

Analysis of the Concept of Mathematical Literacy and Its Implementation in Education

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ABSTRACT

Mathematical literacy is one of the essential competencies in education because it is related to an individual's ability to use mathematical knowledge to understand, analyze, and solve various problems encountered in real-life situations. The concept of mathematical literacy is not limited to the ability to perform arithmetic operations but also encompasses the ability to understand information, formulate problems, apply concepts, reason, interpret results, and make decisions based on mathematical information. This study aims to analyze the concept of mathematical literacy, the competencies it encompasses, and its implementation in the educational process. This study employs the library research method by examining various relevant scholarly sources, including journal articles, books, educational documents, and findings from previous studies. The data were analyzed through a process of identification, selection, classification, comparison, interpretation, and synthesis of findings from the literature. The results of the review indicate that mathematical literacy is closely related to problem-solving, reasoning, communication, representation, and decision-making skills. Its implementation can be achieved through contextual learning, problem-based learning, Realistic Mathematics Education, project-based learning, the use of data and technology, and assessments that emphasize the application of mathematics in real-life situations. Therefore, mathematical literacy should be positioned as an integral part of the educational process to develop students who are able to use mathematics critically, flexibly, and meaningfully in addressing various problems in everyday life.

Keywords: Educational Implementation, Mathematical Literacy, Mathematics Learning, Problem Solving, Mathematical Reasoning

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INTRODUCTION

Mathematics is one of the fields of knowledge that holds an important position in education and everyday life. Mathematics is not only used for performing calculations but also serves as a means of developing logical, systematic, critical, and analytical thinking skills (Al Ayyubi, Nurhikmah, et al., 2025). In everyday life, individuals encounter various situations that require the use of mathematics, such as managing finances, reading tables and graphs, estimating time, determining measurements, comparing options, understanding percentages, and evaluating information presented in numerical form. This condition demonstrates that mathematical proficiency is not sufficiently demonstrated merely by the ability to obtain correct answers to problems, but also by the ability to use mathematical knowledge appropriately in various situations. This ability is closely related to the concept of mathematical literacy. Mathematical literacy can be understood as an individual's ability to use mathematics to understand and address problems that arise in everyday life. The OECD considers the ability to reason mathematically as well as the ability to formulate, employ, and interpret mathematics to be important components of mathematical literacy. This concept demonstrates that mathematical literacy encompasses more than simply mastering procedures and arithmetic operations (OECD, 2023).

Within this framework, students are not only expected to know a mathematical concept but also to understand how the concept can be applied. Students need to be able to identify mathematical elements within a problem, select relevant concepts or strategies, carry out the solution process, and then interpret the results based on the context of the problem. Therefore, mathematical literacy essentially connects mathematical knowledge with thinking skills and the ability to apply such knowledge in real-life situations (Herman et al., 2024; H. Kurniawan et al., 2025). The importance of mathematical literacy has become increasingly evident as the amount of quantitative information encountered in everyday life continues to grow. People today are exposed to information in the form of numbers, percentages, graphs, tables, diagrams, statistics, and various other forms of data representation. Such information can be found in news reports, social media, advertisements, economic reports, health information, and various forms of public communication. Without adequate mathematical literacy, individuals may experience difficulties in understanding such information or may even make decisions based on information that they have not properly understood.

In the context of education, this condition implies that mathematics learning needs to be directed not only toward mastery of subject matter but also toward the ability to use mathematical knowledge meaningfully. Mathematics learning should provide students with opportunities to encounter diverse problems, explain their thinking, compare solution strategies, use representations, and evaluate the reasonableness of a result. Nevertheless, mathematics learning is still often understood as a process of mastering formulas, following solution procedures, and obtaining final answers. Learning patterns that place excessive emphasis on procedures may result in students developing mechanical skills in solving problems without necessarily being able to apply their knowledge when confronted with problems that differ from the examples they have previously studied. This issue is one

of the reasons why the development of mathematical literacy needs greater attention in the educational process (Lestari et al., 2025).

