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Exploring Students' Mathematical Literacy in Understanding and Applying Linear Equations: A Qualitative Inquiry in Indonesian Junior High Schools

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ABSTRACT
Background: Mathematical literacy helps students link abstract reasoning to real situations, yet many still find it difficult to apply such understanding, especially when learning linear equations.
Aims: This research explores how junior high school students understand and apply mathematical literacy when dealing with problems related to linear equations in one variable. It also aims to uncover the factors influencing their ability to reason, interpret, and express mathematical ideas within real-life contexts.
Methods: The study used a qualitative descriptive design involving twenty-five eighth-grade students from SMP Islam Al-Manar, Bekasi, Indonesia. Participants were chosen purposively to represent different literacy levels. Data were collected through mathematical literacy tests and semi-structured interviews, then analyzed thematically to identify patterns in comprehension, algebraic reasoning, and contextual understanding.
Result: The findings reveal that most students had a basic grasp of linear-equation concepts but faced challenges in connecting algebraic operations with everyday situations. Around sixty percent of them were categorized at low to moderate literacy levels, while only a small proportion about fifteen percent showed high literacy competence. Students with better conceptual understanding tended to demonstrate clearer reasoning and more structured strategies when solving contextual problems.
Conclusion: Overall, students' mathematical literacy in linear equations remains limited, particularly in transforming daily problems into mathematical forms. Enhancing this skill requires contextual learning approaches that promote independent exploration, critical reasoning, and authentic problem-based experiences. The insights gained from this study highlight the importance of designing learning models that bridge mathematical theory and practical application in junior high school education.

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Introduction

There is an urgent need to reexamine how mathematical literacy is developed in Indonesian junior high schools, as students continue to struggle with applying mathematical reasoning to everyday contexts. Despite continuous curricular reforms, mathematics learning still emphasizes procedural mastery rather than conceptual understanding and contextual problem-solving (Olivares et al., 2021). Many students can compute answers but fail to interpret what their results mean in real-life situations. This pattern is particularly visible in the topic of linear equations, which forms the foundation for later algebraic reasoning (Harel, 2024; Wilkie, 2024). When students cannot connect symbols and numbers to actual problems, the essence of mathematical learning is lost. The challenge reflects not a lack of intelligence but a lack of literacy oriented pedagogy that encourages interpretation and reasoning. The urgency of addressing this gap lies in its direct impact on students' readiness for higher-level mathematics and everyday decision-making. Hence, this study begins by exploring students' mathematical literacy within the framework of understanding and applying linear equations.

Mathematical literacy, as defined by the Programme for International Student Assessment (PISA), is the capacity to formulate, employ, and interpret mathematics in various contexts to make well-founded judgments. It is not limited to the ability to calculate but includes the reasoning needed to translate a problem from words to symbols and back to interpretation (Manning, 2022; Nikolic et al., 2023). In the

Indonesian educational landscape, this definition is often misunderstood as a higher-level competency rather than a skill to be developed from early grades. Schools tend to prioritize mastery of algorithms over the exploration of meaning behind them. As a result, students can manipulate equations yet cannot relate them to authentic scenarios such as pricing, measurement, or proportion (Kaplan et al., 2021). This disconnection weakens their capacity to think flexibly, evaluate results, and use mathematics for daily reasoning. Investigating how literacy is practiced in a fundamental topic like linear equations thus becomes an essential first step toward improving educational quality.

Junior high school represents a critical stage in students' cognitive development where abstract reasoning begins to take form (Kwangmuang et al., 2021; Sibgatullin et al., 2022). At this stage, learners transition from concrete arithmetic toward generalization and symbolic representation. Linear equations in one variable are introduced as a basic form of algebra, but they also function as a bridge to proportional reasoning and functional thinking (Harel, 2024; Wilkie, 2024). Students who fail to build understanding at this level may face long-term challenges in geometry, algebraic modeling, and applied mathematics. The difficulty lies not in the computation but in the cognitive demand of transforming real problems into mathematical form. When students can solve "x + 5 = 12" but cannot construct the same equation from a word problem, their learning reflects memorization rather than comprehension. This study acknowledges the importance of examining how students reason, interpret, and construct meaning when dealing with linear equations. Such inquiry contributes to identifying where the learning process succeeds and where it breaks down.

