><td>Briefly explain the significance of mathematical literacy in the educational context and why it is important to assess it through the AKM program.</td><td>We added in abstract:

Mathematical literacy is the ability to formulate, apply, and interpret everyday problems. In education, it is essential for problem-solving, decision-making, understanding concepts, job readiness, critical thinking, and community participation, preparing students to face life's challenges and the future. The Minimum Competency Assessment (AKM) program in Indonesia is designed to evaluate these essential skills, similar to the PISA framework. Assessing mathematical literacy through the AKM ensures that students meet basic competency standards, helping to improve overall educational quality and better preparing students for global competition.</td></tr>
<tr><td>Provide more specific insights into the findings rather than general statements. For example, mention common types of errors or specific difficulties students faced.

Discuss the implications of the domino effect of errors on students’ overall performance in mathematical literacy.

Include a sentence or two about the potential implications of the findings for teaching practices or educational interventions.

Suggest possible recommendations for addressing the identified difficulties in mathematical literacy.</td><td>We added in abstract:

Dalam merumuskan permasalahan, siswa mengalami kesulitan dalam memahami permasalahan dengan tepat. Sehingga dalam proses-proses penyelesaian masalah selanjutnya data yang diperoleh tidak lengkap dan menimbulkan kesalahan perhitungan atau kesalahan dalam penggunaan rumus. Kesalahan ini menimbulkan kesalahan yang domino karena berdampak pada kesalahan jawaban yang diperoleh. Kesulitan siswa dalam merumuskan masalah matematika berpotensi dapat menyebabkan kesalahan perhitungan dan penggunaan rumus, yang berujung pada jawaban yang salah. Hal ini berdampak negatif pada pemahaman konsep, motivasi belajar, dan kesiapan mereka menghadapi tantangan pendidikan atau dunia kerja. Untuk mengatasi kesulitan siswa dalam merumuskan masalah matematika, guru dapat meningkatkan pemahaman konsep, melatih berpikir kritis, menerapkan pembelajaran berbasis masalah, menggunakan alat bantu visual, memberikan pendampingan khusus, dan fokus pada pengembangan literasi matematika sejak dini.</td></tr>
<tr><td>1. Strengthen the connection between the identified issues (low mathematical literacy) and the specific research objectives of this study. Clearly state how the research will address these issues.

2. Highlight the gap in existing research more explicitly and explain how your study using AKM problems will fill this gap.

3. Ensure a logical progression of ideas. Start with the broader context of the importance of mathematical literacy, then discuss the current</td><td>This research has been adapted from existing issues (such as the low level of mathematical literacy from PISA and other empirical studies) with the research objective "to identify the characteristics of students' mathematical literacy. These characteristics include students' responses when solving AKM problems, encompassing difficulties and other unique aspects that indicate their mathematical literacy." With this objective, the study will identify students' difficulties in solving AKM problems, from which recommendations can be made to improve teaching methods, thereby enhancing mathematical literacy and even academic achievement in schools.</td></tr>
</table>

state in Indonesia, and finally introduce the AKM and its relevance to your research. 4. Clearly emphasize the novelty of using AKM problems compared to the more commonly used PISA problems. Explain why this approach offers a unique perspective. 5. 1. Discuss the potential implications of your research findings for educational practices and policies in Indonesia.	The research problem has been clearly and explicitly outlined in paragraph 2. The use of AKM aims to assess students' mathematical literacy (which includes components similar to PISA). Through this research, the characteristics and difficulties of students in solving problems will be identified. These findings will contribute to solutions for improving mathematical literacy. This research has been aligned with the importance of mathematical literacy, the issues surrounding mathematical literacy in Indonesia, and finally, a discussion on AKM and its relevance to my study. The novelty of using AKM is discussed in the final paragraph. This approach is noteworthy for two reasons: first, we use AKM to analyze mathematical literacy, a tool rarely employed by other researchers; second, this research not only uncovers the characteristics of mathematical literacy but also identifies student difficulties and offers recommendations. We added the potential implications of this research in the final paragraph. "*This research highlights the importance of an in-depth evaluation of students, revealing that while the AKM program is a good initiative, a comprehensive evaluation of student characteristics during AKM problem-solving is still lacking. Currently, AKM only provides numerical scores without further evaluation. A holistic evaluation is expected to offer a more comprehensive understanding of students' abilities*."
Expand on why phenomenology is particularly suitable for this study. Provide more details on how interpreting students' lived experiences will contribute to understanding mathematical literacy. Clarify the process of initial subject identification and the criteria used for selecting the first subjects. Provide more details on the mathematical literacy test instrument, such as the specific types of problems included and how they are designed to measure different aspects of mathematical literacy. Clarify the process and guidelines used for the think-aloud technique, including any specific instructions given to students. Explain the role of the researcher during the think-aloud sessions and interviews to ensure consistency and minimize bias. Elaborate on the coding process. Explain how codes were developed and applied to the data, including examples of specific codes used. Provide more details on how triangulation was	We added the following statement: "*Through an in-depth analysis of students' experiences, we can understand how they interact with AKM problems. This will reveal the level of students' mathematical literacy, as mathematical literacy is an integral part of how students think and act when facing problems*." We included the following in the methodology section (research subjects): "*The initial students were selected based on teachers' recommendations, focusing on those with strong cognitive abilities. Subsequent subjects were chosen using snowball sampling within one class until saturation was reached with five subjects*." We added this to the research instruments section: "*The research instruments were developed based on existing mathematical literacy indicators, aligning with PISA data, including communication, mathematization, representation, reasoning, strategy design, and the use of symbolic language*." We clarified the think-aloud process: "*In this research, the think-aloud process involved guiding students as they worked on the given*

applied to ensure data validity. Explain how data from different sources (tests, interviews, observations) were compared and contrasted.	*problems. Students were free to express their thoughts while working, and were occasionally asked questions. All observed behaviors were recorded by the researcher and then analyzed*." We added to the coding section: "*This coding was based on the subjects' responses; identical responses were given the same code, while different responses were assigned different codes. Dominant codes were then analyzed*." We included the following in the data triangulation section: "*Triangulation was conducted by comparing responses from tests, interviews, and observations. The data were compared narratively to determine if they confirmed each other or contradicted. If the data were consistent, they were considered valid; if not, they were deemed invalid*."
The study could be strengthened by incorporating a statistical analysis to determine the significance of the observed differences between subjects. For instance, analyzing whether the differences in responses (e.g., IM1 vs. IM3) lead to statistically significant variations in performance or accuracy would add rigor to the findings. Ensure that all figures are clearly labeled and referenced consistently in the text. This helps in maintaining the flow of the report and aids readers in following the analysis. While the comparison between different strategies is insightful, expanding this analysis to include more subjects and varying levels of difficulty in mathematical problems could provide a broader understanding of the effectiveness of different strategies.	This is a qualitative study analyzed in-depth based on phenomena rather than quantitative data. Our clear objective is to identify the characteristics of mathematical literacy and the difficulties students face when solving AKM problems, which cannot be analyzed through statistical methods. We have ensured that the figure numbers and images are correctly aligned. Our analysis is thorough; however, expanding the findings by adding more subjects would require conducting new research at a different school, which is not a feasible solution. The findings we present are as they stand, and any limitations in the scope of the research will serve as a boundary for this study. This, in turn, will inform recommendations for future research.
Dividing the discussion into clear sub-sections (e.g., Problem Identification, Data Recording, Strategy Development, Implementation, and Interpretation) would enhance readability and coherence. While the discussion mentions the advantages and disadvantages of different strategies (e.g., IM1 and IM3), it could provide a more balanced evaluation. For instance, elaborate on the potential downsides of direct calculation on the answer sheet (IM1) beyond just efficiency, such as the increased risk of errors. Encourage critical reflection on the findings by discussing any limitations or potential biases in the study. This could include considerations such as the sample size, the types of mathematical problems used, or the subjective nature of interview responses. Offer more concrete recommendations for educators based on the findings. For example, suggest specific classroom activities or teaching strategies to improve students' problem identification skills or their ability	We divided the discussion into sections, similar to the results, to ensure a more focused analysis. We have adjusted the discussion and balanced the coverage of each stage of mathematical literacy. For instance, in the interpretation process: "*From IN2's response, subjects are more likely to rely on their conceptual understanding and the context of the problem to conclude rather than sticking to the calculation results. Strong confidence in their ability to understand and solve problems prevents students from recalculating before concluding (Bénabou & Tirole, 2002). However, this also reveals a potential risk: the lack of verification that may be required in specific contexts to ensure the correctness of answers. Executive skills such as time management also influence the lack of verification in the interpretation process; the longer the time spent on the previous process, the less time is spent at this stage (Broyden, 1965)*." And in the implementation process:

to transform contextual data into mathematical language. Strengthen the connection between the research findings and their implications for students' everyday lives. Discuss how improved mathematical literacy can benefit students beyond the classroom, in areas such as financial literacy, critical thinking, and decision-making. Consider discussing the implications of the findings for educational policy and curriculum design. Highlight how the insights gained from the research could inform policy decisions to enhance mathematical literacy education at a broader level.	"*IM1 performs calculations directly on the answer sheet, while IM3 uses a separate sheet (scribble sheet) for calculations before writing the answer on the answer sheet. However, solving problems by writing directly on the answer sheet can also increase the potential for errors, as there is no checking before the final answer is recorded*." We have added recommendations for educators: "*It is, therefore, important for educators to ensure a solid understanding from the start to improve the chances of success in the later stages*." We also included implications of mathematical literacy in other fields, placed after the conclusion to clearly delineate the discussion: "*Improving mathematical literacy has significant real-world benefits. It enhances financial literacy by enabling students to manage budgets, compare prices, and save effectively. It strengthens critical thinking skills, allowing for better analysis and evaluation of information, which aids in making informed decisions. Additionally, it supports practical decision-making by helping students systematically analyze data and solve problems. Overall, strong mathematical literacy equips students with essential skills for financial management, critical analysis, and practical problem-solving, preparing them for both personal and professional challenges*."
The conclusion would benefit from a more structured presentation. Breaking it into sub-sections (e.g., Summary of Findings, Implications, Risks, and Recommendations) While the conclusion notes that direct approaches may be more efficient, it could provide a more balanced evaluation by discussing the potential downsides of this approach in more detail. For instance, it could elaborate on the circumstances where a separate worksheet might be more advantageous. Emphasize the contribution of this study to the field of mathematical literacy. Discuss how the findings add to existing knowledge and what new insights have been gained.	We have separated the conclusions, implications and recommendations. We have also emphasized the contribution of this study to the field of mathematical literacy in the recommendations section as well as the implications section.

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BUKTI KONFIRMASI SUBMIT REVISI PERTAMA, RESPON KEPADA REVIEWER, DAN ARTIKEL YANG DIRESUBMIT

(09 agustus 2024)

Konfirmasi Submit pertama

Editor Decision

Decision	Accept Submission 2024-09-22
Notify Editor	Editor/Author Email Record 2024-09-22
Editor Version	5729-27049-1-ED.DOCX 2024-07-31 5729-27049-2-ED.PDF 2024-09-22
Author Version	5729-27212-1-ED.DOCX 2024-08-09 DELETE 5729-27212-2-ED.DOCX 2024-08-09 DELETE 5729-27212-3-ED.DOCX 2024-09-11 DELETE
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Respons reviewer untuk revisi kembali

Widia Yunita <jurnalpendidikanalishlah@gmail.com> Thu, Aug 8, 10:06 AM

to Astri, me

Lukman Lukman hakim muhaimin:

We have reached a decision regarding your submission to AL-ISHLAH: Jurnal Pendidikan, "Analyzing Middle School Students' Mathematical Literacy Characteristics in Solving AKM Problems: What Difficulties Do They Face?".