Mathematical literacy is also strongly related to problem-solving ability. Problems encountered in real life are not always presented in a form that directly indicates which mathematical operation should be used. Individuals must first understand the problem, identify the available information, determine the information needed, select an appropriate strategy, perform calculations, and subsequently assess whether the results obtained are consistent with the context. This process requires more complex thinking skills than simply recalling formulas. In addition to problem solving, mathematical reasoning is an important component of mathematical literacy. Students need to be able to provide reasons for an answer, identify relationships, formulate conjectures, test the validity of a statement, and draw conclusions based on the available information. Therefore, mathematics learning needs to provide students with opportunities to explain their thinking processes rather than merely present final answers.

The implementation of mathematical literacy can be achieved through various learning approaches. Contextual learning, problem-based learning, Realistic Mathematics Education, project-based learning, the use of data, and the utilization of technology are among the approaches that can be used to provide more meaningful learning experiences. These approaches share a common feature in that they provide students with opportunities to use mathematics in broader contexts. In addition to the learning process, assessment also plays an important role in developing mathematical literacy. When assessment focuses only on the ability to memorize formulas and perform routine operations, the learning process tends to follow the same pattern. Conversely, assessments that present contextual problems, data, real-life situations, and questions requiring reasoning can encourage the development of mathematical literacy skills. Based on the foregoing discussion, mathematical literacy needs to be understood as a comprehensive competency that is connected to various aspects of learning. Therefore, this study aims to analyze the concept of mathematical literacy and its implementation in education based on a review of relevant literature. This review is expected to provide an understanding of the nature of mathematical literacy, the competencies it encompasses, its forms of implementation in learning, and the factors that need to be considered in developing mathematical literacy through education.

METHOD

This study employed the library research method. The selection of this method was based on the research objective, which focuses on analyzing the concept and implementation of mathematical literacy based on various research findings and available scholarly sources. Through this method, the researchers did not collect data directly from the field but obtained information through a systematic review of various relevant literature. The data sources in this study consisted of scientific journal articles, academic books, research findings, educational policy documents, research reports, and other scholarly publications discussing mathematical literacy, mathematics learning, problem solving, mathematical reasoning, numeracy, assessment, and various relevant learning approaches. The literature was selected

based on its relevance to the research objectives and its ability to provide information regarding the concept and implementation of mathematical literacy.

The research process was conducted through several stages. The first stage was source identification, which involved searching for various types of literature related to the research topic. The second stage was source selection, which involved selecting literature relevant to the focus of the study. The third stage was classification, in which the information was categorized according to specific themes, such as definitions of mathematical literacy, characteristics of mathematical literacy, the competencies it encompasses, forms of implementation, the role of teachers, assessment, technology, and challenges in its implementation. The next stages were analysis and comparison. At this stage, findings from different sources were compared to identify similarities, differences, and trends in the research findings. Subsequently, synthesis was conducted by integrating the various findings to develop a more comprehensive understanding of the concept of mathematical literacy and its implementation in education (Sugiono, 2025). The data were analyzed using a descriptive-analytical approach. The information obtained was not merely described but also interpreted to examine the relationship between the concept of mathematical literacy and learning practices. Thus, the results of the study are expected not only to provide an overview of what is meant by mathematical literacy but also to explain how this concept can be practically implemented in the educational process.

RESULT AND DISCUSSION

RESULT

The review findings indicate that mathematical literacy encompasses a broader range of abilities than numeracy alone (Al Ayyubi, Rahmawati, et al., 2025). Mathematical literacy includes the ability to understand situations containing mathematical elements, identify relevant concepts, use mathematical knowledge to solve problems, and interpret results according to context. Mathematical literacy positions mathematics as a tool for understanding a situation. Therefore, a mathematically literate person does not merely know particular formulas or procedures but also understands when such knowledge can be used and how the results can be interpreted. Within the OECD framework, mathematical literacy includes three main processes: formulating mathematics in a situation, employing mathematical concepts and procedures, and interpreting and evaluating mathematical results (Truong & Nguyen, 2026). These three processes demonstrate that mathematical literacy involves a relationship between real situations and mathematical representations. Thus, mathematical literacy can be viewed as the ability to use mathematics as a thinking tool when addressing problems. This distinguishes it from learning that focuses only on memorizing formulas or procedures.