In recent years, educational researchers have emphasized multiliteracy as a response to the complexity of learning in the digital and global era. Multiliteracy recognizes that students must not only read and write text but also interpret information through diverse modes numerical, graphical, and symbolic (Lim et al., 2022; Pires Pereira, 2022). Mathematics, therefore, serves as both a language and a tool for communication. However, in many Indonesian classrooms, literacy-based instruction has not yet become a consistent practice (Marmoah & Jenny Indrastoeti Siti Poerwanti, 2022). Teaching often remains teacher-centered, where students listen, copy notes, and complete repetitive exercises with limited engagement in reasoning. Under such circumstances, students rarely experience tasks that require interpretation, justification, or reflection. Consequently, their mathematical literacy stagnates at the procedural level. The present study is motivated by this educational reality and seeks to reveal what literacy looks like when students work through contextual tasks related to linear equations.

The results of international assessments such as PISA have consistently shown that Indonesian students underperform in mathematics, particularly in items requiring formulation and interpretation. These competencies are central to mathematical literacy and directly relate to real-world reasoning (Çakıroğlu et al., 2024; Manfreda Kolar & Hodnik, 2021). Linear equations provide an ideal context for assessing such skills because they demand students to identify relationships, construct models, and interpret results. If students can solve symbolic problems but fail to explain their meaning, it indicates that mathematical learning has remained surface-level. Observations from teachers at SMP Islam Al-Manar show similar patterns: students can follow steps correctly but cannot justify them. This issue suggests that the underlying difficulty lies not in understanding the formula but in applying reasoning within context (Plevris et al., 2023). Therefore, a qualitative approach that captures the nuances of students' thought processes is needed to gain a deeper understanding of these literacy challenges.

Most previous research on mathematical literacy in Indonesia has employed quantitative designs focusing on test performance or statistical relationships among variables. While such studies are informative, they often overlook the cognitive and linguistic processes that occur when students attempt to solve contextual problems. Quantitative results may tell us that literacy is low, but they cannot show why or how students interpret information incorrectly (Kim et al., 2022; Lee et al., 2021). By employing a qualitative approach, this study captures students' voices, reasoning patterns, and the strategies they use when encountering literacy-based mathematical tasks. This kind of evidence is critical for teachers who need practical insights to design instruction that supports different literacy levels (Jerrim et al.,

2022; Ng et al., 2024). Furthermore, qualitative findings allow for a richer interpretation of students' challenges and strengths, which can complement large scale survey data and guide pedagogical intervention.

The context of SMP Islam Al-Manar also adds meaningful perspective to this investigation (AL-Momani, 2024; Firmansyah et al., 2025). As a private Islamic school operating under the national curriculum, it represents a segment of Indonesian education where academic expectations and student backgrounds are highly diverse. Teachers in such settings often face constraints related to resources, heterogeneous ability levels, and traditional teaching habits (Cabanillas-García, 2025; Chanda et al., 2025). Examining students from this environment allows for a realistic picture of how mathematical literacy develops beyond elite urban schools typically studied in research. The findings may inform teacher training programs and curriculum development initiatives aimed at improving literacy-oriented instruction. More importantly, it ensures that discussions about mathematics education reform are grounded in classroom realities rather than theoretical assumptions.

Finally, the urgency of this study lies in its potential contribution to both academic and practical domains. In an increasingly data-driven society, the ability to interpret quantitative information is indispensable (Bachmann et al., 2022; Elgendy et al., 2022). Students who leave school without sufficient mathematical literacy risk becoming passive consumers of information rather than critical thinkers. Strengthening literacy through topics such as linear equations builds a foundation for lifelong numeracy and decision-making skills. By identifying how students construct, reason, and communicate mathematical meaning, this research offers actionable insights for educators seeking to enhance teaching quality (Koskinen & Pitkäniemi, 2022). The study also supports the broader goal of aligning Indonesia's mathematics education with global standards that emphasize understanding, reasoning, and application. Through this work, mathematics is reimagined not merely as a subject to be memorized but as a way of thinking to be lived.