Our decision is: Revisions Required

1. Silahkan download file Reviewer di akun penulis
2. Mohon revisi sesuai saran
3. Upload file revisi sebelum 8 September 2024. lengkapi kembali data

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Artikel revisi pertama

Exploring Middle School Students' Challenges in Mathematical Literacy: A Study on AKM Problem-Solving

2

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ABSTRACT

Mathematical literacy is the ability to formulate, apply, and interpret everyday problems. In education, it is essential for problem-solving, decision-making, understanding concepts, job readiness, critical thinking, and community participation, preparing students to face life's challenges and the future. The Minimum Competency Assessment (AKM) program in Indonesia is designed to evaluate these essential skills, similar to the PISA framework. Assessing mathematical literacy through the AKM ensures that students meet basic competency standards, helping to improve overall educational quality and better preparing students for global competition. This research reveals the characteristics of students' mathematical literacy when solving AKM problems. The study was conducted at a junior high school in Surakarta, Indonesia. The research stages included giving AKM problems, observing students' problem-solving processes through think-aloud methods, conducting interviews for confirmation, reducing data, coding data, analyzing data, and drawing conclusions. The data used included students' answers, observation sheets, and interview transcripts. When formulating problems, students often struggle to accurately understand the issues at hand. This leads to incomplete data during the problem-solving process, resulting in calculation errors or mistakes in applying formulas. These errors create a domino effect, leading to incorrect answers. Students' difficulties in formulating mathematical problems can potentially cause calculation errors and improper use of formulas, ultimately leading to incorrect solutions. This negatively impacts their conceptual understanding, learning motivation, and readiness to face educational challenges or enter the workforce. To address these difficulties, teachers can enhance students' conceptual understanding, promote critical thinking, implement problem-based learning, use visual aids, provide targeted support, and focus on developing mathematical literacy from an early age.

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6. INTRODUCTION

In the era of globalization and rapid technological advancement, comprehending and utilizing information has become one of the critical skills required to address the challenges of the 21st century (Griffin, McGaw, & Care, 2012; Scott, 2015; Tan, 2021). Beyond merely understanding numbers and formulas, mathematical literacy encompasses the ability to apply mathematical concepts in everyday life, solve data-based problems, and make informed decisions based on mathematical analysis, thereby necessitating critical and logical thinking skills when addressing problems (Muhaimin & Kholid, 2023; OECD, 2021; Stacey, 2015).. Therefore, this skill is crucial for students to master and should be included in the mathematics curriculum. Students with good mathematical literacy tend to be more critical and confident in solving complex mathematical problems (Nisa & Arliani, 2023). This underscores the importance of mathematical literacy in everyday life and education for students.

However, the reality is that mathematical literacy among students in Indonesia still needs to improve. A survey conducted by the Organization for Economic Co-operation and Development (OECD) through the Programme for International Student Assessment (PISA) in 2018 revealed that Indonesia ranked 71st out of 77 in reading literacy, mathematical literacy, and scientific literacy, with a mathematical literacy score of 379 (Schleicher, 2018). Numerous studies have shown that Indonesian students' mathematical literacy still needs to improve. Research by Jailani et al. (2020) revealed that one of the causes of low mathematical literacy among junior high school students is difficulty identifying contextual problems. Previous research by Dewantara et al. (2015) showed similar findings, indicating that students struggle to apply mathematical formulas in solving mathematical problems. Another finding by Fauzi & Chano (2022) indicated that weak mathematical literacy also occurs among elementary school students who need help to solve contextual problems and can only apply formulas limited to algorithms already taught and listed in textbooks.

The low mathematical literacy among Indonesian students calls for solutions from various sectors, particularly education. Understanding and improving students' mathematical literacy is not only the responsibility of educators but also a national priority that requires serious attention (Genc & Erbas, 2019; Umbara & Suryadi, 2019). The Indonesian government has made efforts to provide support by implementing the Minimum Competency Assessment (AKM) as a replacement for the National Examination (UN) since 2020 (Ministry of Education, 2020; Pusmendik, 2022). The AKM is an assessment program designed to determine students' basic abilities and improve the quality of education in Indonesia, thus requiring competencies in language and mathematical literacy to measure basic abilities (Handayani, Perdana, & Ukhlumudin, 2021). Based on the AKM concept, its goal is to understand students' potential and abilities and improve the quality of education in Indonesia (Ministry of Education, 2020; Pusmendik, 2022). This aligns with Cahyanovianty (2021) view that the purpose of AKM is to identify and assess students' language and mathematical literacy competencies. Therefore, the AKM is considered a solution to the low mathematical literacy of Indonesian students.

Despite this solution, the AKM only evaluates the outcome based on the obtained score, whether good or bad, without an in-depth investigation of students' problem-solving abilities (Kemendikbudristek, 2022; Rohmah, Sutama, Hidayati, Fauziati, & Rahmawati, 2022). If the result is good, does the student have good mathematical literacy, or were they merely lucky? If wrong, what caused the difficulty in solving the problem? The AKM needs to provide more specific insights, thus necessitating this research to reveal the detailed characteristics of students' mathematical literacy in solving AKM problems. Therefore, this study aims to identify the characteristics of students' mathematical literacy. These characteristics are students' responses when solving AKM problems, including difficulties and other unique aspects that indicate their mathematical literacy.

This research presents another perspective in the realm of existing mathematical literacy studies. Although many research works have explored aspects of mathematical literacy, most rely on PISA problems as their primary instrument (Dewantara et al., 2015; Hayati, 2019; Khoirudin, Styawati, & Nursyahida, 2017; Ozkale & Ozdemir Erdogan, 2022; Thien, 2016; Wijaya, 2016). However, they have yet to explore mathematical literacy using the AKM problem approach. This indicates a new area of exploration in mathematical literacy. While PISA is widely recognized and used in global research

(OECD, 2023), AKM problems may offer a different and more contextual perspective in understanding how students comprehend and use mathematics daily. Therefore, delving deeper into mathematical literacy through the AKM lens can provide additional insights and enrich academic discussions. This research highlights the importance of an in-depth evaluation of students, revealing that while the AKM program is a good initiative, a comprehensive evaluation of student characteristics during AKM problem-solving is still lacking. Currently, AKM only provides numerical scores without further evaluation. A holistic evaluation is expected to offer a more comprehensive understanding of students' abilities.

7. METHODS

The researcher employs qualitative research with a phenomenological design to deeply analyze mathematical literacy. Creswell (2015) emphasizes that phenomenology focuses on interpreting the meaning of individuals' experiences within the context of their life worlds. Therefore, through this study, the researcher aims to provide a deeper insight into how mathematical literacy is understood and experienced by students in the classroom and how it can be applied, specifically to uncover the characteristics of students' mathematical literacy by engaging and understanding their individual experiences. Through an in-depth analysis of students' experiences, we can understand how they interact with AKM problems. This will reveal the level of students' mathematical literacy, as mathematical literacy is an integral part of how students think and act when facing problems.

The research subjects selected are eighth-grade junior high school students considered relevant and unique in the context of the mathematical literacy being studied. At around 15, junior high school corresponds to the age group assessed in the PISA evaluation globally (OECD, 2021). The selected junior high school in Surakarta is recognized for its excellent reputation. Thus, the selection of subjects from this school is expected to represent students' mathematical literacy at the junior high school level.

The subject selection technique uses snowball sampling until a saturation point is reached (Reserved, Url, & Uri, 2020). In snowball sampling, the researcher starts by identifying one or more individuals who have relevant information or experience related to the research objectives. The researcher also seeks recommendations from teachers when selecting subjects, which is expected to provide deeper or different information. This approach allows the researcher to access a group of subjects that might be difficult to reach through conventional subject selection techniques. In this research context, the researcher decided to select five students as research subjects based on initial information and recommendations from initial students. The initial students were selected based on teachers' recommendations, focusing on those with strong cognitive abilities. Subsequent subjects were chosen using snowball sampling within one class until saturation was reached with five subjects. The selection of these five students is based on data saturation and the consideration of the diversity of their experiences and backgrounds in mathematics learning, thus expected to provide a holistic and in-depth picture of mathematical literacy. The snowball sampling technique employed by the researcher is clearly outlined in Table 1.

Table 1. Snowball sampling technique

Research Subjects	Mathematical literacy process		
	Formulation	Implementation	Interpretation
1	F1	IM1	IN1
2	F1	IM1	IN2
3	F3	IM3	IN1
4	F1	IM3	IN2
5	F1	IM1	IN2

Code description:

F1	:	First subject response in the formulation process
F3	:	Third subject's response to the formulation process
IM1	:	First subject's response to the implementation process
IM4	:	Fourth subject's response to the implementation process

IN1 : First subject response in the formulation process
IN2 : Second subject's response to the formulation process

Table 1 shows the codes of the subjects' responses. Identical codes between subjects indicate a similarity in responses among the subjects. These response codes will be discussed in-depth in the findings and discussion section. This coding was based on the subjects' responses; identical responses were given the same code, while different responses were assigned different codes. Dominant codes were then analyzed.

In this study, the researcher acts as the primary instrument in data collection and utilizes various tools to obtain more comprehensive information regarding students' mathematical literacy. These instruments include a mathematical literacy test instrument and non-test instruments such as guidelines for conducting in-depth interviews and special sheets for observations during the research process. The test used refers to AKM problems focused on the algebra domain. More specifically, the problems cover the subdomains of ratio and percentage, which are essential components of mathematical literacy at the junior high school level. The research instruments were developed based on existing mathematical literacy indicators, aligning with PISA data, including communication, mathematization, representation, reasoning, strategy design, and the use of symbolic language. These problems have been revised to ensure they are genuinely relevant to the research objectives and can accurately measure students' competencies. The test instrument is depicted in Figure 1.

Question translation:
Angelia needs three different clothes models for her holiday; she has an IDR of 125,000.00. There are several clothing models from Kroger, Nick Jr., and Walgreens online stores. These shops provide five types of vouchers that can be used. However, vouchers have conditions, namely that each voucher can only be used for one transaction. So which model of clothes should Angelina choose? Explain!

Figure 1. Mathematical literacy test instrument

The researcher employs the think-aloud technique in data collection to obtain comprehensive and in-depth research data from students. According to Macias et al. (2018), think-aloud is a method of data collection that involves verbalizing everything the research subjects are thinking about concerning the test or problem they are working on during the process. In this research, the think-aloud process involved guiding students as they worked on the given problems. Students were free to express their thoughts while working, and were occasionally asked questions. All observed behaviors were recorded by the researcher and then analyzed. This study observes and records various responses from students during the problem-solving process and conducts interviews to confirm these responses. Therefore, the researcher uses tests, interviews, and observations during the think-aloud process.

The validity of the data in this study hinges on the snowball sampling technique, which uses five research subjects, applying source triangulation to test the validity of the data obtained. This involves comparing data collected from all five subjects (Creswell, 2015). Triangulation was conducted by comparing responses from tests, interviews, and observations. The data were compared narratively to determine if they confirmed each other or contradicted. If the data were consistent, they were considered valid; if not, they were deemed invalid. The collected data is then compiled for further processing. Once the data is gathered, the researcher enters the data reduction phase. In this phase, irrelevant or redundant data is filtered out, while vital information is highlighted. This reduction focuses the analysis on the most significant data, eliminating information that might be unimportant or obscure the interpretation. After the reduction, the following process is coding, then presenting the data in a more systematic and easily understandable format. At this stage, the reduced data is organized into tables, charts, or narratives, making it easier for the researcher to identify patterns, relationships, or trends within the data. This presentation is crucial for analyzing the data more effectively and efficiently. Finally, after completing all the above stages, the researcher proceeds to the conclusion-drawing phase.