The review findings indicate that one of the main characteristics of mathematical literacy is the ability to apply knowledge (Muhaimin et al., 2024). Students' mathematical knowledge has greater value when it can be used to understand the problems they encounter. For example, students who understand percentages should not only be able to calculate the percentage of a number but also use the concept to understand discounts, price increases, profits, or statistical information. This demonstrates that conceptual understanding and application are

closely related. Mathematics learning needs to help students move from abstract understanding toward application in more concrete situations.

Based on the synthesis of various sources, several core competencies are included in mathematical literacy: 1) Conceptual Understanding, which forms the foundation of mathematical literacy; students need to understand the meaning of concepts, relationships among concepts, and the conditions under which concepts can be used, 2) Procedural Application, in which students still need to perform mathematical procedures correctly, but use them flexibly according to the needs of a problem, 3) Problem Solving, involving understanding the problem, determining a strategy, carrying out the solution, and checking the result, 4) Reasoning, including providing justification, identifying patterns, making conjectures, testing statements, and drawing conclusions, 5) Representation, involving the use of symbols, pictures, tables, graphs, diagrams, and mathematical models, 6) Communication, involving the ability to explain thinking processes, strategies, and solutions orally and in writing, and 7) Interpretation, in which mathematical results are related back to the context of the problem so that students understand the meaning of the answer obtained (AlAyyubi et al., 2025; Bawadi et al., 2023; Juniar, 2025).

The review findings show that problem solving is one concrete form of using mathematical literacy. Everyday problems usually do not directly provide information about the procedure that should be used. Students must determine the relevant concepts and appropriate solution strategies themselves. This process requires the ability to understand information, connect concepts, make decisions, and evaluate results. Thus, learning that provides non-routine problems can serve as a means of developing mathematical literacy because students are required to use their knowledge flexibly. Reasoning is an important aspect of mathematical literacy. Students need not only to know that an answer is correct but also to understand why it is correct. Activities such as comparing two strategies, identifying patterns, providing reasons, explaining relationships, or determining whether a statement is true can promote the development of reasoning. Therefore, mathematics learning needs to provide more opportunities for questions that not only seek answers but also encourage students to explain their thinking processes.

Mathematical literacy is also related to the ability to communicate ideas. Students need to be able to explain how a problem is solved and why a particular strategy is used. Mathematical communication can be expressed through verbal language, writing, symbols, tables, pictures, graphs, and other forms of representation. This ability is important because explaining a solution can help students clarify their own understanding. Context is an important element of mathematical literacy. Mathematics can be learned through various contexts, such as personal life, social life, work, the environment, economics, and science. The use of context helps students understand that mathematical concepts do not exist in isolation but are connected to various problems they encounter. However, using context does not simply mean turning a mathematics problem into a story. The context should provide opportunities for students to make decisions, select strategies, or interpret results.

Contextual learning is one approach relevant to the development of mathematical literacy. Teachers can begin a lesson with a problem that is close to students' experiences. For example, percentages can be related to discounts and

product prices, measurement to measuring objects, data to collecting information, or geometry to space planning. Through such activities, students can understand that mathematical concepts have functions in solving real-life problems. Problem-based learning gives students opportunities to use mathematics as a tool for solving problems (Al Ayyubi et al., 2024). In this process, students can work individually or in groups to understand problems, identify information, develop strategies, solve problems, and communicate results. This approach can develop mathematical abilities as well as critical thinking, communication, collaboration, and decision-making skills.