Fernández San Martín (2025) explained that literacy becomes meaningful only when individuals interpret knowledge within authentic contexts, which aligns with the essence of mathematical literacy in education. Cao et al. (2025) highlighted that understanding structural relationships improves reasoning, a skill crucial for solving linear equations conceptually. Tashevski et al. (2025) emphasized that students' cognitive diversity requires teachers to build connections between abstract symbols and concrete understanding. Gurmani et al. (2025) showed that effective problem solving emerges when learners integrate multiple sources of information, similar to combining symbolic and contextual reasoning in mathematics. Gandarilla-Javier et al. (2025) found that reflective discussion enhances comprehension, suggesting that mathematics learning should promote interpretive dialogue. LeMasters et al. (2025) stated that inquiry-based learning deepens understanding, reinforcing the need for contextual problems in algebra instruction. Ntizoyimana et al. (2025) argued that decoding complex systems into meaningful representations parallels how students translate word problems into equations. Farzaneh & Banimostafaarab (2025) confirmed that structured frameworks strengthen interpretation, resembling the analytical process of mathematical modeling. Silva Araújo Andrade et al. (2025) demonstrated that analytical modeling supports comprehension when learners visualize relationships among variables. Hegarty (2022) revealed that interpretive reasoning develops through reflection, validating qualitative approaches to explore mathematical thinking. Together, these ten scholars underline that literacy, across disciplines, depends on reasoning, modeling, and contextual application. This study builds on their insights by examining how Indonesian junior high school students develop mathematical literacy through understanding and applying linear equations.

This study is grounded in the understanding that mathematical literacy represents far more than the ability to perform calculations it reflects the learner's capacity to reason, interpret, and apply mathematics to everyday life. In the Indonesian context, efforts to cultivate this form of literacy have been ongoing, yet the outcomes of both national and international assessments show that many students still struggle to apply mathematical reasoning beyond routine exercises. At the junior high school level, where

abstract thinking begins to mature, students are expected to move from mechanical computation toward conceptual understanding and problem modeling. However, the shift from formula based learning to meaning-based reasoning remains limited in practice. Most classroom interactions emphasize correct answers rather than the reasoning process behind them. As a result, learners often know how to manipulate symbols but fail to interpret what those symbols represent in context. This condition underscores the need for research that explores students' literacy from a deeper perspective one that observes not just what they can solve, but how they think while solving it. The present study takes this position, aiming to uncover the reasoning patterns and interpretative processes that underlie students' understanding of linear equations.

A review of existing literature reveals that research on mathematical literacy in Indonesia has mostly centered on quantitative evaluations, focusing on scores and statistical correlations. While such studies provide useful overviews, they leave unanswered questions about how students actually engage with mathematical ideas during contextual problem solving. The processes through which learners interpret problems, form equations, and validate their answers have rarely been examined in detail. Moreover, few studies specifically address the topic of linear equations in one variable a fundamental concept that serves as the basis for algebraic thinking. Previous investigations aligned with the PISA framework often highlight low literacy scores but seldom explore the underlying cognitive and linguistic reasons for those results. This absence of qualitative insight represents a significant gap in the literature. There is also limited understanding of how teaching practices, school culture, and student backgrounds shape the development of mathematical literacy. Recognizing this gap, the present study adopts a qualitative approach to capture the lived cognitive experiences of learners as they attempt to interpret and apply linear equations in meaningful ways. By documenting these thought processes, the research seeks to complement existing quantitative findings with rich, contextual evidence.