8. FINDINGS

To determine various subject responses, researchers conducted an analysis based on the mathematical literacy process, formulation, implementation and interpretation. This mathematical literacy process is important to understand how subjects respond, process and understand the mathematical concepts proposed in mathematical problems (AKM). In the formulation stage, researchers observe how subjects deconstruct and understand a given problem, as well as how they formulate strategies to solve it. Next, in the implementation stage, the researcher evaluates how the subject applies the strategy they have formulated to find a solution to the problem. This stage is important because it shows the subject's ability to apply the mathematical concepts and techniques they have mastered. Finally, at the interpretation stage, researchers examine how subjects understand and analyze the results they obtain, how they explain or convey their ideas to others, and whether these results make sense. Through these three stages, researchers can get a holistic picture of the subject's mathematical literacy abilities and how they construct the given problem.

8.1. Formulation process

Based on Table 1, code F1 is the highest response shown based on the five research subjects, the response of subject 1 during the formulation process. This formulation process begins when the subject is given a problem (AKM), in this process the subject can be seen identifying the problem by writing down the question given (Figure 2). Apart from that, it appears that the subject repeatedly read the questions given up to three times, this condition coincided with scribbling on the question sheet.

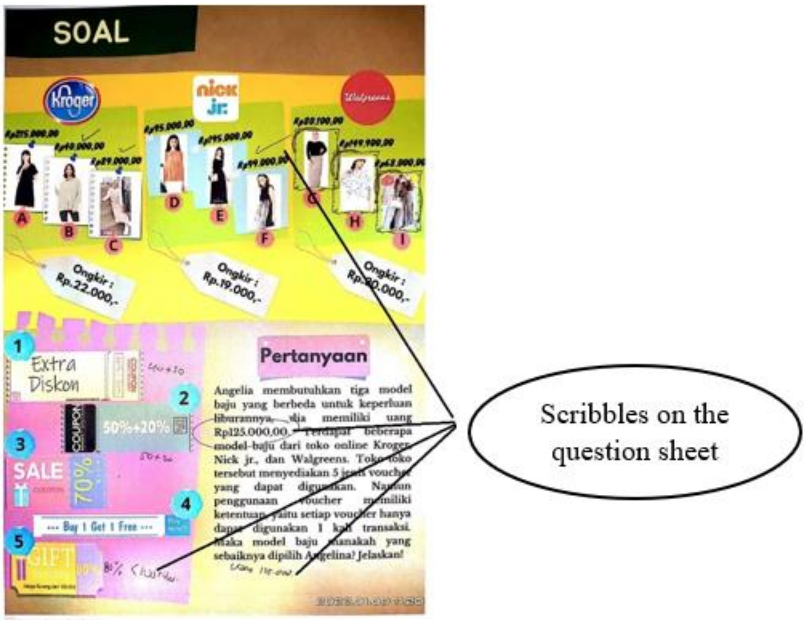


Figure 2. Subject question sheet (FI)

In Figure 2, the subject can be seen scribbling certain parts of the question, the price, discount and initial deposit. based on these conditions, researchers confirmed through interviews.

Researcher (R) : *why did you scribble on your question sheet?*
Subject (S) : *to note important data to make it easier for me to understand the problem*
R : *why did you read the questions several times?*
S : *because I have difficulty understanding the questions*

The interview text highlights the importance of the problem identification strategy carried out by the subject. By scribbling or marking on the question sheet, the subject seems to be giving a visual clue, which makes it easier to recognize key elements or important information in the question. It also helps them to separate relevant information from irrelevant, thereby focusing their attention on important aspects of the problem at hand. In addition, reading the questions repeatedly provides an opportunity for the subject to understand more deeply the nuances and context of the problem. Each repeated reading allows subjects to explore the question from a different perspective, identify potential obstacles, and sharpen their understanding of what the question is actually asking.

When the problem identification process is complete, the next response shown by the subject is to write down the data or information. This is done by the subject to ensure that all important information has been obtained sufficiently before they start working on the questions. By writing data or information explicitly on the answer sheet, the subject makes it easier for him to refer back to the information when needed, without having to go back to check the original question. Based on Figure 3 that the subject wrote the data or information about the question directly on the answer sheet.

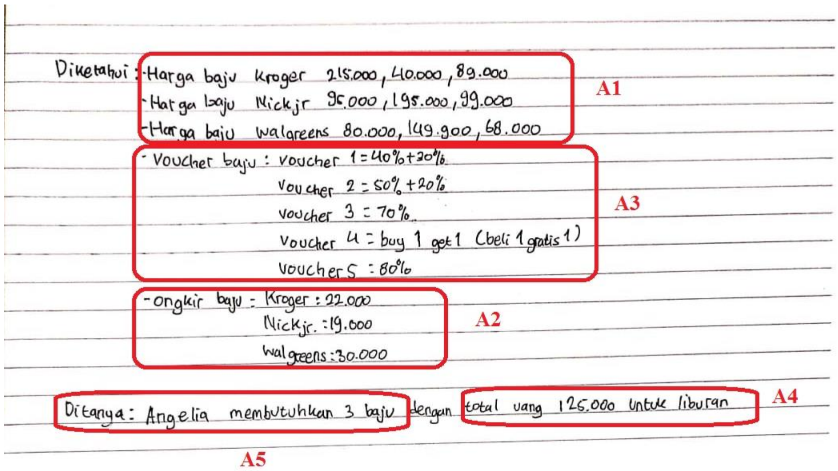


Figure 3. Subject answer sheet (F1) in the data writing process

Figure 3 shows that the data written consists of known data and questionable data. The known data is the price of clothes in each shop (A1), postage prices (A2), and clothes vouchers (A3). Then the data asked is three clothes that must be chosen with the available money (A4). These data are written directly by the subject on the answer sheet. This condition was confirmed by researchers.

R : *Why did you write the question information directly on your answer sheet?*

S : *To make it easier for me without having to look back at the information on the questions or other sheets.*

The interview indicated that writing information on the question sheet made it easier for the subject to solve the problem without having to reopen the question or another sheet, this was also to consider the efficiency level in solving the problem. By minimizing the need to return to the source, subjects can move more quickly through the problem-solving steps, increasing their chances of reaching the correct solution in less time. Thus, the interviews underscore the importance of proactive strategies in problem-solving and how simple steps such as writing down information can significantly impact the final outcome and efficiency of the process.

After writing down the data or information about the problem, it can be seen that the subject not only passively receives the information but is also active in processing it to reach a solution. The selection of a formula as the next step shows the subject's understanding of the mathematical concepts involved in the problem. By explicitly writing the formula, the subject provides a framework for himself, ensuring that the next steps are based on a sound mathematical approach. Figure 4, which displays the subject's answer, shows details of the formula used, as well as how the subject applies it to the data that was recorded previously.

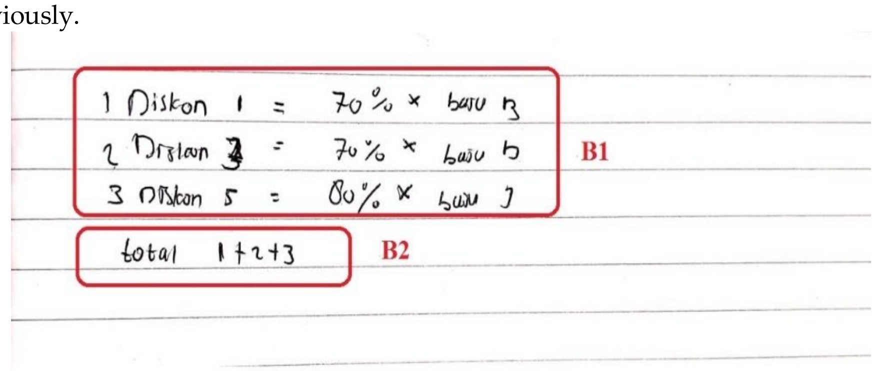


Figure 4. Subject answer sheet (F1) in the strategy development process

The formula written in Figure 4 shows the discount calculation formula (B1) and total discount (B2). The writing of this formula is not without reason, so confirmation is needed for this condition through interviews with the subject.

R : *Why did you write that formula?*

S : *To plan strategies for solving problems*

The subject's response to writing this formula was based on designing how to solve the problem. Subjects seemed aware that solving mathematical problems often requires a structured approach. By writing the formula first, the subject creates a frame of reference to help them carry out the following steps more systematically and organized.

The process of writing problem data and formulas by the subjects above (Figure 3 and Figure 4) reflects the transformation process of a concrete situation or problem that exists in reality into a more abstract mathematical representation. It represents an attempt to understand and define a complex problem from everyday life into mathematical language, which allows for more systematic analysis and solutions.

Another finding in the subject with code F3, in the formulation process, showed a response that the subject did not identify the questions by scribbling on the question sheet or reading the questions repeatedly. On the question sheet, there is also no complete writing of the data or question information (Figure 5), this is different from the F1 code, which identifies by marking information on the question sheet and reading it repeatedly, besides also writing all the data or question information on the answer sheet.

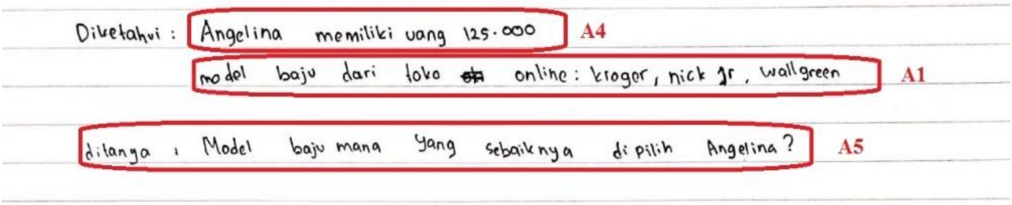


Figure 5. Subject answer sheet (F3)

Code F3 only writes the clothing model from each shop (A1), the initial money (A4), and the data requested (A5). These data are also incomplete in terms of completeness components. However, F3 showed the same response as F1 when designing a problem solving strategy, namely writing down the formula used to solve mathematical problems (AKM).

8.2. Implementation Process

This implementation is a concrete manifestation of the ideas and plans processed and formulated in the formulation process, providing an accurate picture of how these plans are implemented in practice. Based on Table 1, we can observe that the implementation process with IM1 code dominates, even more than with other possible codes. Response code IM1, the subject begins the step by rewriting the question data, but this data is more specific based on what is required in the formula written in the formulation process. The subject answer sheet is clearly shown in Figure 6.

