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E-modules assisted learning: Mathematical reasoning of junior high school students in solving mathematical literacy problems

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Abstract

The growing use of digital learning media in mathematics classrooms has not been matched by sufficient evidence of students' mathematical reasoning (MR) when solving mathematical literacy problems. This study aims to analyze the MR of junior high school students at different MR levels while solving mathematical literacy problems on systems of linear equations in two variables (SLETV) in a learning context supported by a mathematical literacy-based e-module. Using a descriptive qualitative design, the study involved ninth-grade students from a public junior high school in Palembang, South Sumatra, Indonesia. Data were obtained through three written mathematical literacy problems and follow-up semi-structured interviews and then analyzed using three MR indicators: finding patterns of relationships and generalizing a statement, proposing conjecture, and verifying the truth of an argument. The results reveal that students' MR remains limited, with only a small proportion demonstrating medium to high-level reasoning. High-reasoning students are already capable of demonstrating all indicators of MR, but low-reasoning students struggle to develop mathematical models from contextual problems. These findings suggest that e-module-assisted learning can support reasoning, but students at lower reasoning levels still require more explicit scaffolding, particularly for modeling, conjecturing, and justification.

Keywords: e-modules; linear equations with two variables; mathematical literacy; mathematical reasoning

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Introduction

One of the main objectives of school mathematics is to develop mathematical reasoning, since it allows learners to find patterns of relationships, generalize mathematical statements, make conjectures, test the validity of arguments, and draw conclusions based on mathematical relationships (Ojose, 2011; Jeannotte & Kieran, 2017; Kollosche, 2021). Current research in mathematics education no longer views reasoning as a skill confined to formal proof, but rather as a multidimensional process involving the recognition of relationships, the formulation of generalizations, the evaluation of the soundness of arguments in classroom situations and task types (Valenta et al., 2024; Reuter, 2023; Stylianides et al., 2024). In this regard, reasoned thinking is an intended learning outcome as well as a theoretical perspective to analyze the ways students confront mathematical concepts, describe connections, and defend conclusions when solving contextual problems (Alderton & Pratt, 2025; Arnesen & Rø, 2024). To operationalize MR in this study, three indicators were adopted from Suparman et al., (2021), namely finding patterns of relationships and generalizing a statement, proposing conjecture, and verifying the truth of an argument. These indicators were selected because they represent observable forms of students' reasoning in problem solving and provide a clear analytical framework for examining how students identify relationships, formulate possible situations, and justify the validity of their answers when working on mathematical literacy tasks. This perspective is also consistent with the Indonesian Independent Curriculum, which emphasizes students' ability to identify patterns, generalize, construct arguments, and express mathematical concepts in a meaningful way (Education Standards Curriculum and Assessment Agency, 2025).

Mathematical literacy is the area where the urgency of improvement in reasoning is especially noticeable. Tasks in mathematical literacy demand more than just memorizing procedures, as they need students to interpret situations, mathematize problems, put assumptions to the test, and reason why mathematics is significant in schools, connecting to decision-making in everyday life (Ojose, 2011; OECD, 2023). The results of PISA 2022 in Indonesia are a major issue, and the mathematical result shows that the country has a score of 366, which means that most students are still unable to cope with higher-order requirements inherent in non-routine problems (OECD, 2023). Similarly, national studies indicate that the reasoning of students in mathematical literacy and systems of linear equations in two variables (SLETV) is still constrained, particularly when students are required to make conjectures, construct mathematical models, and prove arguments (Vebrian et al., 2021; Nurhalin & Effendi, 2022). Yet, this issue must be perceived not only as a local achievement question but also as an extended global issue where reasoning opportunities within school mathematics tend to be imbalanced, unspoken, or not well-provided by classroom resources and task designs (Valenta et al., 2024; Lessing & Ogbonnaya, 2026).

Recent global studies also reveal that digital technology has the potential to affect mathematics learning, but its impacts remain conditional. Systematic reviews and meta-analyses concluded that technology-supported learning tends to positively affect mathematics performance, with the technology tool used to extend learning through visualization, interaction, feedback, and appropriate teacher guidance (Bray & Tangney, 2017; Hillmayr et al., 2020; Young et al., 2018). In mathematics education, digital technologies are no longer understood as delivery tools, but as potentially transforming the nature of mathematical activity, mediating meaning-making, and introducing new opportunities in the way of interaction, exploration, and assessment (Drijvers & Sinclair, 2024; Engelbrecht & Borba, 2024; Weigand et al., 2024). Within this perspective, a mathematical literacy-based e-module is not just useful because it is easy to use and engaging, but also a valuable tool that connects real-life mathematics problems, explanations using different methods, examples to follow, and practice exercises students can do on their own. Empirical studies on e-modules in mathematics education also support this position. The study by Marsitin & Sesanti (2023) found that a mathematical literacy-based e-module with a problem-based learning approach was valid, very effective, and very feasible, and that its use was associated with a 39% increase in students' MR in multivariable calculus. Similarly, Efendi et al., (2024) reported that a mathematical literacy-based e-module for statistics was valid and practical for classroom use, indicating that such resources can provide structured and accessible opportunities for students to engage with mathematical content through integrated explanations and tasks designed to support reasoning processes. Accordingly, mathematical literacy-based e-modules are theoretically important not simply as digitalized versions of printed materials, but as learning resources that may mediate the relationship between task design, learner engagement, and the development of MR.