The central purpose of this research is to describe and analyze how eighthgrade students understand and apply mathematical literacy when learning linear equations in one variable. The study aims to identify patterns of reasoning, interpretation, and contextual application that emerge among students with varying literacy levels whether high, moderate, or low. Through written tasks and follow-up interviews, this inquiry seeks to reveal how learners translate everyday situations into mathematical expressions and what difficulties they face in doing so. The investigation is not intended to test a numerical hypothesis but to illuminate the conceptual and linguistic pathways through which mathematical understanding develops. It also assumes that students who display reflective thinking and conceptual comprehension tend to show stronger mathematical literacy. The expected outcome is a clearer picture of how contextual reasoning can be nurtured through classroom practices that move beyond memorization. Ultimately, this study aspires to contribute both theoretically and practically by providing educators and curriculum developers with evidence-based insights to strengthen literacy-oriented mathematics instruction in Indonesian schools.

Method

Research Design

This research applied a qualitative descriptive design aimed at gaining a deep understanding of students' mathematical literacy in the context of linear equations with one variable. The qualitative approach was chosen because it allows the researcher to observe and describe students' reasoning as it naturally occurs, rather than reducing it to numerical data. Through this design, the study focuses on how students interpret, model, and communicate mathematical ideas while solving contextual problems. The qualitative descriptive framework also provides room for narrative exploration, allowing individual differences in thinking and interpretation to emerge clearly. This design is particularly suitable for educational research where the goal is to capture the complexity of students' learning behavior rather than to test hypotheses statistically.

Participant

The participants in this study were 25 eighth grade students from SMP Islam Al-Manar, Bekasi, Indonesia. The selection used purposive sampling to ensure that the participants represented various levels of mathematical literacy categorized as high, medium, and low. From this group, three students were selected as the main subjects for in depth analysis based on their test results and recommendations from their mathematics teacher. Each of these students reflected different literacy characteristics that helped the researcher portray a broader picture of learning diversity in the classroom. All participants were informed about the objectives of the study, and consent was obtained from the school administration and the students themselves. Ethical considerations were upheld throughout the research, ensuring that data were collected respectfully and kept confidential.

Instrument

Two main instruments were developed and used to collect the data. The first instrument was a mathematical literacy test consisting of five open ended questions related to real-life situations involving linear equations in one variable. The test was designed to assess three literacy components understanding, application, and interpretation based on the OECD PISA mathematical literacy framework. Each item encouraged students to translate real situations into mathematical form and to explain their reasoning behind each answer. The second instrument was a semi structured interview guide, used to explore students' thought processes in greater depth. The interview questions were flexible, allowing the researcher to ask follow-up questions when necessary to clarify reasoning or identify misconceptions. Expert review was conducted before implementation to ensure both instruments were valid, relevant, and aligned with the purpose of the research.

Data Analysis

The data were analyzed using a thematic qualitative technique that combined descriptive and interpretative processes. First, students' written answers and interview transcripts were reviewed carefully to identify recurring ideas and reasoning patterns. Then, the responses were coded according to literacy indicators: comprehension, application, and contextual interpretation. The coding followed an inductive process, meaning that the themes were developed directly from the data rather than imposed by theory. Afterward, the data from each student were compared to reveal similarities and differences among those with high, moderate, and low literacy levels. Triangulation was used by comparing test results, interview data, and teacher notes to strengthen the credibility of the findings. Finally, the researcher interpreted these patterns narratively to provide a holistic understanding of how students approached mathematical problems in the topic of linear equations.