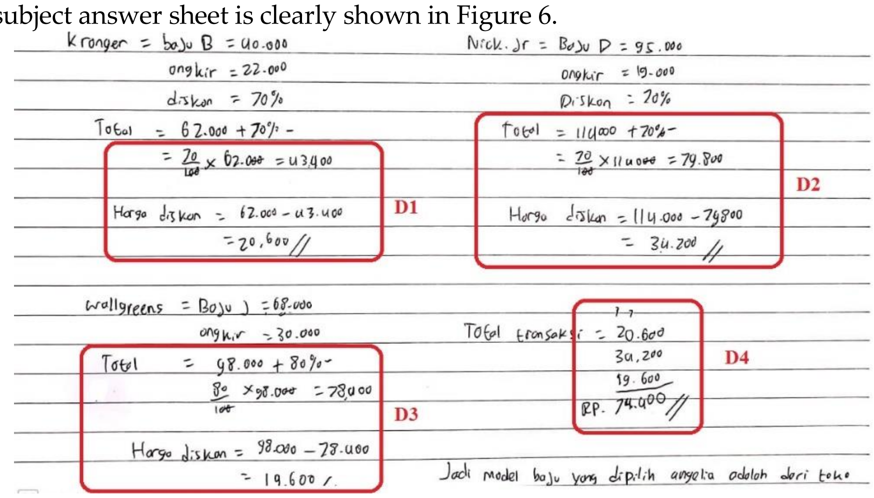


Figure 6. Subject answer sheet (IM1) in the implementation process

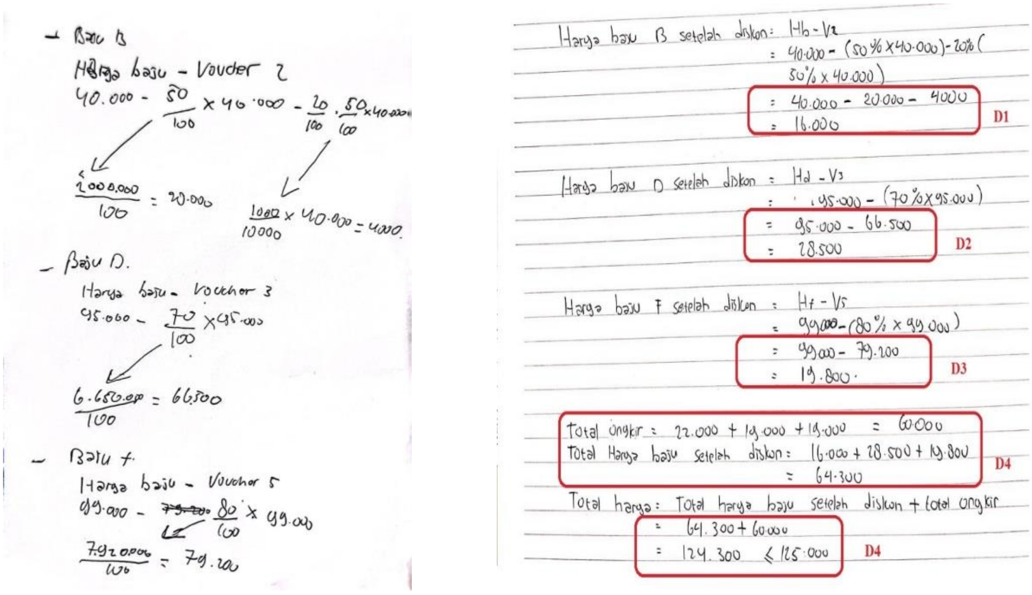
Figure 6 illustrates that the subject performs computations in the form of calculations on his answer sheet. From what we can see in the image, the subject carefully researches the price of each shirt in various stores after considering the discounts given. The goal is clear, the subject wants to ensure that the total cost of the clothes he chooses does not exceed the initial amount of money. The calculation details, as shown by codes D1, D2, and D3, show the price search process after discounts, while code D4 represents the step of adding up all these prices. What is interesting about this observation is the approach the subject took in executing his calculations. Instead of using a scratch sheet as a starting place for carrying out initial calculations or sketches, the subject confidently immediately wrote the results of his calculations on the answer sheet. This may indicate that the subject has high confidence in his mathematical abilities or that the subject prefers to rely on his memory. Through interviews, researchers confirmed this.

R : *Why do you do calculations directly on the answer sheet?*

S : *I am used to doing calculations like this so that problem solving is done quickly*

From the interview it is clear that the subject performs calculations directly on the answer sheet so that it is fast, apart from that, with high self-confidence and a deep understanding of the material, the subject feels he is more efficient and effective in applying the concepts that the subject has mastered. This self-confidence is not without reason, the subject stated that through various training and experiences in the past that strengthened his ability to face similar problems. By practicing calculations directly on the answer sheet, the subject eliminates the need for intermediate steps or transitions, which might slow down the thought process or even be a source of confusion. This allows the subject to fully focus on the question and answer it at his or her desired pace without being distracted.

In contrast to code IM1, other findings in code IM3 reflect a more careful and systematic strategy. Subject 3 and subject 4, when using this approach, seemed to appreciate the importance of a draft or initial draft before putting their answers on the answer sheet. This may indicate that they are more likely to minimize the risk of error or that they need to visualize their calculations more clearly before feeling confident in their final answer. The scribble sheets used by subjects 3 and 4 are necessary for them to organize their thoughts, verify, and ensure that each calculation step is correct before writing it on the answer sheet. The subject's scratch sheet and answer sheet are clearly shown in Figure 7.



(a) (b)

Figure 7. Scribble sheet (a) and answer sheet (b) subject to code IM3

Figure 7 clearly shows the voucher discount calculations carried out by the subject on the scratch sheet. These scratch sheets allow subjects to easily modify, correct, or repeat calculations without crossing out or changing the official answer sheet. As the interview progressed, this subject said, "This is done as an effort to increase calculation accuracy and minimize errors." This method may take longer than the direct method on IM1. However, for the subject, this additional time, the benefits outweigh the investment in terms of accuracy and certainty gained.

8.3. Interpretation Process

After the formulation and implementation process, the following process is interpretation. In this process, researchers see how the subject responds when the answers obtained in the computational calculation process can be reprocessed to become a conclusion to answer the question in the problem. This process produces various response codes from the five subjects. Of these two codes, IN2 is the majority of the IN1 codes. Both codes give rise to the same response, namely using their reasoning abilities to conclude the calculations obtained, but the two codes have different ways of deducing the answer.

In the initial interpretation process, subjects with response code IN2 showed the process of inferring answers. The subject not only carried out a simple evaluation of the results of his calculations but also carried out in-depth reflection to ensure that the resulting answer had a context appropriate to the question given. The subject carefully compares every detail of the answer with the information provided in the question, assessing the relevance and validity of the answer based on the data and parameters provided. From this process, the subject looks back at the answers he received and then at the data in the question. The results of this interpretation are presented in Figure 8.

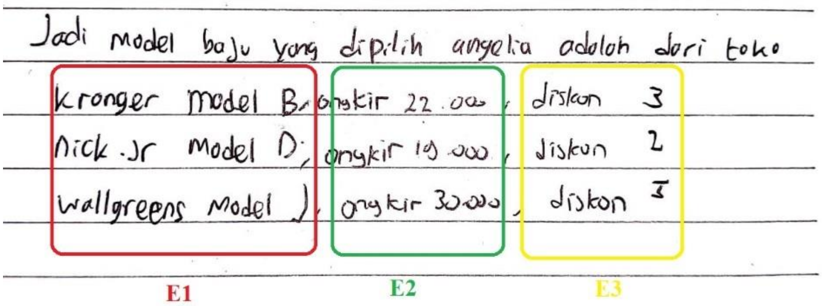


Figure 8. Subject answer sheet (IN2) in the interpretation process

Based on Figure 8, subjects can write down their answer conclusions, starting from the clothes chosen (E1), shipping costs (E2), and discount vouchers chosen (E3), even though they do not do the calculations again. Through interviews, researchers confirmed this condition.

R : *Why don't you check the calculations before concluding the answer?*

S : *To shorten the time, because the processing time is short, I do not have enough time to do the calculations again*

The interview quoted above indicates that poor time management will result in less-than-optimal work steps being taken. In contrast, as seen in IN1's response, efficient time management allows subjects to allocate sufficient time to each aspect of the problem. In this case, subjects with an IN1 response can not only solve the problem, but also have the freedom to review their calculations before deducing an answer.

9. DISCUSSION

9.1. Formulation process

In formulating initial findings, the subject identifies the problem by Muhaimin & Kholid (2023) revealed that mathematical literacy is the ability to solve problems related to everyday problems so that in solving mathematical problems, the first step is to identify the problem first. This opinion is also supported by Laamena & Laurens (2021) that mathematical literacy's first ability is analyzing or identifying problems. Identify problems that arise by scribbling on the question sheet and rereading the questions repeatedly. This scribble is the subject's attempt to visualize or map information that is considered necessary (Venkat, 2010), making it easier for the subject to solve the problem so that they do not see the problem continuously during the process of solving the problem. Likewise, reading the questions repeatedly helps the subject understand the problems in the questions. Various findings from other research also say that students often read questions repeatedly to understand the problem (Anwar & Rahmawati, 2017; Robinson & Kevoe-Feldman, 2010; Therrien & Hughes, 2008). Another finding (F3) that we understood was that the subject needed to recognize issues the way F1 did (did not mark or scribble on the response sheet and did not repeatedly read the questions). According to Schoenfeld (1988), students with good understanding only need to read the problem once, and they will understand the meaning of the problem in the questions.

The next ability that emerges is writing down the data obtained; this data is the known data, and the data asked about in the question. In this case, two different responses are writing information or data thoroughly and systematically (F1) and only writing some information or data on the answer sheet (F3). Remember that mathematical literacy is the ability to solve everyday problems (Ministry of Education, 2020; OECD, 2019), so the forms of questions given are usually related to everyday life (Gatabi, Stacey, & Gooya, 2012). Therefore, we need to understand and record relevant data well. Sometimes, the data presented in a problem may contain additional information not needed to solve the problem (Najafabadi et al., 2015). Therefore, the ability to sort and focus on critical data is essential. In addition, it is important to record data clearly and systematically (English, 2015). This will help us in the thinking process and help us solve problems later. Sometimes, errors in recording data can result in errors in completion. According to Sundayana & Parani (2023), The student's initial error in solving the problem was due to incomplete data or information obtained based on the problem, and this condition will affect the subsequent process where incomplete data may make the written formula and solution strategy incorrect and result in incorrect answers being obtained. So, accuracy in this process is essential. In mathematical literacy, this ability functions to solve problems and is also valuable for students' daily lives (Genc & Erbas, 2019). For example, when we shop, make a budget, or even when talking about statistics and data in real life. Identifying, recording, and sorting data correctly will help us make more precise decisions based on accurate information.

The response to the formulation process we found next was the ability to develop problem-solving strategies; all codes (F1, F3) in the formulation process showed this response. Developing this strategy takes the form of formulating a formula that will be used to solve the problem faced and planning the steps that must be taken to solve the problem. This process requires critical and analytical thinking (Bali, Capano, & Ramesh, 2019). The ability to develop problem-solving strategies is an essential aspect of mathematical literacy. This is because mathematical literacy is the ability to carry out simple mathematical operations and the ability to analyze, interpret, and use mathematics in various real situations (Ministry of Education, 2020; OECD, 2019). With a clear strategy, one may find it easier to find efficient and effective solutions (Basadur, 2004). Many problems, especially in mathematics, require specific problem-solving strategies (Gupta & Mishra, 2021; Muhaimin, Dasar, & Kusumah, 2023). Therefore, having the right strategy will speed up the problem-solving process and increase the accuracy of answers. However, we found the subject's error in determining the formula to solve the problem. Of course, the solution strategy will also be inappropriate in this condition. According to Cho & Nagle (2017), the need for an in-depth understanding of basic mathematical concepts makes students choose the wrong formula. Therefore, the results may be different from what was expected. This statement is in line with the findings we obtained, which stated that the subjects needed to understand the material about discounts well, which resulted in errors in formulating strategies, which impacted the calculation results.

In writing down data and developing strategies when solving problems, we also found that students carried out data transformations, such as changing contextual data or information into mathematical language data. Mathematical problems designed to test or explore the depth of students' mathematical literacy must have several elements or components, one of which is that the problem must have a specific context (Almarashdi & Jarrah, 2022; Stacey, 2011). This context provides background or story to the problem and serves as a source of information that students need to find a solution. AKM is a mathematical problem with a context within the problem (Cahyani & Susanah, 2022; Ministry of Education, 2020; Muhaimin et al., 2023). This requires students' ability to change data or information based on the problem presented into mathematical form. Additionally, Muhaimin & Kholid (2023) stated that although conceptual understanding in recognizing problem patterns, identifying relationships between existing variables, and understanding basic mathematical concepts are essential, all of this will be worthwhile if students can transform information into relevant mathematical language. This transformation ability is essential for students to apply their knowledge in solving problems in everyday life.

