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Profiling Junior High School Students' Mathematical Literacy Difficulties in Solving Contextual Mathematical Problems

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Abstract

Mathematical literacy is an essential competence that enables students to use mathematical knowledge to understand, solve, and evaluate problems arising in real-life situations. However, students often experience difficulties when solving contextual problems that require them to move beyond procedural calculations toward mathematical reasoning, representation, and interpretation. This study aims to profile the mathematical literacy difficulties of seventh-grade students in solving contextual mathematical problems and to identify aspects that require further instructional support. A descriptive quantitative approach was employed involving 20 seventh-grade students from SMP Negeri 1 Tallunglipu, North Toraja, Indonesia. Data were collected using a context-based essay test on algebraic expressions developed with reference to the mathematical literacy processes in the PISA framework. Students' responses were analyzed based on their ability to understand and formulate problems, construct mathematical representations, employ mathematical concepts and procedures, communicate mathematical reasoning, and interpret results within the given context. The findings indicate that students experienced substantial difficulties in connecting contextual information with appropriate mathematical representations. Of the 20 students, 10 (50%) were categorized as requiring further guidance, 8 (40%) as having sufficient ability, and only 2 (10%) as having good ability; no students reached the very good category. The most prominent difficulties were found in identifying relevant information, formulating mathematical models, selecting appropriate solution strategies, communicating mathematical reasoning, and interpreting mathematical results in relation to the original context. These findings suggest that mathematics instruction should provide more systematic opportunities for students to engage in contextual problem solving through activities involving understanding situations, mathematization, reasoning, communication, and reflection on solutions.

Keywords: *mathematical literacy, contextual problems, mathematization, problem solving, junior high school students)*

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INTRODUCTION

Mathematics plays an important role in helping individuals understand and respond to situations encountered in everyday life. In real-world settings, mathematical problems are rarely presented in the form of clearly defined exercises that explicitly indicate which formula or procedure should be applied. Instead, individuals are required to identify relevant information, recognize relationships among quantities, select appropriate mathematical representations, perform calculations, and determine whether the resulting solution is meaningful within the original situation. The ability to use mathematics in such circumstances is closely associated with mathematical literacy.

Mathematical literacy has become an important competency in contemporary education because mathematics is increasingly used not only for academic purposes but also for decision-making, interpreting information, evaluating alternatives, and addressing practical problems. The OECD defines mathematical literacy as an individual's capacity to reason mathematically and to formulate, employ, and interpret mathematics to solve problems in a variety of real-world contexts. This perspective positions mathematics not merely as a collection of concepts and procedures but as a tool for understanding phenomena and making informed decisions (OECD, 2023).

The PISA framework emphasizes three interconnected mathematical literacy processes: formulating situations mathematically, employing mathematical concepts, facts and procedures, and interpreting, applying, and evaluating mathematical outcomes. These processes describe the movement between the real-world context and the mathematical world. Students are expected to recognize the mathematical aspects of a situation, translate the situation into a mathematical form, apply appropriate mathematical knowledge and procedures, and subsequently interpret the mathematical results in relation to the original context (OECD, 2023).

This perspective indicates that mathematical literacy is fundamentally different from procedural mathematical competence. A student may be able to perform algebraic operations correctly but still experience difficulties when required to determine which operation or representation is appropriate for a contextual problem. Similarly, obtaining a numerically correct answer does not necessarily indicate that a student is able to explain the meaning of that answer or determine whether it is reasonable within the given situation. Mathematical literacy therefore involves an integrated process of understanding, mathematizing, reasoning, solving, communicating, and interpreting.