Nevertheless, there is a gap in the existing literature. International reviews have documented the potential benefits of digital tools in mathematics education. Still, much of this work focuses on achievement, general technology use, or teacher competencies, rather than on how a particular mathematical literacy-based e-module relates to specific indicators of MR in lower secondary classrooms (Bray & Tangney, 2017; Hillmayr et al., 2020; Weigand et al., 2024). Studies on MR, on the other hand, have elaborated theoretical models and classroom opportunities for reasoning. Still, fewer studies describe how students demonstrate MR across different reasoning levels when working on mathematical literacy tasks in a digital learning environment, particularly in a specific content domain such as SLETV (Jeannotte & Kieran, 2017; Kollosche, 2021; Lessing & Ogbonnaya, 2026). In the Indonesian context, previous studies have separately examined students' reasoning in mathematical literacy tasks and the development or use of mathematical literacy-based e-modules, but the intersection of these two issues remains underexplored, especially for junior high school students learning SLETV in an e-module-assisted instruction (Vebrian et al., 2021; Rosyada et al., 2024). Although the mathematical literacy-based e-module used in the present study was adapted from a product developed in a previous study, the current research addresses a different problem by using a revised version of the e-module with different participants and different mathematical literacy tasks to investigate students' MR rather than to develop or validate the product itself. This gap is important because previous findings suggest that students' reasoning difficulties often become visible when they are required to identify relationships, move from contextual situations to mathematical models, propose conjectures, and verify whether an argument is correct (Endrawati & Ramlah, 2021; Erfani et al., 2020).

Based on this gap, the present study addresses the question of how MR is demonstrated by junior high school students at high, medium, and low reasoning levels when solving mathematical literacy problems in e-module-assisted learning on SLETV. Rather than testing the effectiveness of the e-module experimentally, this study focuses on how students' reasoning becomes visible in a digital learning context supported by a revised mathematical literacy-based e-module. In this way, the study contributes theoretically by extending the discussion of how MR manifests across different reasoning levels in e-module-assisted mathematical literacy learning, and practically by identifying aspects of reasoning that require stronger scaffolding in the design and use of e-modules, particularly in modeling, conjecturing, and justification.

Methods

The study employed a descriptive design with a qualitative approach because it aimed to analyze students' MR at different levels when solving mathematical literacy problems within a learning environment supported by a mathematical-literacy-based e-module, rather than to test the e-module's effectiveness experimentally. In this study, the e-module served as an instructional medium and learning context rather than the main object of evaluation. The mathematical-literacy-based e-module was adapted from a product previously developed by members of the research team (Rosyada et al., 2024), but it was revised to align with the mathematical literacy framework, the characteristics of the current participants, and the different mathematical literacy tasks used for data collection. In terms of structure, it consisted of a table of contents, a framework of mathematical literacy used, instructions for use, prerequisite material, explanations of SLETV concepts, worked examples, video discussions of example problems, interactive quizzes, and practice tasks. The content was organized to guide students from understanding contextual situations to identifying relevant information, representing the situation mathematically, solving the problem, and interpreting the result. In this way, the e-module operationalized mathematical literacy-based learning by presenting real-life tasks and encouraging students to connect contextual information with mathematical representations and solutions. The practice tasks included contextual SLETV problems designed to prompt students to identify relationships, formulate possible solution strategies, and justify their answers.

The participants were 32 ninth-grade students from a public junior high school in Palembang, South Sumatra, Indonesia. All students learned the SLETV using the revised mathematical-literacy-based e-module for three meetings. Data were collected through a written test and semi-structured interviews. The written test, administered to all 32 students, consisted of three validated mathematical literacy problems, each representing one indicator of MR ability as shown in Table 1.

Table 1. Indicator of MR ability

Indicator	Problem
Finding patterns of relationships and generalizing a statement	Number 1

<table>
<tr><th>Indicator</th><th>Problem</th></tr>
<tr><td></td><td>A store sells shoes and sandals. The price for a shoe is Rp 65.000 and the price for a sandal is Rp 35.000. The store offers several packages to offer customers a lower price, as shown in the image below.

How much does a shoe and a sandal cost after being made per package?</td></tr>
<tr><td>Proposing a conjecture</td><td>Number 2
One day, Kazim and Keenan went to Nai Market to shop. After they finished shopping, they received a receipt. When they wanted to take the receipt, it was torn, as shown in the image below.

On the same day, Fairah also wants to go to Nai Market. If Fairah has Rp. 180.000 and she wants to buy ice cream cups and chocolate wafers with the number of chocolate wafers twice as many as the number of ice cream cups. How many of each item can Fairah buy?</td></tr>
<tr><td>Verifying the truth of an argument</td><td>Number 3
A trader sells two types of fruit, namely apples and oranges.

One day, the trader finished selling and calculated the day's sales. He managed to sell a total of 50 kilograms of fruit, earning a total revenue of Rp1.600.000. He suspected that oranges outsold apples. Check to see if his prediction that oranges outsold apples was correct!</td></tr>
</table>

The results of the written test were scored using the MR assessment rubric adapted by Suparman et al. (2021), as presented in Table 3. To ensure scoring reliability, two raters independently scored the students' responses, and the inter-rater reliability was calculated using Cohen's kappa. The Cohen's kappa value was 0.72, which indicates strong inter-rater agreement.