9.2. *Implementation process*

The following process in mathematical literacy after the formulation process is implementation. In this process, all codes show the same response, implementing the planned problem-solving strategy and, in this case, carrying out computational calculations. This stage is where basic mathematical skills, such as arithmetic, algebra, and geometry, are often applied (Kholid et al., 2022). In PISA, this stage also involves skills in using mathematical tools, such as calculators or special software, if necessary (OECD, 2019, 2021). However, for researchers, the questions used simple numbers and wanted to see how students apply their numeracy skills in depth, so using mathematical tools is not permitted in this process. The difference in response we found between IM1 and IM3 lies in how they calculate. IM1 is doing calculations directly on the answer sheet, and IM3 is not doing calculations directly on the answer sheet but instead doing calculations on another sheet (scribble sheet) before writing the answer on the answer sheet. However, in solving by writing directly on the answer sheet, there is also the potential for increasing errors. Because there is no checking before it is written on the answer sheet in the final form. Our findings in Table 1 show that most responses were in IM1. According to Foshay & Kirkley (1998), working directly on the answer sheet is more efficient in solving problems. PISA also states that the time given to work on questions is short (OECD, 2019, 2021). In this case, it confirms our findings that subjects perform calculations directly on the answer sheet to be efficient. It is important to note that both IM1 and IM3 codes have advantages and disadvantages. While IM1 may be faster and more efficient for subjects with high confidence and a deep understanding of the material, IM3 may be better suited for those needing additional clarification or who tend to make mistakes when rushed. In an educational context, these findings emphasize the importance of introducing various calculation strategies to students. It also underscores the need to provide flexibility in learning approaches, recognizing that each student is unique in processing information and solving problems.

The discussion on the formulation process mentioned that mistakes made at the beginning of problem-solving will impact the process afterward. Imagine if the foundation of a building is not solid or inappropriate, the building is at risk of collapsing when faced with pressure. As with solving mathematical problems, if the basic understanding or strategy used is not appropriate at the formulation stage, then in subsequent stages, the chance of getting the correct answer becomes smaller (Schafer, M., & Brown, 2006). This condition is confirmed in the implementation process in Figure 6 and Figure 7. This visualization shows how initial errors that appear at the formulation stage affect the results at the implementation stage. The findings we obtained are, in fact, in line with the research results by Huu Tong & Phu Loc (2017) and Astutik & Purwasih (2023), which also shows that the majority of incorrect answers obtained were caused by previous steps needing to be corrected. It is, therefore, important for educators to ensure solid understanding from the start to have a greater chance of success in the later stages.

9.3. *Interpretation process*

The findings of this research show the importance of the interpretation stage in the mathematical literacy process. This interpretation process involves not only understanding mathematical concepts but also reasoning skills that enable the subject to reflect on the results of his work and draw appropriate conclusions (Machaba, 2018). Our findings show that the response code in this process shows students' reasoning abilities in concluding answers. This is seen in how subjects with response code IN2 process their answers. From IN2's response, subjects are more likely to rely on their conceptual understanding and the context of the problem to conclude rather than sticking to the calculation results. Strong confidence in their ability to understand and solve problems prevents students from recalculating before concluding (Bénabou & Tirole, 2002). However, this also reveals a potential risk: the lack of verification that may be required in specific contexts to ensure the correctness of answers. Executive skills such as time management also influence the lack of verification in the interpretation process; the longer the time spent on the previous process, the less time is spent at this stage (Broyden, 1965). Then, errors in the formulation process impact the implementation process and, finally, the interpretation process. Interestingly, despite errors, the subjects seemed confident in their understanding even though they were wrong. This error is not surprising because many students sometimes misunderstand certain concepts without realizing it (diSessa, 2002). This phenomenon is a "cognitive error," in which a person believes something to be true even though the facts differ (Miller, Holcombe, & Latham, 2020). In the learning context, this phenomenon underlines the importance of constructive feedback and double-checking in the learning process. This ensures that students' understanding is not only deep but also accurate. The existence of cognitive bias reminds educators to always emphasize to students the importance of reflection, re-examination, and the willingness to accept and process criticism or correction.

10. CONCLUSION

This study reveals the diverse responses of subjects in solving contextual mathematical problems (AKM) through mathematical literacy, which includes formulation, implementation, and interpretation. In the formulation stage, subjects identify problems using various approaches. Problem identification begins with marks or notes on the question sheet and re-reading the problem statement to visualize important information. This ability helps in understanding and solving mathematical problems more effectively. The systematic and comprehensive data recording was also observed, indicating the subjects' understanding of relevant information in the problems. Subsequently, the subjects demonstrated the ability to formulate problem-solving strategies, including developing appropriate formulas and planning the necessary steps. The implementation process of these strategies involves computation, with some subjects performing calculations directly on the answer sheet while others use a separate worksheet before writing their answers. The results show that direct approaches may be more efficient, but subjects also demonstrated flexibility in their methods depending on the problem's complexity. The interpretation process reflects the subjects' ability to conclude their work. Some subjects relied on conceptual understanding and the problem context to conclude without redoing calculations. However, there is a potential risk when overconfidence hampers result verification. Initial errors in problem formulation can significantly impact the subsequent stages, including implementation and interpretation. This emphasizes the importance of establishing a solid foundation to ensure success in solving mathematical problems. Overall, this study highlights the complexity of mathematical literacy in everyday problem-solving, underscoring the importance of accurate problem identification, precise data recording, effective problem-solving strategies, and careful interpretation to achieve accurate and meaningful solutions.

11. IMPLICATIONS FOR EDUCATION AND GOVERNMENT POLICY

This research underscores the vital importance of mathematical literacy in the educational system, particularly in how students approach and solve contextual problems. The study reveals that mathematical literacy—covering problem formulation, implementation, and interpretation—is fundamental for accurate and meaningful problem-solving. Mistakes in the initial stages, especially in problem formulation, can have a domino effect, leading to errors throughout the entire problem-solving process. This finding highlights the need for a strong foundation in mathematical literacy to ensure students can systematically and effectively tackle problems.

From an educational perspective, the implications are clear: schools must prioritize the development of mathematical literacy from an early stage. This requires curriculum reforms that integrate comprehensive mathematical literacy training, ensuring that students not only learn mathematical concepts but also how to apply them in real-world contexts. Educators should receive professional development to better understand how to teach and assess these skills, moving beyond rote memorization towards fostering critical thinking and problem-solving abilities.

For government policy, the implications extend to the design and implementation of assessment programs like the AKM. The current approach of providing only numerical scores without deeper evaluation is insufficient. There is a pressing need for policies that mandate holistic assessments, which include qualitative evaluations of how students solve problems, not just the final answers. This would provide a more nuanced understanding of students' mathematical literacy and inform targeted interventions to address gaps in learning.

Furthermore, government policies should support ongoing research and development in educational practices, ensuring that programs like the AKM evolve based on empirical findings. Investing in teacher training, curriculum development, and assessment tools that emphasize mathematical literacy can lead to long-term improvements in student outcomes, better preparing them for the demands of the modern world. This approach aligns with global educational standards and enhances the competitiveness of students in the international arena.

Improving mathematical literacy has significant real-world benefits. It enhances financial literacy by enabling students to manage budgets, compare prices, and save effectively. It strengthens critical thinking skills, allowing for better analysis and evaluation of information, which aids in making informed decisions. Additionally, it supports practical decision-making by helping students systematically analyze data and solve problems. Overall, strong mathematical literacy equips students with essential skills for financial management, critical analysis, and practical problem-solving, preparing them for both personal and professional challenges.

12. RECOMENDATIONS

Educators should focus on strengthening students' mathematical literacy by emphasizing the skills required for accurately formulating, implementing, and interpreting problems, providing them with the tools to confidently solve complex mathematical challenges. Schools should integrate comprehensive mathematical literacy training into the curriculum, ensuring students can systematically analyze problems, record relevant data, and apply effective strategies. To further support mathematical literacy, students should be encouraged to critically assess their problem-solving processes and verify their results at each stage, which will refine their skills and improve overall accuracy. Incorporating more real-world, contextual problems in the classroom will also help students apply their mathematical literacy in everyday situations, preparing them to tackle challenges with confidence. Continuous feedback from teachers, focusing on key components such as problem formulation, data recording, strategy implementation, and interpretation, will further help students refine these skills and apply them effectively across different contexts.

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Bukti konfirmasi review dan hasil review kedua
(11 september 2024)

Konfirmasi review
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to Astri, me

Lukman Lukman hakim muhaimin:

We have reached a decision regarding your submission to AL-ISHLAH: Jurnal Pendidikan, "Exploring Middle School Students' Challenges in Mathematical Literacy: A Study on AKM Problem-Solving".

Our decision is: Revisions Required

1. Abstract: 150-250 kata
2. Jumlah kata maksimal dalam artikel: 7000 kata, silahkan disesuaikan
3. Sederhanakan lagi bagian CONCLUSION. Cek template: tidak ada nomor 6 dan 7. Uraikan keterbatasan penelitian, rekomendasi bagi penelitian lain dalam paragraf bagian CONCLUSION. Tidak perlu membuat SUBJUDUL tambahan

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5
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(11 september 2024)

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Revisi	Tanggapan
Abstract: 150-250 kata, silahkan disesuaikan	Sudah disesuaikan dengan perintah revisi
Jumlah maksimal kata dalam 1 artikel: 7000 kata, mohon menyesuaikan.	Abstrak sudah diperbaharui

artikel yang di submit

Exploring Middle School Students' Challenges in Mathematical Literacy: A Study on AKM Problem-Solving

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ABSTRACT

Mathematical literacy is the ability to formulate, apply, and interpret everyday problems. The Minimum Competency Assessment (AKM) program in Indonesia is designed to evaluate these essential skills, similar to the PISA framework. Assessing mathematical literacy through the AKM ensures that students meet basic competency standards, helping to improve overall educational quality and better preparing students for global competition. This research reveals the characteristics of students' mathematical literacy when solving AKM problems. The study was conducted at a junior high school in Surakarta, Indonesia. The research stages included giving AKM problems, observing students' problem-solving processes through think-aloud methods, conducting interviews for confirmation, reducing data, coding data, analyzing data, and drawing conclusions. The data used included students' answers, observation sheets, and interview transcripts. When formulating problems, students often struggle to accurately understand the issues at hand. This leads to incomplete data during the problem-solving process, resulting in calculation errors or mistakes in applying formulas. These errors create a domino effect, leading to incorrect answers. Students' difficulties in formulating mathematical problems can potentially cause calculation errors and improper use of formulas, ultimately leading to incorrect solutions. This negatively impacts their conceptual understanding, learning motivation, and readiness to face educational challenges or enter the workforce. To address these difficulties, teachers can enhance students' conceptual understanding, promote critical thinking, implement problem-based learning, use visual aids, provide targeted support, and focus on developing mathematical literacy from an early age.

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13. INTRODUCTION

In the era of globalization and rapid technological advancement, comprehending and utilizing information has become one of the critical skills required to address the challenges of the 21st century (Griffin, McGaw, & Care, 2012; Scott, 2015; Tan, 2021). Beyond merely understanding numbers and formulas, mathematical literacy encompasses the ability to apply mathematical concepts in everyday life, solve data-based problems, and make informed decisions based on mathematical analysis, thereby necessitating critical and logical thinking skills when addressing problems (Muhaimin & Kholid, 2023; OECD, 2021; Stacey, 2015). Therefore, this skill is crucial for students to master and should be included in the mathematics curriculum. Students with good mathematical literacy tend to be more critical and confident in solving complex mathematical problems (Nisa & Arliani, 2023).