At the junior high school level, the development of mathematical literacy is particularly important because students begin to encounter increasingly complex mathematical concepts and are expected to apply them to a variety of situations. Contextual mathematical problems can provide opportunities for students to recognize the usefulness of mathematics and to develop connections between formal mathematical knowledge and everyday experiences. Masjaya and Wardono (2018) emphasized that mathematical literacy is closely related to students' ability to establish mathematical connections and use mathematics to address problems encountered in everyday life.Nevertheless, previous studies have indicated that many students continue to experience difficulties when dealing with mathematical literacy tasks. Nuurjannah et al. (2018), for example, reported that junior high school students still encountered difficulties in achieving mathematical literacy indicators, particularly when dealing with problems requiring the application of mathematical knowledge in contextual situations. Such difficulties indicate that students may possess certain mathematical knowledge but have not yet developed sufficient capacity to mobilize that knowledge appropriately when faced with unfamiliar or non-routine problems.

Similar concerns have been identified in studies examining students' experiences with mathematical literacy. Bolstad (2023) found that students' encounters with mathematical literacy in school may remain strongly connected to school mathematics, while opportunities to use mathematics for understanding authentic situations can be more limited. This distinction is important because mathematical literacy requires students to recognize mathematical structures within situations that are not initially presented as mathematical problems.

The Indonesian context presents an additional challenge. Various studies have identified students' limited experience with contextual problems, procedural orientations in mathematics instruction, and difficulties in connecting mathematical concepts with real-life situations as factors associated with low mathematical literacy. Sulfayanti (2023), through a literature review, identified several factors contributing to students' low mathematical literacy, including limited contextual learning experiences, insufficient exposure to literacy-oriented problems, and difficulties in applying mathematical concepts to everyday situations.

These issues were also identified among seventh-grade students at SMP Negeri 1 Tallunglipu, North Toraja. An assessment conducted with 20 students revealed that many students experienced difficulties when solving contextual problems involving algebraic expressions. The difficulties were not limited to performing mathematical calculations but were evident from the initial stage of understanding the problem. Many students had difficulty identifying known and unknown information, translating contextual information into mathematical representations, selecting appropriate solution procedures, communicating their reasoning, and relating their mathematical results back to the original context.

The findings suggest that the central issue is not simply a lack of mathematical knowledge but a gap between knowing mathematics and using mathematics. Students may recognize algebraic concepts in routine exercises but encounter substantial difficulties when these concepts must be mobilized to represent and solve a contextual situation. Therefore, examining students' errors and difficulties across the different processes of mathematical literacy is important for understanding the specific instructional needs of learners.

Previous research has generally examined mathematical literacy in terms of achievement levels, problem-solving abilities, cognitive styles, or relationships with other variables. While such studies provide valuable information, a closer examination of the specific points at which students experience difficulties during the mathematical literacy process can provide more practical information for classroom instruction. Identifying whether difficulties occur during problem comprehension, mathematization, mathematical procedures, communication, or interpretation can help teachers design more targeted learning experiences.

Therefore, this study focuses on the profile of students' mathematical literacy difficulties in solving contextual

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mathematical problems. Rather than merely describing whether students have high or low mathematical literacy, the study examines the specific difficulties that emerge throughout the problem-solving process. This focus is expected to provide a more informative basis for developing contextual mathematics instruction, particularly for students at the junior high school level.

Based on this background, the objectives of this study are to: (1) describe the mathematical literacy performance of seventh-grade students in solving contextual mathematical problems; (2) identify the specific difficulties experienced by students in understanding, formulating, solving, communicating, and interpreting contextual mathematical problems; and (3) derive instructional implications for strengthening mathematical literacy through contextual mathematics learning.