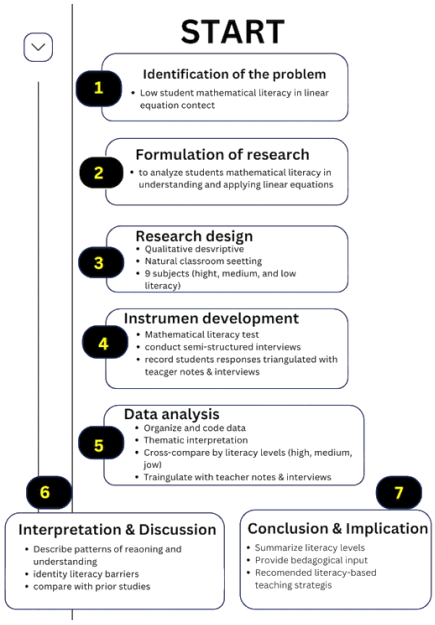

Figure 1. Flowchart of the Research Process

Results and Discussion

Results

The findings of this study provide a detailed picture of how eighth-grade students at SMP Islam Al-Manar performed when faced with mathematical literacy tasks related to linear equations in one variable. The results are presented through quantitative data from literacy tests and qualitative evidence from interviews that reveal students' reasoning patterns and problem solving behavior. Overall, the results indicate that most students possess adequate conceptual understanding but encounter difficulties when applying that knowledge to contextual situations.

The first part of the analysis examined how students performed across three main literacy indicators: understanding, application, and contextual problem solving. The results are shown in Table 1, which highlights the gradual decline in achievement as the cognitive demand of the task increases.

Table 1. Achievement of Mathematical Literacy Indicators

Indicator	Number of Students	Percentage
Understanding the concept of one-variable linear equations	16	80%
Applying algebraic operations to solve one-variable linear equations	11	55%
Solving real-life problems involving one-variable linear equations	7	35%

Students demonstrated the strongest results in basic conceptual understanding, with 80 percent showing that they could recognize and describe the structure of a linear equation. The percentage dropped to 55 percent in applying algebraic operations, suggesting that while students could manipulate symbols, many relied on memorized procedures. The lowest score 35 percent appeared in the contextual problem-solving indicator, where students needed to connect abstract equations to real-life examples. This trend illustrates that comprehension alone does not automatically translate into literacy; students must also learn to interpret mathematical meaning in context.

To provide a broader view of overall performance, students' test scores were grouped into three literacy levels: low, moderate, and high. The data in Table 2 and Figure 2 show the frequency and proportion of students within each level.

Table 2. Distribution of Students' Mathematical Literacy Levels

Score Interval	Frequency	Percentage	Literacy Level
20 – 47	6	30%	Low
48 – 75	9	45%	Moderate
76 – 103	3	15%	High
Total	20	100%	—

Table 2 presents the distribution of students' mathematical literacy levels based on their test scores. Of the 20 students involved in the study, the largest proportion falls within the moderate literacy level, with 9 students or 45 percent achieving scores in the range of 48 to 75. This indicates that nearly half of the participants demonstrate an adequate ability to understand, apply, and interpret mathematical concepts, although their literacy has not yet reached an advanced level.

Meanwhile, 6 students or 30 percent are categorized as having a low level of mathematical literacy, with scores ranging from 20 to 47. This group reflects students who experience difficulties in comprehending mathematical problems, applying appropriate procedures, or interpreting mathematical situations contextually. In contrast, only 3 students or 15 percent achieve scores between 76 and 103, placing them in the high literacy level category. These students show strong mastery in understanding concepts, applying mathematical reasoning, and interpreting problems effectively. Overall, the

distribution suggests that most students are clustered at the moderate level, with relatively fewer students demonstrating high mathematical literacy.