However, the reality is that mathematical literacy among students in Indonesia still needs to improve. A survey conducted by the Organization for Economic Co-operation and Development (OECD) through the Programme for International Student Assessment (PISA) in 2018 revealed that Indonesia ranked 71st out of 77 in reading literacy, mathematical literacy, and scientific literacy, with a mathematical literacy score of 379 (Schleicher, 2018). Numerous studies have shown that Indonesian students' mathematical literacy still needs to improve. Research by Jailani et al. (2020) revealed that one of the causes of low mathematical literacy among junior high school students is difficulty identifying contextual problems. Previous research by Dewantara et al. (2015) showed similar findings, indicating that students struggle to apply mathematical formulas in solving mathematical problems. Another finding by Fauzi & Chano (2022) indicated that weak mathematical literacy also occurs among elementary school students who need help to solve contextual problems and can only apply formulas limited to algorithms already taught and listed in textbooks.

The low mathematical literacy among Indonesian students calls for solutions from various sectors, particularly education. Understanding and improving students' mathematical literacy is not only the responsibility of educators but also a national priority that requires serious attention (Genc & Erbas, 2019; Umbara & Suryadi, 2019). The Indonesian government has made efforts to provide support by implementing the Minimum Competency Assessment (AKM) as a replacement for the National Examination (UN) since 2020 (Ministry of Education, 2020; Pusmendik, 2022). The AKM is an assessment program designed to determine students' basic abilities and improve the quality of education in Indonesia, thus requiring competencies in language and mathematical literacy to measure basic abilities (Handayani, Perdana, & Ukhlumudin, 2021). Based on the AKM concept, its goal is to understand students' potential and abilities and improve the quality of education in Indonesia (Ministry of Education, 2020; Pusmendik, 2022). This aligns with Cahyanovianty (2021) view that the purpose of AKM is to identify and assess students' language and mathematical literacy competencies. Therefore, the AKM is considered a solution to the low mathematical literacy of Indonesian students.

Despite this solution, the AKM only evaluates the outcome based on the obtained score, whether good or bad, without an in-depth investigation of students' problem-solving abilities (Kemendikbudristek, 2022; Rohmah, Sutama, Hidayati, Fauziati, & Rahmawati, 2022). If the result is good, does the student have good mathematical literacy, or were they merely lucky? If wrong, what caused the difficulty in solving the problem? The AKM needs to provide more specific insights, thus necessitating this research to reveal the detailed characteristics of students' mathematical literacy in solving AKM problems. Therefore, this study aims to identify the characteristics of students' mathematical literacy. These characteristics are students' responses when solving AKM problems, including difficulties and other unique aspects that indicate their mathematical literacy.

This research presents another perspective in the realm of existing mathematical literacy studies. Although many research works have explored aspects of mathematical literacy, most rely on PISA problems as their primary instrument (Dewantara et al., 2015; Hayati, 2019; Khoirudin, Styawati, & Nursyahida, 2017; Ozkale & Ozdemir Erdogan, 2022; Thien, 2016; Wijaya, 2016). However, they have yet to explore mathematical literacy using the AKM problem approach. This indicates a new area of exploration in mathematical literacy. While PISA is widely recognized and used in global research (OECD, 2023), AKM problems may offer a different and more contextual perspective in understanding how students comprehend and use mathematics daily. Therefore, delving deeper into mathematical literacy through the AKM lens can provide additional insights and enrich academic discussions. This research highlights the importance of an in-depth evaluation of students, revealing that while the AKM program is a good initiative, a comprehensive evaluation of student characteristics during AKM problem-solving is still lacking. Currently, AKM only provides numerical scores without further evaluation. A holistic evaluation is expected to offer a more comprehensive understanding of students' abilities.

14. METHODS

The researcher employs qualitative research with a phenomenological design to deeply analyze mathematical literacy. Creswell (2015) emphasizes that phenomenology focuses on interpreting the meaning of individuals' experiences within the context of their life worlds. Therefore, through this study, the researcher aims to provide a deeper insight into how mathematical literacy is understood and experienced by students in the classroom and how it can be applied, specifically to uncover the characteristics of students' mathematical literacy by engaging and understanding their individual experiences. Through an in-depth analysis of students' experiences, we can understand how they interact with AKM problems. This will reveal the level of students' mathematical literacy, as mathematical literacy is an integral part of how students think and act when facing problems.

The research subjects selected are eighth-grade junior high school students considered relevant and unique in the context of the mathematical literacy being studied. At around 15, junior high school corresponds to the age group assessed in the PISA evaluation globally (OECD, 2021). The selected junior high school in Surakarta is recognized for its excellent reputation. Thus, the selection of subjects from this school is expected to represent students' mathematical literacy at the junior high school level.

The subject selection technique uses snowball sampling until a saturation point is reached (Reserved, Url, & Uri, 2020). In snowball sampling, the researcher starts by identifying one or more individuals who have relevant information or experience related to the research objectives. The researcher also seeks recommendations from teachers when selecting subjects, which is expected to provide deeper or different information. This approach allows the researcher to access a group of subjects that might be difficult to reach through conventional subject selection techniques. In this research context, the researcher decided to select five students as research subjects based on initial information and recommendations from initial students. The initial students were selected based on teachers' recommendations, focusing on those with strong cognitive abilities. Subsequent subjects were chosen using snowball sampling within one class until saturation was reached with five subjects. The selection of these five students is based on data saturation and the consideration of the diversity of their experiences and backgrounds in mathematics learning, thus expected to provide a holistic and in-depth picture of mathematical literacy. The snowball sampling technique employed by the researcher is clearly outlined in Table 1.

Table 1. Snowball sampling technique

Research Subjects	Mathematical literacy process		
	Formulation	Implementation	Interpretation
1	F1	IM1	IN1
2	F1	IM1	IN2
3	F3	IM3	IN1
4	F1	IM3	IN2
5	F1	IM1	IN2

Code description:

F1 : First subject response in the formulation process
F3 : Third subject's response to the formulation process
IM1 : First subject's response to the implementation process
IM4 : Fourth subject's response to the implementation process
IN1 : First subject response in the formulation process

IN2 : Second subject's response to the formulation process

Table 1 presents the response codes from the subjects, with identical codes indicating similar responses. These codes will be further discussed in the findings and discussion section. The coding process involved assigning the same code to identical responses, while differing responses were given distinct codes. Dominant codes were then analyzed for deeper insights. In this study, the researcher serves as the primary instrument for data collection, employing various tools to gather comprehensive information on students' mathematical literacy. These tools include a mathematical literacy test and non-test instruments, such as guidelines for in-depth interviews and observation sheets used during the research. The test focuses on AKM problems in the algebra domain, specifically covering ratios and percentages—key components of junior high school mathematical literacy. The research instruments were developed based on existing mathematical literacy indicators aligned with PISA, including communication, mathematization, representation, reasoning, strategy design, and symbolic language usage. The problems were revised to ensure they accurately reflect the research objectives and effectively measure students' competencies. Figure 1 illustrates the test instrument.

Figure 1. Mathematical literacy test instrument

The researcher uses the think-aloud technique to gather comprehensive and in-depth data from students. As described by Macias et al. (2018), this method involves having subjects verbalize their thoughts while working on a test or problem. In this study, students were guided through the problems, freely expressing their thoughts, and were occasionally asked questions. All observations were recorded and later analyzed. To ensure thoroughness, the researcher utilized tests, interviews, and observations during the think-aloud process. Data validity was ensured using source triangulation with five subjects, as outlined by Creswell (2015). Triangulation involved comparing data from tests, interviews, and observations. Consistent data across these sources was considered valid, while discrepancies led to further investigation. The researcher then conducted data reduction, filtering out irrelevant or redundant information to focus on key insights. After reduction, the data was coded and organized systematically into tables, charts, or narratives for clearer analysis. This structured presentation helped in identifying patterns, relationships, and trends within the data. Finally, the researcher proceeded to draw conclusions based on the findings..

15. FINDINGS

15.1. Formulation process

Based on Table 1, code F1 is the most common response among the five subjects during the formulation process. Subject 1, when given an AKM problem, identified the issue by writing down key information and rereading the question up to three times, as seen in Figure 2. The subject also scribbled on the question sheet, highlighting details like price, discount, and deposit.

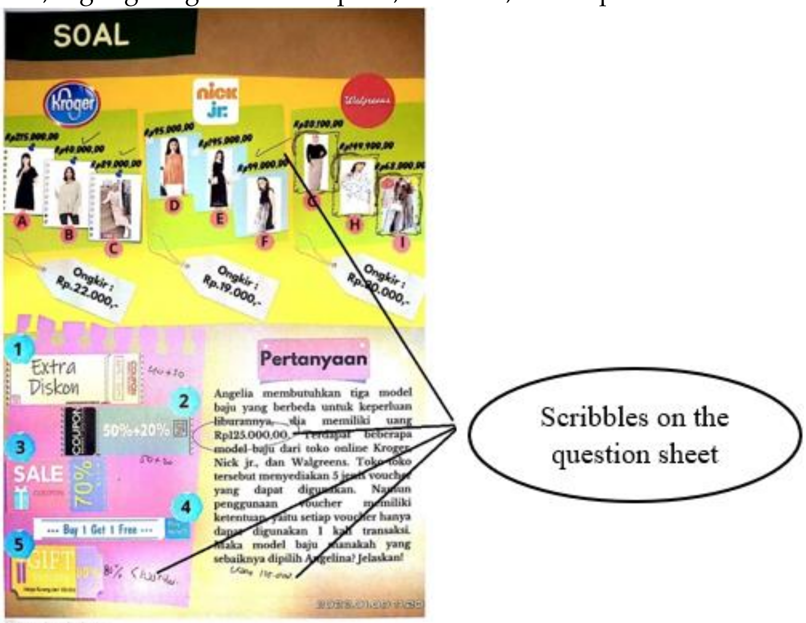


Figure 2. Subject question sheet (FI)

In Figure 2, the subject can be seen scribbling certain parts of the question, the price, discount and initial deposit. based on these conditions, researchers confirmed through interviews.

Researcher (R) : *why did you scribble on your question sheet?*
Subject (S) : *to note important data to make it easier for me to understand the problem*
R : *why did you read the questions several times?*
S : *because I have difficulty understanding the questions*

The interview highlights the subject's problem identification strategy. By scribbling or marking the question sheet, the subject visually identifies key elements, making it easier to focus on important information and separate relevant from irrelevant details. Repeatedly reading the question allows for deeper understanding and helps the subject explore the problem from different perspectives. After identifying the problem, the subject writes down key data on the answer sheet to ensure all important information is available before solving the problem. This method helps avoid rechecking the original question, as shown in Figure 3.

Figure 3 shows that the data written consists of known data and questionable data. The known data is the price of clothes in each shop (A1), postage prices (A2), and clothes vouchers (A3). Then the data asked is three clothes that must be chosen with the available money (A4). These data are written directly by the subject on the answer sheet. This condition was confirmed by researchers.

R : *Why did you write the question information directly on your answer sheet?*
S : *To make it easier for me without having to look back at the information on the questions or other sheets.*

The interview indicated that writing information on the question sheet made it easier for the subject to solve the problem without having to reopen the question or another sheet, this was also to consider the efficiency level in solving the problem. By minimizing the need to return to the source, subjects can move more quickly through the problem-solving steps, increasing their chances of reaching the correct solution in less time. Thus, the interviews underscore the importance of proactive strategies in problem-solving and how simple steps such as writing down information can significantly impact the final outcome and efficiency of the process.