METHOD

This study employed a descriptive quantitative research design to examine the profile of junior high school students' difficulties in solving contextual mathematical problems. The descriptive approach was selected because the study aimed to describe students' mathematical literacy performance and identify the difficulties that emerged during the process of solving contextual problems rather than to test the effectiveness of a particular instructional treatment. The participants were 20 seventh-grade students of SMP Negeri 1 Tallunglipu, North Toraja, Indonesia. The participants were selected randomly from the seventh-grade student population. Data collection was conducted in May 2025. The study was conducted in the context of regular mathematics learning and focused on students' ability to apply algebraic concepts to contextual situations. Data were collected using a context-based essay test consisting of mathematical problems involving algebraic expressions. The problems were designed to require students to use mathematical knowledge in situations related to everyday life rather than simply perform routine algebraic procedures. The development of the assessment was guided by the mathematical literacy perspective in the PISA framework, particularly the processes of formulating situations mathematically, employing mathematical concepts and procedures, and interpreting and evaluating mathematical outcomes (OECD, 2023). The instrument was also informed by previous research on mathematical literacy among junior high school students (Nuurjannah et al., 2018). Students were given 60 minutes to complete the test. The assessment required students to demonstrate several interconnected abilities: understanding the information presented in a contextual problem, identifying relevant information, representing the situation mathematically, selecting and applying appropriate mathematical procedures, explaining the reasoning used to obtain a solution, and interpreting the result in relation to the original situation.

RESULTS AND DISCUSSION

Overall Profile of Students' Mathematical Literacy

The analysis of students' responses showed that the majority of participants had not yet demonstrated optimal mathematical literacy when solving contextual problems. The distribution of students' performance is presented in Table 1.

Table 1. Distribution of Students' Mathematical Literacy Performance

Category	Number of Students	Percentage
Very good	0	0%
Good	2	10%
Sufficient	8	40%
Requiring further guidance	10	50%
Total	20	100%

Table 1 shows that half of the participants (50%) were categorized as requiring further guidance. Another 40% demonstrated sufficient performance, while only 10% were categorized as having good mathematical literacy. No student reached the very good category. Consequently, 90% of the participants were below the good category. This distribution indicates that the main challenge was not simply students' ability to carry out mathematical calculations. Rather, the findings point to difficulties in mobilizing mathematical knowledge when students encountered a problem presented through a real-life context. This distinction is important because mathematical literacy requires students to use mathematics as a means of understanding and responding to situations, rather than merely reproduce mathematical procedures. The findings are consistent with the PISA conception of mathematical literacy, in which students are expected to move between the real-world and mathematical worlds by formulating a situation mathematically, employing mathematical concepts and procedures, and subsequently interpreting and evaluating the mathematical outcomes (OECD, 2023). Students who are accustomed primarily to routine exercises may therefore encounter difficulties when the mathematical structure of a problem is not explicitly provided. The results also support Nuurjannah et al. (2018), who found that junior high school students experienced difficulties in achieving mathematical literacy indicators, particularly when tasks required the application of mathematical knowledge in more complex contextual situations. The findings suggest that mathematical literacy should be viewed as a process of using mathematical knowledge rather than simply as mastery of mathematical content.

Difficulties in Understanding and Formulating Contextual

Problems One of the prominent difficulties identified from students' responses occurred at the initial stage of problem solving. Several students had difficulty identifying the information that was relevant to the problem and distinguishing between information that was known and what needed to be determined. This difficulty is important because contextual problems do not always present mathematical variables and relationships explicitly. Students must first understand the situation, identify the quantities involved, recognize their relationships, and determine what mathematical information can be extracted from the context. From the perspective of mathematical literacy, this stage corresponds closely to the process of formulating situations mathematically. The PISA framework emphasizes that formulation requires students to recognize and identify the mathematical aspects of a real-world situation and translate them into a mathematical form (OECD, 2023).

When students fail to understand the structure of the situation, subsequent mathematical procedures may also become inappropriate. Thus, an incorrect final answer does not necessarily

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indicate that students lack knowledge of algebraic operations. It may instead originate from an earlier difficulty in interpreting the problem and determining what mathematics should be used. This finding is also consistent with Rahmasari and Setyaningsih (2023), who showed that students' ability to solve contextual mathematical problems is closely related to their ability to understand the information contained in mathematical word problems and organize it into an appropriate solution process.