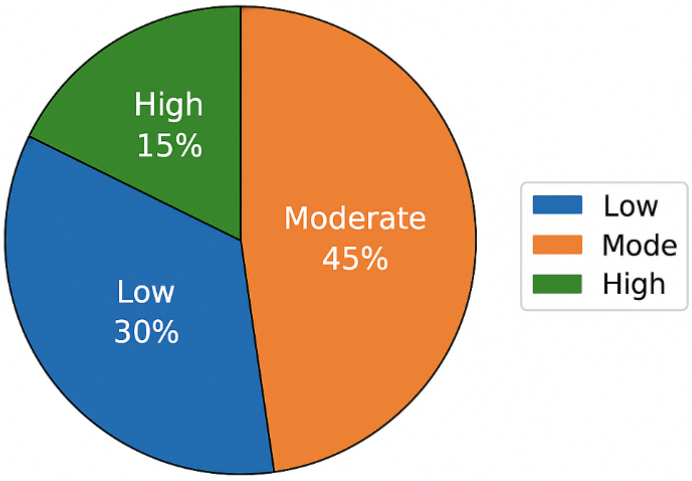

Figure 2. Pie Chart of Students' Mathematical Literacy Levels

The data show that nearly half of the students (45 percent) fell into the moderate category, demonstrating partial literacy skills. About 30 percent were in the low category, indicating persistent difficulty in reasoning and modeling. Only a small group, around 15 percent, reached the high literacy level and were able to connect mathematical processes with contextual meaning. These findings imply that while students have learned how to operate within formulas, most are still developing the reflective and interpretive abilities required for mathematical literacy.

Discussion

The results of this study reveal that students' mathematical literacy in understanding and applying linear equations remains limited, especially when contextual reasoning is involved. Many students could handle symbolic manipulation but struggled to interpret what the equations represented in real situations. This finding is consistent with the view of Fernández San Martín (2025), who argued that literacy only becomes meaningful when knowledge is applied to authentic contexts rather than isolated exercises. The students' performance shows that their learning experience has been largely procedural, relying on memorized patterns instead of flexible reasoning. Mathematics in many classrooms is still presented as a set of rules rather than a way to understand the world. When concepts are taught without context, learners develop mechanical habits but not interpretive understanding. The implication is that teachers must create opportunities for students to experience mathematics through realistic tasks. This change in pedagogy is crucial to transforming mathematical knowledge into genuine literacy.

The relationship between reasoning and literacy was also evident in the students' responses. Cao, Jia, and Luo (2025) noted that comprehension improves when learners recognize the structural relationships underlying a concept rather than focusing on calculation alone. In this study, students who achieved high literacy demonstrated the ability to maintain the balance of an equation while considering its meaning in a given problem. They showed awareness of how changing one variable affects the others, which is a form of structural reasoning. In contrast, students with low literacy treated numbers and symbols separately, showing no connection between operations and meaning. This pattern emphasizes that mathematical literacy depends on understanding relationships rather than memorizing steps. Teachers should therefore guide students to explore why procedures work instead of only how to perform them. Such awareness can help shift mathematical learning from procedural to conceptual understanding.

The findings also highlight the essential role of dialogue and reflection in improving mathematical literacy. Gandarilla, et all (2025) emphasized that reflective conversation helps learners articulate reasoning and evaluate their thought process. In this study, students who could explain their strategies verbally often showed stronger understanding. They were able to justify their solutions and identify errors through discussion. However, many classroom practices still emphasize silent problem solving, leaving little room for interaction. Without reflection and communication, learners' reasoning remains implicit and fragmented. Encouraging students to discuss and question their work allows them to transform abstract ideas into coherent understanding. Dialogue not only deepens reasoning but also builds confidence in expressing mathematical ideas meaningfully.

A related pattern found in this study is the importance of contextual reasoning for developing literacy. Gurmani et al. (2025) explained that effective decision making requires integrating multiple sources of information to reach logical conclusions. The students who performed best in this study were able to combine numerical data, textual clues, and algebraic representation when solving problems. They adjusted their reasoning flexibly as new information appeared. Those in the lower category, however, relied heavily on isolated formulas and failed to connect them to the context of the task. This shows that mathematical literacy grows when students learn to think across representations and not just within a single symbolic frame. Integrating multiple perspectives strengthens their ability to analyze and model real-life situations. Contextual reasoning thus serves as a bridge between abstract algebra and everyday logic.

Inquiry-based learning also appeared to play an important role in the students' performance. Le Masters, et al. (2025) argued that when learners are encouraged to explore ideas rather than memorize formulas, they develop deeper and more sustainable understanding. Students who reached high literacy levels in this study often approached problems through exploration testing different strategies, asking questions, and reflecting on the outcomes. They did not depend solely on the teacher's examples but instead constructed their own reasoning pathways. Meanwhile, students who were accustomed to traditional instruction struggled to work independently. This difference suggests that inquiry-based environments encourage curiosity and persistence, two traits necessary for literacy growth. When students are allowed to investigate, they learn to view mathematics as a creative rather than mechanical activity. Fostering inquiry habits can therefore improve literacy outcomes in a meaningful way.