Table 2. Rubric for scoring the MR ability test

Score	Description
0	There is no answer.
1	The reasoning indicator required in the question is not demonstrated or, if demonstrated, is inaccurate.
2	The reasoning indicator required in the question is present but not yet accurate.
3	The reasoning indicator required in the question is presented accurately, but the answer provided is incorrect or contains a slight error.
4	The reasoning indicator required in the question is accurate, and the answer provided is correct.

After that, the results of the MR ability test will be divided into three categories of MR ability levels according to Sulistiawati et al. (2015) as in Table 3.

Table 3. Category of MR ability

Achievement of MR Ability	Category
$N > 70$	High
$55 < N \leq 70$	Medium
$N \leq 55$	Low

$$N = \frac{\text{total score obtained}}{\text{maximum score}} \times 100$$

N = Achievement of MR ability

The test results were used to classify students' MR ability into low, medium, and high levels. Based on this classification, one student from each level was purposively selected for in-depth analysis and interviews. The selection was based not only on category membership, but also on the clarity and completeness of the students' written responses and their ability to represent the general characteristics of reasoning performance within each level. Thus, the three selected students were intended to serve as illustrative cases of high, medium, and low MR, rather than as fully representative cases of all students in each category. Before data collection, school approval and informed consent from students and their parents or guardians were obtained, and participants' identities were anonymized using codes. The interviews explored students' reasoning processes, difficulties, and perceptions of how the e-module supported their engagement with mathematical literacy problems. Each interview followed a protocol that addressed students' understanding of the task, the solution steps, the justification of their answers, and the challenges they experienced. The interviews were audio-recorded and transcribed verbatim. The interview data in this study provided only limited insight into students' understanding of SLETV learning supported by the e-module. This is because the data depended on students' ability to verbalize their thinking, and not all thought processes could be fully articulated during the interviews. Therefore, the interview findings were interpreted cautiously and used in conjunction with other data sources, particularly students' written responses, to provide a more comprehensive understanding of students' MR. Data from both instruments were then analyzed using the established indicators of MR ability. The findings from the written test were compared with the interview data to assess the consistency of students' MR across the two data sources. To enhance the credibility of the findings, triangulation was conducted by comparing students' written responses and interview results.

Results

Before the in-depth analysis of three selected students, a quantitative overview of the MR ability of all 32 participants is presented to illustrate the overall distribution of students across the high, medium, and low reasoning categories. Table 5 shows the frequency of students in each category with the mean and standard deviation of total MR scores.

Table 4. The distribution of overall MR ability

Category of MR	Total of Students	Mean	Standard Deviation
High	8	87.75	7.7
Medium	2	62.5	5.8
Low	22	33.4	14.5
Total	32	48.6	26.9

As shown in Table 4, most students were classified in the low reasoning category, while fewer were in the medium and high categories. The high category obtained the highest mean score, 87.75, with a relatively small standard deviation of 7.7, indicating that students in this group not only performed well but also showed fairly consistent reasoning performance. The medium category had a mean of 62.5 and the smallest standard deviation (5.8), suggesting relatively similar performance within this group. However, this result should be interpreted cautiously because the category included only two students. In contrast, the low category had the lowest mean score (33.4) and the largest standard deviation (14.5), indicating that, although these students were grouped in the same category, their reasoning performance varied more widely than in the other categories. Overall, the mean score of 48.6 and a standard deviation of 26.9 suggest that students' MR remained relatively low at the group level and showed considerable variation across the full sample. Based on this classification, one student from each MR category was purposively selected for in-depth analysis to illustrate how MR was demonstrated at the high, medium, and low levels shown in Table 5.

Table 5. Results of the MR ability test of selected students

No	Name	Score			Category
		1	2	3	
1	AK	4	3	4	High
2	NM	3	2	3	Medium
3	EA	0	0	1	Low

It can be observed that students who reach the high category can demonstrate all indicators of MR, though they still make minor errors in proposing conjectures. In the sample in the medium category, they have not yet met the indicators of MR, particularly in finding patterns and relationships, generalizing statements, and proposing conjectures. In the sample with a low category, they still have not demonstrated indicators of MR.

Students with high mathematical reasoning ability (AK)

On the indicator of finding patterns of relationships and generalizing a statement, AK demonstrates this aspect. This is evident from AK's answers in Figure 1.