Difficulties in Constructing Mathematical Representations

Another important difficulty involved translating contextual information into mathematical representations. Students were not always able to transform relationships described in everyday language into appropriate algebraic expressions or mathematical models. This finding demonstrates the importance of mathematization in mathematical literacy. In a contextual problem, students must identify the mathematical structure underlying a situation before they can perform appropriate calculations. The transition from contextual language to mathematical representation is therefore a critical stage in the solution process. Students' difficulties at this stage suggest that familiarity with algebraic procedures does not automatically guarantee the ability to use algebra in contextual situations. A student may know how to simplify an algebraic expression or perform an operation involving variables but still struggle to determine which expression should represent a particular real-world relationship. This issue is particularly relevant to mathematics instruction because classroom activities may sometimes emphasize symbolic manipulation without providing sufficient opportunities for students to construct mathematical representations from authentic situations. Mathematical literacy-oriented instruction needs to give students opportunities to formulate their own representations and justify why those representations are appropriate. The finding is in line with the argument of Masjaya and Wardono (2018) that mathematical literacy is closely connected with students' ability to establish mathematical connections and use mathematical ideas to address situations encountered in everyday life.

Difficulties in Selecting and Applying Solution Strategies

Students also demonstrated difficulties in selecting an appropriate mathematical strategy after identifying the information contained in the problem. Some students appeared to focus on performing calculations without first establishing a clear relationship between the contextual information and the mathematical operations required. This finding suggests that students' mathematical activity may still be dominated by procedural approaches. In routine exercises, the mathematical operation or formula is generally indicated by the structure of the question. In contextual problems, however, students must determine the appropriate strategy independently. The PISA framework describes the employing process as the use of mathematical concepts, facts, procedures, and reasoning to obtain a mathematical solution. Therefore, employing mathematics involves more than carrying out calculations correctly; students must determine which mathematical tools are appropriate for the situation (OECD, 2023).

The findings reinforce the need to distinguish between knowing a procedure and knowing when and why to use that procedure. Mathematical literacy requires the latter. Students need opportunities to encounter non-routine problems in which the appropriate strategy is not immediately apparent. Rayhan and Juandi (2023), through a systematic literature review, similarly identified learning obstacles related to mathematical literacy problems, particularly obstacles associated with the demands of contextual and non-routine mathematical tasks. Such findings indicate that students require sustained exposure to problems that demand reasoning, representation, and decision making.

Difficulties in Communicating Mathematical Reasoning

The students' written responses also indicated weaknesses in communicating the reasoning underlying their solutions. In some responses, students provided numerical or symbolic work without sufficiently explaining the relationship between the mathematical steps and the information presented in the problem. Mathematical communication is an important component of mathematical literacy because students need to make their mathematical thinking understandable to others and, at the same time, organize their own reasoning coherently. A solution that contains only calculations may not adequately demonstrate whether students understand why a particular strategy was selected. This finding suggests that mathematical communication should not be treated as a separate activity that occurs only when students are asked to present their work. Instead, explanation and justification should become an integral part of mathematical problem solving. Teachers can encourage students to explain the meaning of variables, justify the mathematical model they construct, describe the reason for selecting a particular procedure, and explain how the final answer relates to the original problem. Such practices can help students develop both mathematical reasoning and communication. The importance of this aspect is particularly relevant in contextual problems because students need to communicate not only mathematical procedures but also the connection between mathematics and the real-world situation.

Difficulties in Interpreting Mathematical Results

The final difficulty concerned students' ability to interpret mathematical results in relation to the original context. Obtaining a numerical result is not necessarily the final stage of mathematical literacy. Students must determine what the result means and whether it is reasonable in the situation described. This difficulty corresponds to the interpreting, applying, and evaluating process in the PISA framework. After obtaining a mathematical result, students are expected to return to the real-world context and consider whether the result answers the original question appropriately (OECD, 2023). The difficulty in interpretation indicates that students may perceive mathematical problem solving as ending once a calculation has produced an answer. Such a perception can limit the development of mathematical literacy because real-world problem solving requires reflection on the meaning and plausibility of mathematical outcomes. Consequently, classroom instruction should include explicit opportunities for students to check and interpret their answers. Questions such as "What does this answer mean in the situation?", "Does the answer make sense?", and "Can this result be used to make a decision?" can encourage students to reconnect mathematical results with the original context.