The results also point to variations in cognitive organization among students with different literacy levels. Tashevski, et al. (2025) observed that differences in cognitive clustering lead to varying patterns of understanding. High literacy students in this study displayed well structured reasoning that allowed them to transfer concepts across problems. In contrast, those in the moderate or low categories showed disorganized thinking, often losing focus midway through problem solving. This indicates that literacy depends not only on content mastery but also on cognitive discipline. Helping students recognize patterns, group ideas, and connect procedures with meaning could improve their mental organization. Instructional strategies that emphasize pattern recognition and conceptual mapping may therefore enhance literacy development. Recognizing the diversity of thinking among students is also essential for teachers to design inclusive and effective instruction.

The study further reinforces the idea that literacy involves breaking down complex structures into simpler, meaningful components. Ntizoyimana, et al (2025) found that literacy in law depends on decoding abstract systems into understandable rules a process that mirrors how students interpret mathematical models. The students in this research who demonstrated literacy were able to "read" mathematical problems by separating known and unknown information and reconstructing it logically. Those who failed to do so treated mathematics as disconnected symbols, unable to see the structure behind equations. This comparison shows that literacy, whether legal or mathematical, is fundamentally about comprehension and interpretation. Developing this ability requires teaching approaches that emphasize reasoning, reading comprehension, and symbolic communication in mathematics. Helping students view equations as languages of relationships can transform how they understand the subject.

Farzaneh and Banimostafaarab (2025) stated that interpreting complex information requires systematic frameworks, which directly relates to the analytical habits seen in high-literacy students. These learners organized their reasoning clearly, defining each step before moving to the next. Their methods were not random but followed logical sequences that led to meaningful conclusions. Students who lacked such structure often produced incomplete or inconsistent solutions. This finding implies that explicit instruction in problem-structuring skills can improve mathematical literacy. Teaching students to outline what is known, what needs to be found, and how ideas connect builds a framework for comprehension. Such metacognitive organization also helps learners monitor and evaluate their reasoning. In mathematics, structure is not just a tool but a reflection of how understanding develops.

The ability to visualize relationships between variables was another key factor influencing literacy development. Silva Araújo Andradet al (2025) emphasized that semi-analytical modeling helps learners grasp abstract ideas by allowing them to visualize relationships. In this study, students who could imagine the relationship between coefficients and results tended to reason more effectively. Visualization allowed them to see how equations represented balance and proportion, transforming symbolic expressions into mental images. On the other hand, students who viewed equations merely as sequences of steps struggled to interpret meaning. Visualization thus acts as a cognitive bridge between conceptual and contextual understanding. Teachers can strengthen this skill by using diagrams, graphs, or real-life simulations that link mathematics to tangible experiences. This practice not only enhances literacy but also builds intuition in algebraic reasoning.

Finally, the development of literacy is closely tied to reflection, a point also made by Hegarty et al. (2025). Reflection enables learners to analyze their reasoning and recognize the logic behind their actions. In this study, students who habitually reviewed their solutions and questioned their own steps achieved more consistent results. They were able to identify weaknesses and correct them independently, demonstrating genuine understanding. Reflection transforms mathematics from a mechanical task into a conscious process of thought. Teachers can foster this by asking students to explain their reasoning or to write brief reflections on what they learned. Such metacognitive activities cultivate awareness and accountability in learning. When reflection becomes part of routine practice, students begin to internalize the logic of mathematics, developing literacy that extends beyond the classroom into real life.