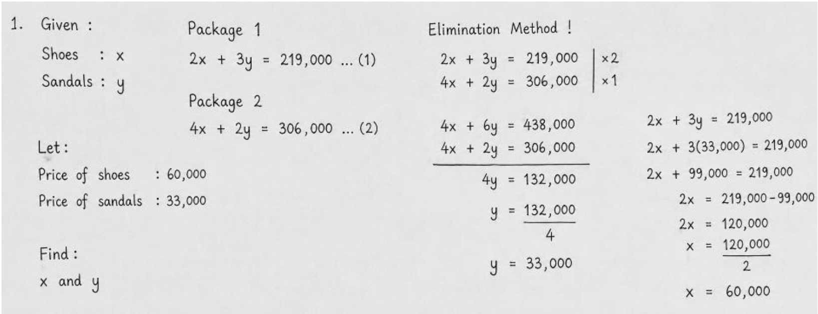


Figure 1. Answer to problem number 1 by a high-ability student

AK's answer shows that AK has been able to demonstrate the aspect of finding relational patterns, namely by choosing a pattern that starts with using a mixed method to solve the problem and generalizing a statement to obtain conclusions in the form of prices for each pair of sandals and shoes after being packaged in the SLETV problem. The interview related to problem number 1, conducted with AK, is as follows.

R : *"Do you perceive that the mathematics literacy–based e-module assists you in identifying patterns or relationships within the concept of systems of linear equations in two variables (SLETV)?"*

AK : *"Yes, it does. After understanding the problems presented, I can determine the most appropriate method to solve them."*

R : *"Are there any tools or features within the e-module that support your understanding of the SLETV material?"*

AK : *"Yes, there are. For instance, the video explanation feature. In addition to written explanations, the availability of video explanations makes it easier for me to comprehend the given problem."*

R : *"In what way does the e-module support you in constructing a mathematical model from an SLETV problem?"*

AK : *"The e-module provides numerous examples of problems along with clear and comprehensible solutions. To construct a mathematical model, I first review the sample problems and then identify and extract the relevant information from those problems."*

Regarding the indicator of making assumptions, AK can present that aspect. This is evident from AK's answer in Figure 2.

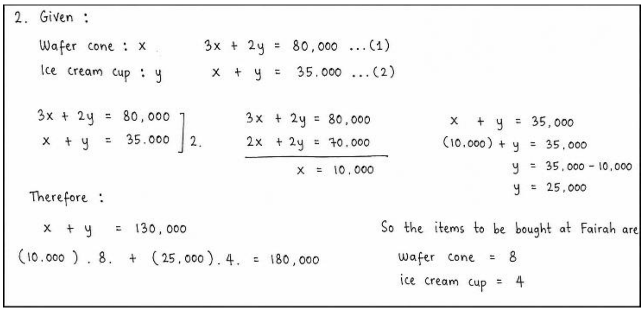


Figure 2. Answer to problem number 2 by a high-ability student

AK's answer shows that she has been able to introduce the aspect of proposing a conjecture. AK formulated the problem as a mathematical model, then used a mixed-method approach to estimate the prices of chocolate wafers and ice cream cups. After that, AK was able to reason that to determine the number of items that can be purchased, one would multiply the price of each item by estimating the quantity of each item based on the amount of money Fairah has. Thus, AK also introduced the indicator of making assumptions in solving it. As for the interview regarding problem number 2 conducted with AK, it is as follows.

R : *"How did you estimate the number of chocolate wafers and ice cream cups purchased in such large quantities?"*
AK : *"After identifying the price of each chocolate wafer and ice cream cup, and based on the information stated in the problem that the number of chocolate wafers purchased was twice the number of ice cream cups, I inferred that there were 8 chocolate wafers and 4 ice cream cups."*
R : *" From where did you obtain the price of each item?"*
AK : *"By applying a mixed method."*

On the indicator of verifying the truth of an argument, AK is able to present that aspect. This is evident from AK's answer in Figure 3.

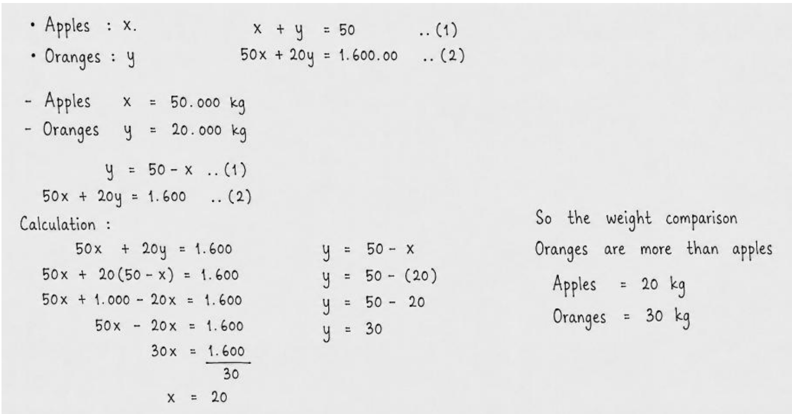


Figure 3. Answer to problem number 3 by a high-ability student

AK's answer shows that she has been able to demonstrate the aspect of verifying the truth of an argument, meaning she can prove that the argument made by the trader is true by performing calculations using the substitution method to find the quantity of each orange and apple, thus allowing AK to verify the trader's argument that more oranges were sold than apples. The interview for question number 3, conducted with AK, is as follows.

R : *"From which information can you determine the variables x and y?"*
AK : *"From the information given in the problem."*
R : *"How can you verify the claim that the trader has sold more oranges than apples?"*
AK : *"I can verify this claim by determining the quantities of oranges and apples sold using the system of linear equations in two variables and applying the substitution method. The trader's claim is confirmed if the calculated number of oranges exceeds the number of apples sold."*

Students with medium mathematical reasoning ability (NM)

On the indicators of finding patterns of relationships and generalizing a statement, NM is able to bring that aspect to light. This is evident from the answer provided by NM in Figure 4.