Implications for Contextual Mathematics Learning

The overall findings indicate that the students' difficulties occurred across several interconnected stages of mathematical literacy rather than being concentrated solely on mathematical computation. The major difficulties involved understanding contextual information, constructing mathematical representations, selecting solution strategies, communicating reasoning, and interpreting results. This

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pattern has important implications for mathematics instruction at the junior high school level. First, contextual problems should not be introduced merely as additional exercises after students have learned a mathematical procedure. Context should become an integral component through which mathematical concepts are introduced, explored, represented, and discussed. Second, teachers need to provide scaffolding during the mathematization process. Students can initially be guided to identify relevant information, formulate what is known and unknown, represent relationships using diagrams or symbols, and explain the mathematical meaning of their representations. Gradually, this support can be reduced as students become more independent. Third, classroom assessment should consider students' solution processes rather than focusing exclusively on final answers. A response that contains an incorrect final answer may still reveal an appropriate understanding of the context or an emerging mathematical representation. Conversely, a correct numerical answer does not necessarily demonstrate strong mathematical literacy if the student cannot explain or interpret the solution. These implications are consistent with the literature emphasizing the importance of contextual and literacy-oriented learning experiences. Sulfayanti (2023) identified limited contextual learning experiences and students' difficulties in applying mathematical concepts to everyday situations as factors associated with low mathematical literacy. Therefore, systematic integration of contextual problems into mathematics instruction is necessary. The findings also support the broader view that mathematical literacy develops through repeated opportunities to use mathematics meaningfully. Bolstad (2023) highlighted the importance of examining how students encounter mathematical literacy in school and how these experiences may remain closely associated with traditional school mathematics. For students to develop stronger mathematical literacy, classroom experiences need to expand beyond routine exercises toward tasks that require interpretation, modelling, reasoning, communication, and reflection. Overall, the present study indicates that the students' difficulties should be understood as a gap between learning mathematical procedures and using mathematics in context. Strengthening mathematical literacy therefore requires instructional practices that deliberately connect mathematical concepts with meaningful situations and guide students through the complete process of understanding, mathematizing, solving, communicating, and interpreting.

CONCLUSION

This study examined the profile of mathematical literacy difficulties among seventh-grade students in solving contextual mathematical problems. The findings showed that the majority of students had not yet demonstrated optimal mathematical literacy. Among the 20 participants, 50% were categorized as requiring further guidance, 40% demonstrated sufficient performance, and only 10% demonstrated good performance. No students reached the very good category. The students' difficulties extended beyond mathematical computation. The main difficulties were identified in understanding and formulating contextual problems, constructing mathematical representations, selecting appropriate solution strategies, communicating mathematical reasoning, and interpreting mathematical results in relation to the original context. These findings indicate that students' challenges were closely associated with the process of using mathematics rather than simply knowing mathematical procedures. The study therefore highlights the need to strengthen contextual mathematics learning at the junior high school level. Learning activities should provide systematic opportunities for students to understand real-world situations, mathematize contextual information, select and apply appropriate mathematical strategies, communicate their reasoning, and reflect on the meaning of their solutions. Assessment should similarly consider students' mathematical processes rather than relying exclusively on final answers. Although the study provides useful information about students' mathematical literacy difficulties, its findings should be interpreted within the context of its limitations. The study involved only 20 students from one junior high school and relied primarily on a written assessment. Future studies could involve larger and more diverse samples and combine written tests with interviews, classroom observations, or think-aloud protocols to obtain a deeper understanding of students' reasoning processes. Further research could also examine the effectiveness of specific contextual learning approaches in addressing the difficulties identified in this study.

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