Implications

The results of this study carry meaningful implications for mathematics education, particularly in the effort to strengthen students' mathematical literacy through contextual learning. One of the key messages from this research is that literacy cannot develop if instruction continues to focus only on formulas and fixed procedures. Teachers must create opportunities for students to connect mathematical ideas with situations that are familiar and relevant to their lives. When students interpret equations as representations of relationships rather than as abstract symbols, they begin to see mathematics as a language for reasoning. Another implication concerns the classroom atmosphere. Students who are encouraged to explain their thought processes and discuss alternative solutions tend to develop stronger conceptual understanding. Reflection and dialogue help transform mechanical learning into meaningful engagement. This also has implications for assessment teachers should move away from tests that reward memorization and instead use tasks that assess reasoning and interpretation. In a broader sense, the findings contribute to the ongoing conversation about educational reform in Indonesia by positioning mathematical literacy as an essential foundation for 21st-century skills.

Limitations

Although the study provides valuable insights into students' mathematical literacy, several limitations must be acknowledged to maintain transparency and academic rigor. The first limitation lies in the scope of participants, as the research involved only twenty-five students from a single private junior high school. Such a small sample limits the generalizability of the findings to other school types and regions. In addition, the qualitative nature of this study relies heavily on the researcher's

interpretation, which, even with triangulation, cannot fully eliminate the possibility of bias. Time constraints also limited the depth of the interview sessions, reducing the opportunity to capture broader variations in students' reasoning patterns. Another limitation is the focus on a single mathematical topic linear equations in one variable which may not represent literacy behavior in other mathematical domains such as geometry, statistics, or number sense. Finally, contextual factors such as teacher experience, school culture, and the students' prior exposure to literacy-based instruction may have influenced the results. These limitations do not diminish the value of the study but serve as considerations for future research.

Suggestions

Building on the findings and limitations, several recommendations can be made for teachers, researchers, and policymakers. For teachers, it is crucial to adopt learning strategies that integrate literacy development into daily classroom practice. This includes using contextual problems, encouraging open-ended questioning, and allowing students to explain their reasoning aloud. Teachers should also design lessons that promote exploration rather than repetition, helping students see mathematics as a process of thinking, not just answering. For researchers, future studies should involve a larger and more diverse group of participants to obtain broader and more representative findings. It would also be beneficial to conduct comparative studies across different mathematical topics or grade levels to identify trends in literacy growth. For policymakers and curriculum developers, mathematical literacy should be emphasized explicitly in learning standards and teacher training programs. Providing continuous professional development can help educators design literacy-based instruction that aligns with international frameworks such as PISA. Strengthening collaboration between schools, universities, and government institutions will be essential to ensure that literacy-oriented learning becomes a sustainable part of educational practice. Ultimately, improving mathematical literacy is not a task for teachers alone it requires collective commitment to transform the way mathematics is taught and learned.

Conclusion

The findings of this study show that students' mathematical literacy in learning one-variable linear equations is still developing and varies across individuals. Most students demonstrated adequate skills in performing algebraic operations but found it difficult to interpret and connect mathematical concepts with real world situations. Their ability to use equations as representations of relationships was limited, suggesting that learning has been largely focused on memorizing procedures rather than understanding meaning. The differences observed between students with high, moderate, and low literacy levels highlight that literacy is built through learning experiences that promote reasoning, dialogue, and reflection. To strengthen this ability, teachers need to shift from procedural instruction toward a literacy-based approach that engages students in interpreting, questioning, and applying mathematics in meaningful contexts. Such teaching practices will help students perceive mathematics as a way of reasoning and problem-solving rather than as a mechanical skill, ultimately preparing them to think critically and use mathematical knowledge to navigate challenges in everyday life.

Author Contributions Statement

All authors contributed substantially to the conception, design, execution, and revision of this study. Arie Purwa Kusuma led the research design, developed the theoretical framework, and supervised the overall project to ensure academic rigor. Nurina Kurniasari Rahmawati was responsible for data collection, classroom coordination, and the organization of student assessments during the research process. Khoirunisah contributed to data analysis and interpretation, particularly in identifying literacy patterns and categorizing student performance based on the research indicators. Zahratul Fauziah managed the validation of instruments, compiled the final manuscript, and handled correspondence and revisions with the journal. All authors discussed the results together, provided critical feedback

throughout the drafting stages, and approved the final version of the manuscript for submission and publication.

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