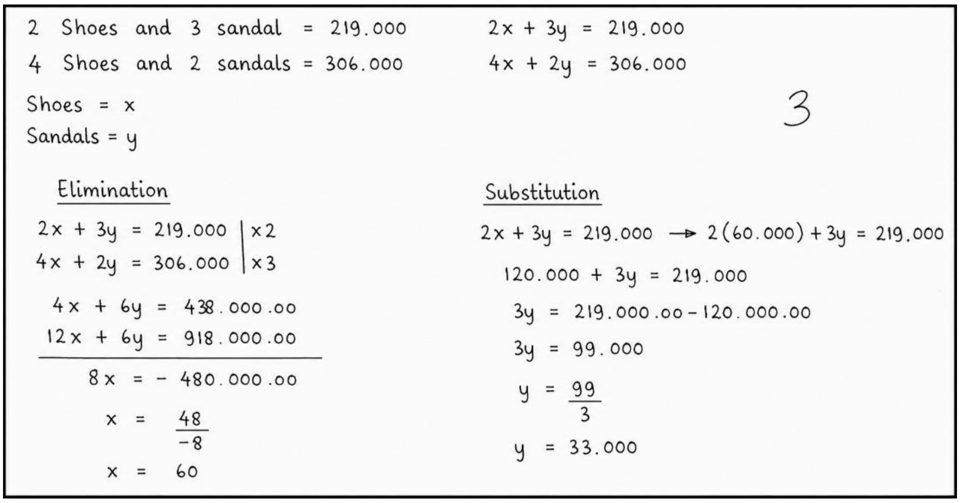


Figure 4. Answer to problem number 1 by a medium-ability student

NM's answer shows that NM has been able to identify the aspect of finding relationships by using a mixed-method approach to determine the price of each shoe and sandal after packaging them, and then generalizing a statement by drawing a conclusion about the price. However, there was a mathematical error where 480.000 was written as 48, resulting in a final answer of 60 instead of 60.000. As for the interview regarding question number 1 conducted with NM, it is as follows.

R : "Do you perceive that the mathematics literacy–based e-module assists in recognizing patterns or relationships within the system of linear equations in two variables (SLETV) concept?"

NM : "Yes, I do."

R : "Could you explain which aspects of the e-module are helpful in this regard?"

NM : "From the problem and the information given in it."

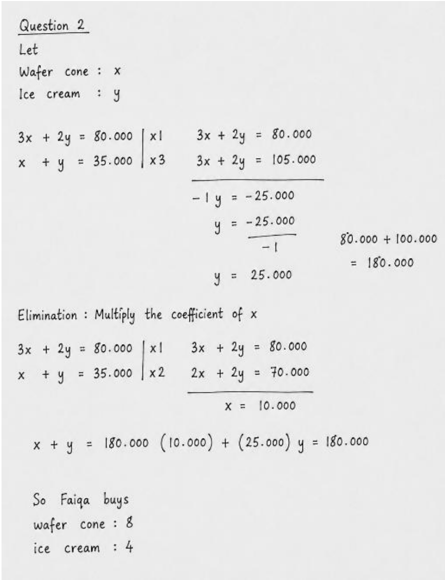
R : "Are there any specific tools or features in the e-module that support your understanding of SLETV material?"

NM : "Yes, there are. The e-module includes numerous examples and explanations, particularly those presented in video format, which are easy to understand."

R : "How does the e-module assist you in constructing a mathematical model from an SLETV problem?"

NM : "By analyzing the problem, I can identify the variables and then formulate the corresponding equations."

Regarding the indicator of making assumptions, NM can highlight that aspect. This is evident from NM's answer in Figure 5.


Question 2
Let
Wafer cone : x
Ice cream : y

3x + 2y = 80.000 | x1   3x + 2y = 80.000
x + y = 35.000 | x3   3x + 2y = 105.000
−1 y = −25.000
y = −25.000 / −1
y = 25.000
80.000 + 100.000
= 180.000

Elimination : Multiply the coefficient of x
3x + 2y = 80.000 | x1   3x + 2y = 80.000
x + y = 35.000 | x2   2x + 2y = 70.000
x = 10.000

x + y = 180.000 (10.000) + (25.000) y = 180.000

So Faiqa buys
wafer cone : 8
ice cream : 4

Figure 5. Answer to problem number 2 by a medium-ability student

NM's answer shows that NM is already capable of presenting the aspect of proposinga conjecture, as can be seen from NM's answer which starts with modeling the problem, then finding the price of a chocolate wafer and an ice cream cup using the elimination method, after which he assumes that the number of chocolate wafers is 8 and the number of ice cream cups is 4 that Fairah can buy. The interview for question number 2, conducted with NM, is as follows.

R : *"How did you estimate that the number of chocolate wafers was eight and the number of ice cream cups was four?"*
NM : *"The estimation was made based on the known prices of the chocolate wafers and the ice cream cups."*
R : *"From which process did you obtain the price of each item?"*
NM : *"The prices were determined by applying the elimination method and the substitution method."*

Regarding the indicator of verifying the truth of an argument, NM can present that aspect. This is evident from the answer provided by NM in Figure 6.