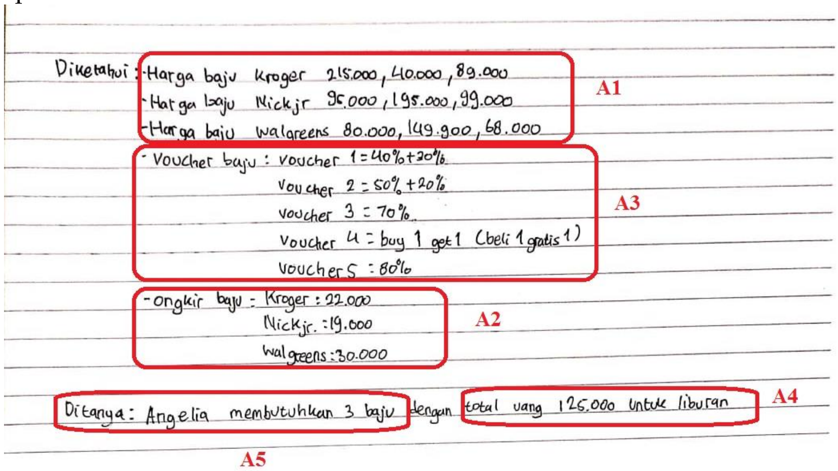


Figure 3. Subject answer sheet (F1) in the data writing process

After writing down the data or information about the problem, it can be seen that the subject not only passively receives the information but is also active in processing it to reach a solution. The selection of a formula as the next step shows the subject's understanding of the mathematical concepts involved in the problem. By explicitly writing the formula, the subject provides a framework for himself, ensuring that the next steps are based on a sound mathematical approach. Figure 4, which displays the subject's answer, shows details of the formula used, as well as how the subject applies it to the data that was recorded previously.

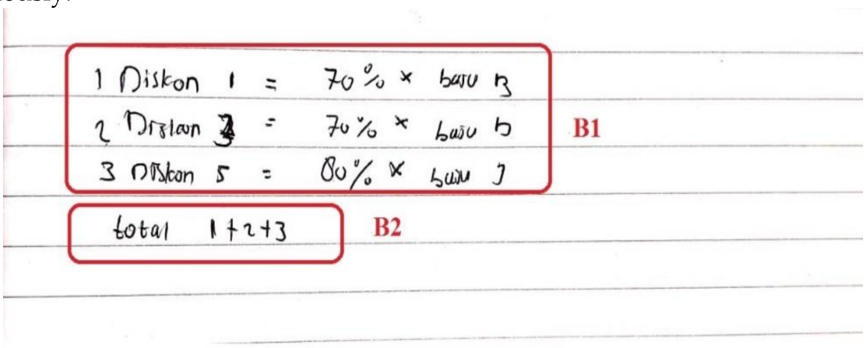


Figure 4. Subject answer sheet (F1) in the strategy development process

The formula written in Figure 4 shows the discount calculation formula (B1) and total discount (B2). The writing of this formula is not without reason, so confirmation is needed for this condition through interviews with the subject.

R : *Why did you write that formula?*

S : *To plan strategies for solving problems*

The subject's response to writing this formula was based on designing how to solve the problem. Subjects seemed aware that solving mathematical problems often requires a structured approach. By writing the formula first, the subject creates a frame of reference to help them carry out the following steps more systematically and organized.

The process of writing problem data and formulas by the subjects above (Figure 3 and Figure 4) reflects the transformation process of a concrete situation or problem that exists in reality into a more abstract mathematical representation. It represents an attempt to understand and define a complex problem from everyday life into mathematical language, which allows for more systematic analysis and solutions.

Another finding in the subject with code F3, in the formulation process, showed a response that the subject did not identify the questions by scribbling on the question sheet or reading the questions repeatedly. On the question sheet, there is also no complete writing of the data or question information (Figure 5), this is different from the F1 code, which identifies by marking information on the question sheet and reading it repeatedly, besides also writing all the data or question information on the answer sheet.

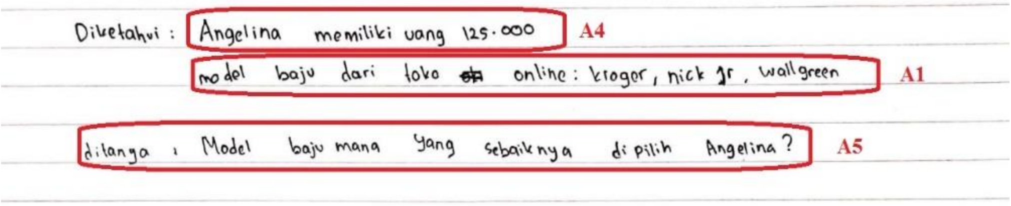


Figure 5. Subject answer sheet (F3)

Code F3 only writes the clothing model from each shop (A1), the initial money (A4), and the data requested (A5). These data are also incomplete in terms of completeness components. However, F3 showed the same response as F1 when designing a problem solving strategy, namely writing down the formula used to solve mathematical problems (AKM).

15.2. Implementation Process

This implementation is a concrete manifestation of the ideas and plans processed and formulated in the formulation process, providing an accurate picture of how these plans are implemented in practice. Based on Table 1, we can observe that the implementation process with IM1 code dominates, even more than with other possible codes. Response code IM1, the subject begins the step by rewriting the question data, but this data is more specific based on what is required in the formula written in the formulation process. The subject answer sheet is clearly shown in Figure 6.

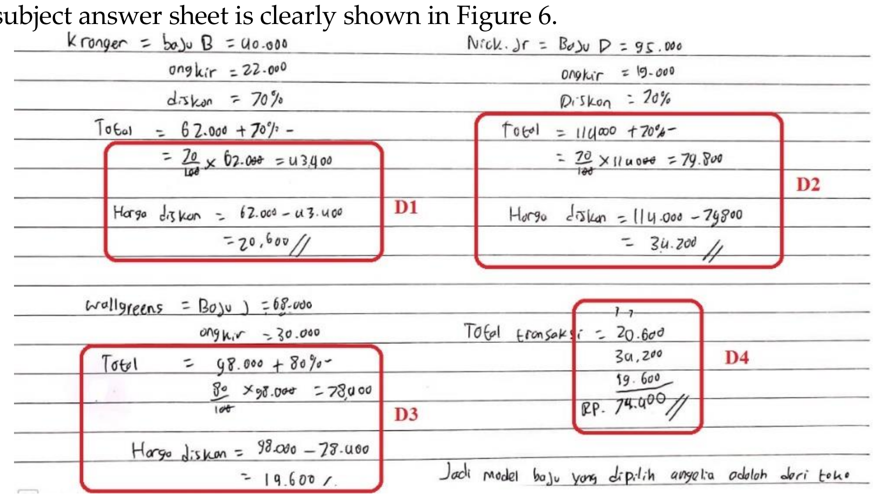


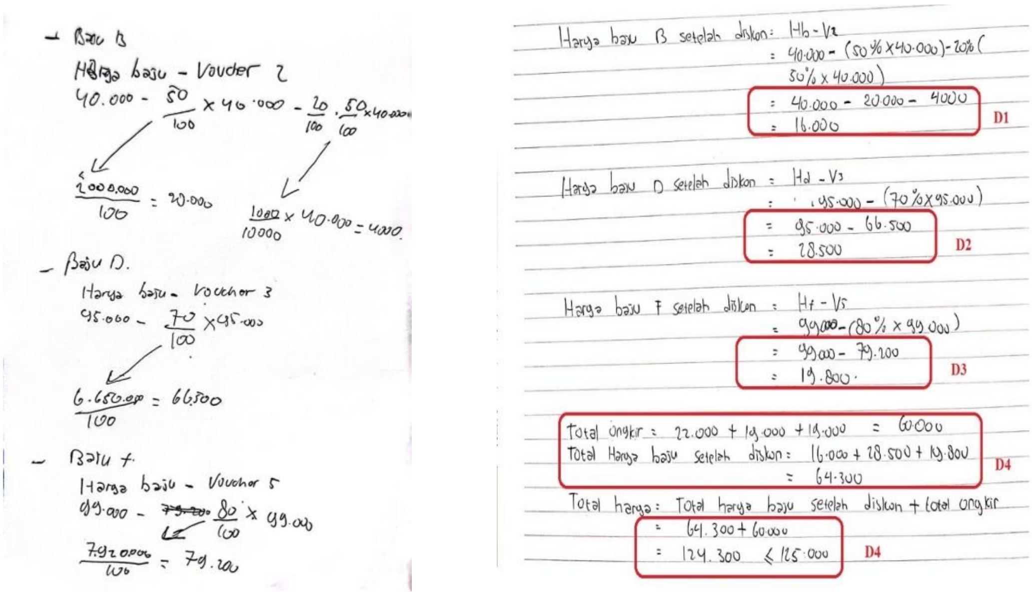
Figure 6. Subject answer sheet (IM1) in the implementation process

Figure 6 illustrates how the subject performed calculations directly on the answer sheet. The image shows that the subject carefully compared the prices of shirts from various stores, factoring in discounts to ensure the total cost did not exceed the budget. Codes D1, D2, and D3 represent the price calculations after discounts, while code D4 captures the summing of these prices. Notably, the subject bypassed using a scratch sheet and instead wrote the results immediately on the answer sheet. This could indicate high confidence in their mathematical skills or a preference for relying on memory.

R : *Why do you do calculations directly on the answer sheet?*

S : *I am used to doing calculations like this so that problem solving is done quickly*

The interview reveals that the subject aims for efficiency, relying on confidence and a strong understanding of the material. Previous practice and experience in handling similar problems likely reinforced this confidence. By skipping scratch work, the subject eliminates unnecessary steps that could slow down or confuse the process, allowing them to focus entirely on solving the problem at their own pace. In contrast, subjects 3 and 4, as shown by code IM3, used a more cautious and systematic approach. They relied on draft calculations or scratch sheets before transferring answers to the answer sheet, as shown in Figure 7. This method suggests that they aimed to reduce errors and preferred to visualize their calculations more clearly before finalizing their answers. The scratch sheet helped them organize their thoughts and verify the correctness of each step before committing it to the final answer.



(a) (b)

Figure 7. Scribble sheet (a) and answer sheet (b) subject to code IM3

Figure 7 clearly shows the voucher discount calculations carried out by the subject on the scratch sheet. These scratch sheets allow subjects to easily modify, correct, or repeat calculations without crossing out or changing the official answer sheet. As the interview progressed, this subject said, "This is done as an effort to increase calculation accuracy and minimize errors." This method may take longer than the direct method on IM1. However, for the subject, this additional time, the benefits outweigh the investment in terms of accuracy and certainty gained.

15.3. Interpretation Process

After the formulation and implementation process, the next step is interpretation. In this phase, the researcher examines how subjects reprocess their computed answers to form conclusions that address the problem. This stage yields different response codes from the five subjects, with two prominent codes, IN1 and IN2. Although both codes reflect the use of reasoning to deduce the final answer, they differ in their approach to drawing conclusions. Subjects with response code IN2, in particular, demonstrated a more thoughtful interpretation process. Instead of merely evaluating the calculation results, they engaged in deeper reflection to ensure their answers were aligned with the context of the question. These subjects carefully compared every detail of their answers with the information provided in the problem, evaluating the relevance and accuracy based on the given data and parameters. By revisiting their conclusions and checking them against the question's details, they ensured that the final answer was well-grounded. The results of this interpretation process are illustrated in Figure 8.

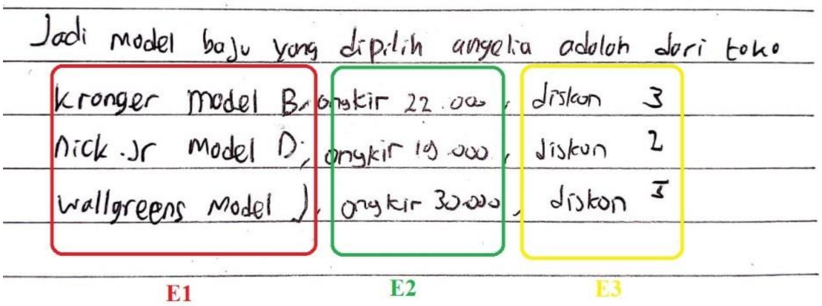


Figure 8. Subject answer sheet (IN2) in the interpretation process

Based on Figure 8, subjects can write down their answer conclusions, starting from the clothes chosen (E1), shipping costs (E2), and discount vouchers chosen (E3), even though they do not do the calculations again. Through interviews, researchers confirmed this condition.