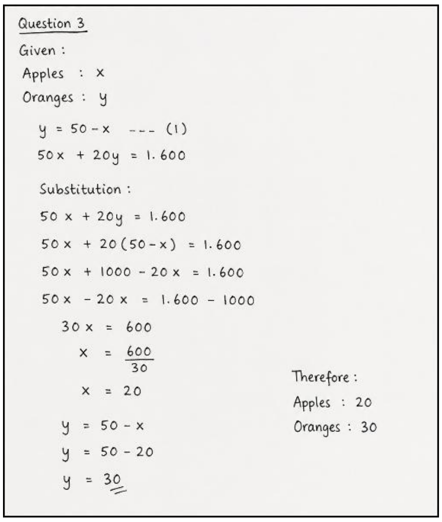

Question 3
Given :
Apples : x
Oranges : y
y = 50 − x --- (1)
50x + 20y = 1.600
Substitution :
50 x + 20y = 1.600
50 x + 20 (50 − x) = 1.600
50 x + 1000 − 20 x = 1.600
50 x − 20 x = 1.600 − 1000
30 x = 600
x = 600 / 30
x = 20
y = 50 − x
y = 50 − 20
y = 30
Therefore :
Apples : 20
Oranges : 30

Figure 6. Answer to problem number 3 by a medium-ability student

NM's answer shows that NM has been able to demonstrate the aspect of verifying the truth of an argument, meaning NM can prove that the argument made by the trader is true by performing calculations using the substitution method to verify the trader's argument that oranges are sold more than apples, but did not write a clear conclusion. As for the interview regarding question number 3 conducted with NM, it is as follows.

R : *"On what basis did you determine the variables and ?"*

NM : *"The variables were identified based on the information provided in the problem. Since the question examines whether the number of oranges sold exceeded the number of apples sold, the variables represent oranges and apples, respectively."*

R : *"How can you verify the validity of the claim that the trader sold more oranges than apples?"*

NM : *"This can be verified by applying the substitution method to the system of equations, which allows us to determine the corresponding values and confirm the result."*

Students with low mathematical reasoning ability (EA)

Regarding the indicator of finding patterns and generalizing a statement, EA has not yet demonstrated this aspect. This is evident from the EA's answer in Figure 7.

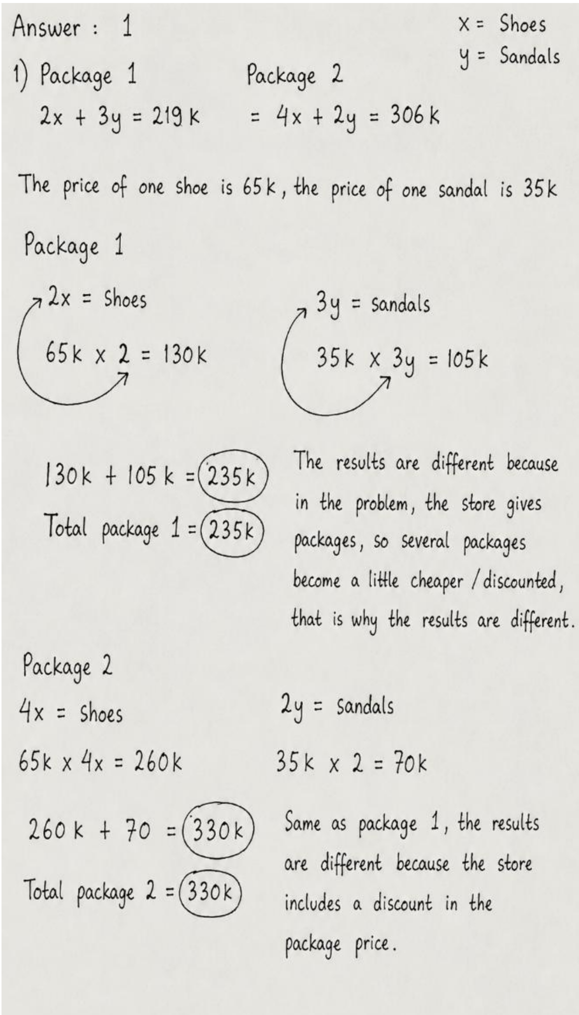


Figure 7. Answer to problem number 1 by a low-ability student

EA's answer shows that it has not yet identified the aspect of finding relational patterns and generalizing a statement about the SLETV problem. EA only substituted each value already listed in the question into the equation, resulting in an incorrect conclusion. As for the interview regarding question number 1 conducted with EA, it is as follows.

R : *"Can the information provided in the e-module assist you in solving the problem?"*
EA : *"Yes, it can."*
R : *"In what way do you solve the problem?"*
EA : *"I solve the problem by identifying and organizing the information given in the question. Since the prices of the sandals and the shoes are explicitly stated, I directly substituted those values into Package 1 and Package 2, thereby obtaining the total price for each package".*
R : *"What exactly is being asked in the question?"*
EA : *"The question asks for the price of a pair of shoes and a pair of sandals after they are packaged. However, Ma'am, the prices are already provided in the question."*
R : *"Please read the question more carefully. There is a statement indicating that the store created several packages so customers could obtain a lower price. This implies that the question is asking for the prices of the sandals and shoes after a discount has been applied."*
EA : *"I understand now, Ma'am. I did not pay sufficient attention to that part of the question."*

On the indicator of proposing a conjecture, EA has not yet been able to present that aspect. This is evident from the EA's answer in Figure 8.

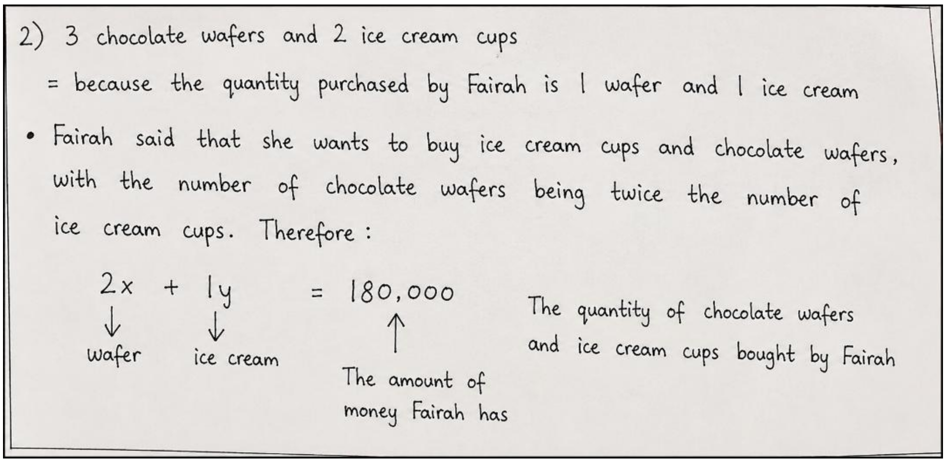


Figure 8. Answer to problem number 2 by a low-ability student

EA's answer shows that he has not yet introduced the aspect of proposing a conjecture because he directly created equations from the statements in the problem, but the equations made by him are still not correct, and he has not yet found the prices for chocolate wafers and ice cream cups, so the final result given is also not correct. As for the interview regarding question number 2 conducted with EA, it is as follows.

R : *"From where did you derive the result of three chocolate wafers and two ice cream cups?"*
EA : *"This is because Fairah intends to purchase chocolate wafers in a quantity twice that of ice cream cups, which I represented as 2x + 1y. Meanwhile, Kazim*

purchases one chocolate wafer and one ice cream cup. Therefore, the total becomes three chocolate wafers and two ice cream cups, Ma'am."

R : "Is it correct to state 2x + 1y = 180.000? In the problem, it is stated that Fairah wants to buy chocolate wafers in a quantity twice that of ice cream cups. Does three chocolate wafers truly represent twice as many as two ice cream cups?"

EA : "Oh, I see, Ma'am."

R : "Given that conclusion, what should be done next?"

EA : "I am unsure, Ma'am."

Regarding the indicator for verifying the truth of an argument, EA can highlight that aspect. This is evident from the EA's answer in Figure 9.

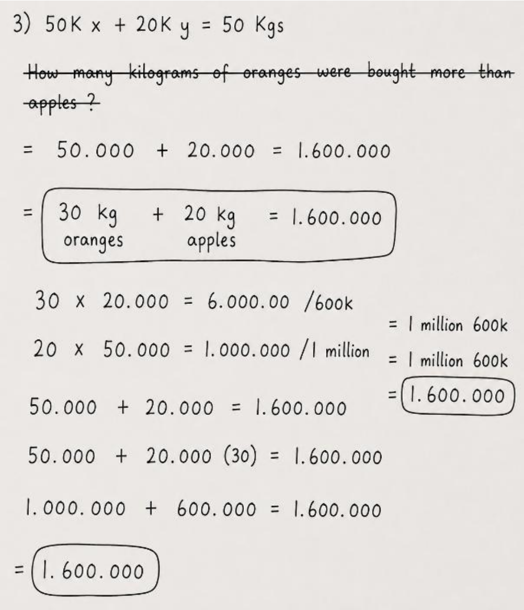


Figure 9. Answer to question number 3 by a low-ability student

EA's answer shows that he has not yet been able to demonstrate the aspect of verifying the truth of an argument, as he is still mistaken in creating a mathematical model of the problem and directly guessing the final result without any calculations. As for the interview regarding question number 3 conducted with EA, it is as follows.

R : "In your response, you wrote the equation 30kg + 20 kg = 1,600,000. Could you explain how you determined that the quantities were 30kg of oranges and 20kg of apples?"

EA : "Based on the problem statement, it is mentioned that the amount of oranges sold was greater than the amount of apples. Since the total weight of fruit sold was 50kg, I assumed that the oranges weighed 30 kg and the apples weighed 20kg."

R : "Then, what is the purpose of the equation 50,000x + 20,000?"

EA : "I am not certain. I wrote that equation solely based on the information provided in the problem statement."