R : *Why don't you check the calculations before concluding the answer?*

S : *To shorten the time, because the processing time is short, I do not have enough time to do the calculations again*

The interview quoted above indicates that poor time management will result in less-than-optimal work steps being taken. In contrast, as seen in IN1's response, efficient time management allows subjects to allocate sufficient time to each aspect of the problem. In this case, subjects with an IN1 response can not only solve the problem, but also have the freedom to review their calculations before deducing an answer.

16. DISCUSSION

16.1. Formulation process

In formulating the initial findings, the subject identifies the problem using the approach outlined by Muhaimin & Kholid (2023), which defines mathematical literacy as the ability to solve everyday problems. The first step is to identify the problem. This is supported by Laamena & Laurens (2021), who also highlight problem identification as the first ability in mathematical literacy. The subject scribbles on the question sheet and rereads the questions to help visualize key information (Venkat, 2010), facilitating problem-solving without revisiting the question repeatedly. Similarly, rereading aids in understanding the nuances of the problem, as confirmed by other studies (Anwar & Rahmawati, 2017; Robinson & Kevoe-Feldman, 2010; Therrien & Hughes, 2008). In contrast, students who demonstrate strong comprehension, as noted by Schoenfeld (1988), often only need to read the problem once to understand it.

Next, the subject writes down the data, distinguishing between relevant and irrelevant information. Mathematical literacy involves solving real-world problems (Ministry of Education, 2020; OECD, 2019), and effective problem-solving requires the ability to sift through data, as noted by Najafabadi et al. (2015). Systematically recording data aids in accurate problem-solving (English, 2015), and errors in this process can lead to mistakes (Sundayana & Parani, 2023). Accurate data identification and recording help students make better decisions in everyday situations, such as budgeting or analyzing statistics (Genc & Erbas, 2019).

The response to the formulation process we found next was the ability to develop problem-solving strategies; all codes (F1, F3) in the formulation process showed this response. Developing this strategy takes the form of formulating a formula that will be used to solve the problem faced and planning the steps that must be taken to solve the problem. This process requires critical and analytical thinking (Bali, Capano, & Ramesh, 2019). The ability to develop problem-solving strategies is an essential aspect of mathematical literacy. This is because mathematical literacy is the ability to carry out simple mathematical operations and the ability to analyze, interpret, and use mathematics in various real situations (Ministry of Education, 2020; OECD, 2019). With a clear strategy, one may find it easier to find efficient and effective solutions (Basadur, 2004). Many problems, especially in mathematics, require specific problem-solving strategies (Gupta & Mishra, 2021; Muhaimin, Dasar, & Kusumah, 2023). Therefore, having the right strategy will speed up the problem-solving process and increase the accuracy of answers. However, we found the subject's error in determining the formula to solve the problem. Of course, the solution strategy will also be inappropriate in this condition. According to Cho & Nagle (2017), the need for an in-depth understanding of basic mathematical concepts makes students choose the wrong formula. Therefore, the results may be different from what was expected. This statement is in line with the findings we obtained, which stated that the subjects needed to understand the material about discounts well, which resulted in errors in formulating strategies, which impacted the calculation results.

In writing down data and developing strategies when solving problems, we also found that students carried out data transformations, such as changing contextual data or information into mathematical language data. Mathematical problems designed to test or explore the depth of students' mathematical literacy must have several elements or components, one of which is that the problem must have a specific context (Almarashdi & Jarrah, 2022; Stacey, 2011). This context provides background or story to the problem and serves as a source of information that students need to find a solution. AKM is a mathematical problem with a context within the problem (Cahyani & Susanah, 2022; Ministry of Education, 2020; Muhaimin et al., 2023). This requires students' ability to change data or information based on the problem presented into mathematical form. Additionally, Muhaimin & Kholid (2023) stated that although conceptual understanding in recognizing problem patterns, identifying relationships between existing variables, and understanding basic mathematical concepts are essential, all of this will be worthwhile if students can transform information into relevant mathematical language. This transformation ability is essential for students to apply their knowledge in solving problems in everyday life.

16.2. Implementation process

The following process in mathematical literacy after the formulation process is implementation. In this process, all codes show the same response, implementing the planned problem-solving strategy and, in this case, carrying out computational calculations. This stage is where basic mathematical skills, such as arithmetic, algebra, and geometry, are often applied (Kholid et al., 2022). In PISA, this stage also involves skills in using mathematical tools, such as calculators or special software, if necessary (OECD, 2019, 2021). However, for researchers, the questions used simple numbers and wanted to see how students apply their numeracy skills in depth, so using mathematical tools is not permitted in this process. The difference in response we found between IM1 and IM3 lies in how they calculate. IM1 is doing calculations directly on the answer sheet, and IM3 is not doing calculations directly on the answer sheet but instead doing calculations on another sheet (scribble sheet) before writing the answer on the answer sheet. However, in solving by writing directly on the answer sheet, there is also the potential for increasing errors. Because there is no checking before it is written on the answer sheet in the final form. Our findings in Table 1 show that most responses were in IM1. According to Foshay & Kirkley (1998), working directly on the answer sheet is more efficient in solving problems. PISA also states that the time given to work on questions is short (OECD, 2019, 2021). In this case, it confirms our findings that subjects perform calculations directly on the answer sheet to be efficient. It is important to note that both IM1 and IM3 codes have advantages and disadvantages. While IM1 may be faster and more efficient for subjects with high confidence and a deep understanding of the material, IM3 may be better suited for those needing additional clarification or who tend to make mistakes when rushed. In an educational context, these findings emphasize the importance of introducing various calculation strategies to students. It also underscores the need to provide flexibility in learning approaches, recognizing that each student is unique in processing information and solving problems.

The discussion on the formulation process mentioned that mistakes made at the beginning of problem-solving will impact the process afterward. Imagine if the foundation of a building is not solid or inappropriate, the building is at risk of collapsing when faced with pressure. As with solving mathematical problems, if the basic understanding or strategy used is not appropriate at the formulation stage, then in subsequent stages, the chance of getting the correct answer becomes smaller (Schafer, M., & Brown, 2006). This condition is confirmed in the implementation process in Figure 6 and Figure 7. This visualization shows how initial errors that appear at the formulation stage affect the results at the implementation stage. The findings we obtained are, in fact, in line with the research results by Huu Tong & Phu Loc (2017) and Astutik & Purwasih (2023), which also shows that the majority of incorrect answers obtained were caused by previous steps needing to be corrected. It is, therefore, important for educators to ensure solid understanding from the start to have a greater chance of success in the later stages.

16.3. Interpretation process

The findings of this research show the importance of the interpretation stage in the mathematical literacy process. This interpretation process involves not only understanding mathematical concepts but also reasoning skills that enable the subject to reflect on the results of his work and draw appropriate conclusions (Machaba, 2018). Our findings show that the response code in this process shows students' reasoning abilities in concluding answers. This is seen in how subjects with response code IN2 process their answers. From IN2's response, subjects are more likely to rely on their conceptual understanding and the context of the problem to conclude rather than sticking to the calculation results. Strong confidence in their ability to understand and solve problems prevents students from recalculating before concluding (Bénabou & Tirole, 2002). However, this also reveals a potential risk: the lack of verification that may be required in specific contexts to ensure the correctness of answers. Executive skills such as time management also influence the lack of verification in the interpretation process; the longer the time spent on the previous process, the less time is spent at this stage (Broyden, 1965). Then, errors in the formulation process impact the implementation process and, finally, the interpretation process. Interestingly, despite errors, the subjects seemed confident in their understanding even though they were wrong. This error is not surprising because many students sometimes misunderstand certain concepts without realizing it (diSessa, 2002). This phenomenon is a "cognitive error," in which a person believes something to be true even though the facts differ (Miller, Holcombe, & Latham, 2020). In the learning context, this phenomenon underlines the importance of constructive feedback and double-checking in the learning process. This ensures that students' understanding is not only deep but also accurate. The existence of cognitive bias reminds educators to always emphasize to students the importance of reflection, re-examination, and the willingness to accept and process criticism or correction.

17. CONCLUSION

This study reveals the diverse responses of subjects in solving contextual mathematical problems (AKM) through mathematical literacy, which includes formulation, implementation, and interpretation. In the formulation stage, subjects identify problems using various approaches. Problem identification begins with marks or notes on the question sheet and re-reading the problem statement to visualize important information. This ability helps in understanding and solving mathematical problems more effectively. The systematic and comprehensive data recording was also observed, indicating the subjects' understanding of relevant information in the problems. Subsequently, the subjects demonstrated the ability to formulate problem-solving strategies, including developing appropriate formulas and planning the necessary steps. The implementation process of these strategies involves computation, with some subjects performing calculations directly on the answer sheet while others use a separate worksheet before writing their answers. The results show that direct approaches may be more efficient, but subjects also demonstrated flexibility in their methods depending on the problem's complexity. The interpretation process reflects the subjects' ability to conclude their work. Some subjects relied on conceptual understanding and the problem context to conclude without redoing calculations. However, there is a potential risk when overconfidence hampers result verification. Initial errors in problem formulation can significantly impact the subsequent stages, including implementation and interpretation. This emphasizes the importance of establishing a solid foundation to ensure success in solving mathematical problems. Overall, this study highlights the complexity of mathematical literacy in everyday problem-solving, underscoring the importance of accurate problem identification, precise data recording, effective problem-solving strategies, and careful interpretation to achieve accurate and meaningful solutions.

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Widia Yunita <jurnalpendidikanalishlah@gmail.com> Sun, Sep 22, 2024 at 3:30 PM
To: Lukman Lukman hakim muhaimin <muhaiminlukman@upi.edu>
Cc: Astri Wahyuni <astriwahyuni@edu.uir.ac.id>, Agus Hendriyanto <agushendriyanto@upi.edu>, Yuliana Tririnika <tririnikayuliana@gmail.com>

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Exploring Middle School Students' Challenges in Mathematical Literacy: A Study on AKM Problem-Solving

Astri Wahyuni, Lukman Hakim Muhaimin, Agus Hendriyanto, Yuliana Tririnika

Abstract

Mathematical literacy is the ability to formulate, apply, and interpret everyday problems. The Minimum Competency Assessment (AKM) program in Indonesia is designed to evaluate these essential skills, similar to the PISA framework. Assessing mathematical literacy through the AKM ensures that students meet basic competency standards, helping to improve overall educational qualit and better preparing students for global competition. This research reveals the characteristics of students' mathematical literacy when solving AKM problems. The study was conducted at a junior high school in Surakarta, Indonesia. The research stages included giving AKM problems, observing students' problem-solving processes through think-aloud methods, conducting interviews for confirmation, reducing data, coding data, analyzing data, and drawing conclusions. The data used included studen answers, observation sheets, and interview transcripts. When formulating problems, students often struggle to accurately understand the issues at hand. This leads to incomplete data during the problem-solving process, resulting in calculation errors mistakes in applying formulas. These errors create a domino effect, leading to incorrect answers. Students' difficulties in formulating mathematical problems can potentially cause calculation errors and improper use of formulas, ultimately leading to incorrect solutions. This negatively impacts their conceptual understanding, learning motivation, and readiness to face educatior challenges or enter the workforce. To address these difficulties, teachers can enhance students' conceptual understanding, promote critical thinking, implement problem-based learning, use visual aids, provide targeted support, and focus on developing mathematical literacy from an early age.

Keywords

AKM Problem, Mathematical Literacy, Problem-solving

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