Discussion

Since solving mathematical problems necessitates reasoning and learning mathematics helps develop reasoning ability, mathematics and reasoning are inextricably linked (Niswah & Qohar, 2020). Therefore, to improve a student's mathematical capabilities, mathematical thinking abilities are required (Hasanah et al., 2019). Based on the overall research stages, this finding suggests that the use of digital media-based electronic modules has not optimally facilitated the even development of students' MR. Although a small percentage of students demonstrated high MR, the dominance of students in the low-ability category indicates that not all indicators were raised by these students. Most students in the lower category still struggle to model mathematical concepts. Some students are also confused by the information presented in the e-module problems. The e-module fully explains how to model a problem mathematically, both in written form and through video lessons, so the e-module is not a contributing factor to these weaknesses. Furthermore, the teacher is negligent, failing to fully supervise students, resulting in some students using their devices to play games rather than accessing the e-module. Through the multifaceted process of self-regulated learning (SRL), students actively organize, track, and assess their behavioral, motivational, and cognitive engagement with academic assignments (Greene, 2017).

Although digital media has advantages, some previous studies have shown that it also has weaknesses. Some of these weaknesses include not all areas having internet access, which is a constraint in operating internet-based digital media (Hamidah, 2021). There are some areas where students are not yet technologically literate, and students tend to play games when using gadgets (Khairunnisa & Ilmi, 2020). The findings of this study also indicate that e-modules based on digital media are more beneficial for students with high MR compared to those with low abilities. High-achieving students tend to actively monitor their own learning process. In general, cognitive load theory supports a teaching approach that emphasizes high levels of instructional assistance and supervision (Evans et al., 2023). They can use e-modules as a learning resource to explore ideas, test hypotheses, and connect SLETV concepts to contextual situations. Thus, e-modules serve as a reinforcement for MR, not merely as a tool for delivering material.

This is in line with the research conducted by Vebrian et al. (2021) which revealed that students' mastery of MR is very low in solving mathematical literacy problems. This is evident from the scores on the indicators of making conjectures, mathematical manipulation, and constructing proofs and arguments, which reached only 42.88%, while the indicator of drawing conclusions obtained a score of 41.36%. Students who do not meet the indicators may be due to their insufficient understanding of strategies for transforming into mathematical models (Endrawati & Ramlah, 2021).

There are students who are not yet able to demonstrate the indicators of recognizing patterns and generalizing a statement because they do not understand, or have only a limited understanding, of the problems in the questions, and they struggle to determine the steps to solve them. As a result, they cannot draw conclusions from the statements in the questions. This is in agreement with (Erfani et al., 2020) that because students are afraid to ponder, they are unable to solve problems and fail to verify their conclusions.

During classroom learning, students with high MR made more productive use of the e-module. Not only did they pay attention to written explanations, but they also followed the video discussions and completed the quizzes provided in the e-module, which seemed to help them understand contextual problems and identify relevant mathematical relationships. In contrast, students with low MR still struggled to construct mathematical models from contextual systems of linear equations in two variables (SLETV) problems. This difficulty could be due to a lack of focus during lessons, reluctance to ask questions when confused, and low engagement in learning activities. Although the e-module provided explanations, examples, videos, and practice tasks, the scaffolding for transforming contextual information into mathematical models may not have been sufficiently explicit for students who needed stronger step-by-step guidance. As a result, some students did not fully use the available scaffolds and tended to respond procedurally without clearly identifying variables, relationships, and assumptions embedded in the problem. These findings suggest that the presence of digital learning materials alone does not guarantee that students, particularly those at lower reasoning levels, will successfully engage in modeling processes. Rather, such students may require more explicit support within the learning materials, especially in moving from contextual situations to mathematical representations before proceeding to formal solution steps. This interpretation is consistent with the view that students' learning is influenced by how instructional materials are structured and how they support cognitive processing in relation to prior knowledge (Evans et al., 2023).

Conclusion

The research findings provide empirical insight into how junior high school students demonstrate MR when engaging with mathematical literacy problems through e-module-assisted learning. The findings show that students' reasoning performance varied across high, medium, and low categories, with stronger performers demonstrating the ability to find patterns and relationships, generalize a statement, propose a conjecture, and verify the truth of an argument more coherently. Students with high MR ability can demonstrate all indicators of MR, engage actively in learning, and utilize literacy-based e-modules optimally, both in understanding the material and completing assignments. Students with medium MR ability can generate some indicators of MR ability, but still make a few errors. They are able to use e-modules, but their cognitive participation is limited, as indicated by their low initiative to ask the teacher when experiencing difficulties and their tendency to rely on peers. Meanwhile, students with low MR ability are still unable to generate reasoning indicators and show minimal learning engagement, limited use of e-modules, and low learning discipline, so the e-module does not adequately support the development of their MR.

From a practical perspective, the study indicates that mathematical literacy-based e-modules can serve as valuable learning resources to support students' reasoning development when used alongside appropriate pedagogical support. In particular, e-modules may be strengthened by incorporating more explicit scaffolding for interpreting contextual situations, constructing mathematical models, testing conjectures, and communicating conclusions. At the same time, this study was conducted with a limited number of participants and a single mathematical topic. These conditions should be considered when interpreting the findings. Future research is recommended to specifically test whether providing structured mathematical modeling activities within a literacy-based e-module results in greater improvements in reasoning skills for low-ability students than for medium- and high-ability students. Furthermore, research could compare the effectiveness of different instructional support formats and specific digital design features in improving MR skills.

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