Realistic Mathematics Education is relevant to the development of mathematical literacy because it connects learning with situations that students can understand. Students are given opportunities to build understanding through contexts before being guided toward more formal mathematical forms. This process enables students to understand the relationship between real experiences and mathematical concepts. Thus, mathematics learning does not occur only through the presentation of formulas but through a gradual process of constructing understanding. Project-based learning can be an alternative for developing mathematical literacy because it enables students to use mathematics in activities with specific purposes. In a project, students can measure, collect data, perform calculations, create tables or graphs, estimate requirements, and make decisions based on calculations. Such activities can provide the experience that mathematics is part of completing a task or project, rather than merely subject matter studied to obtain grades (Al Ayyubi, Noerzanah, et al., 2025).

The ability to read and understand data is an important part of mathematical literacy. Students need to be able to read information presented through tables, graphs, diagrams, percentages, and other forms of representation. Learning can use data that are close to students' lives as well as data related to social and environmental phenomena. Students can then be asked to compare data, identify trends, draw conclusions, or make decisions based on the information. Technological developments provide opportunities to expand the implementation of mathematical literacy. Technology can be used to create visualizations, conduct simulations, explore patterns, process data, and present mathematical information. However, technology should be directed toward supporting thinking processes. It should not merely be used to accelerate calculations or provide answers but should help students explore relationships and understand concepts. Teachers play an important role in determining the quality of mathematical literacy implementation. Teachers need to be able to select problems that are appropriate to learning objectives and students' characteristics. They also need to ask questions that encourage students to think more deeply. Questions such as "Why?", "What if?", "Is there another way?", and "Does the answer make sense?" can promote reasoning. Teachers should also give students opportunities to make and correct mistakes. Errors can be used as material for discussion to understand thinking processes.

Assessment is an inseparable part of developing mathematical literacy. Assessment should be designed to determine not only whether students obtain the correct answer but also how they arrive at that answer. Problems may take the form of contextual problems, open-ended questions, data presented in graphs or tables, and questions that require students to explain their reasoning. Thus, assessment can function as part of the learning process while also providing information about the

development of mathematical literacy. The implementation of mathematical literacy faces several challenges. One is the persistence of learning practices that position the teacher as the primary source of knowledge and students as recipients of information. Another challenge is teachers' ability to design high-quality problems. Problems that are too simple do not provide sufficient cognitive challenge, whereas problems that are too complex may make it difficult for students to understand the context. In addition, limited time, learning resources, technological facilities, diverse student abilities, and assessment systems can also affect the implementation of mathematical literacy. For clarity, these aspects can be seen in the following figure.

DISCUSSION

The review shows that developing mathematical literacy requires a change in the orientation of mathematics learning. Procedural learning remains necessary because students need basic knowledge and computational skills. However, mastery of procedures should not be the ultimate goal. Students need to understand the meaning behind the procedures they use (Herman et al., 2024; Yulius & Zainil, 2025). For example, when students learn percentages, they should not only know how to calculate percentages but also understand their use in discounts, interest, profits, losses, statistical data, and various other situations. This change in orientation can make mathematics learning more meaningful. Students no longer view mathematics merely as a collection of formulas to memorize but as knowledge that can be used to understand everyday life. Mathematical literacy cannot be understood as a single independent ability. It results from the interconnectedness of conceptual understanding, procedural application, reasoning, problem solving, representation, communication, and interpretation. When students encounter a problem, they need to use several of these abilities simultaneously. They must understand information, determine concepts, select strategies, perform calculations, explain the process, and evaluate the results. Therefore, learning that trains only one ability in isolation may not be sufficient to develop mathematical literacy comprehensively.

The use of context in mathematics learning is often regarded merely as a way to make problems more interesting. However, context has a deeper function in developing mathematical literacy. Context provides situations that require students to determine how mathematics can be used. For example, when students are given information about several product choices, they must determine comparison criteria and perform calculations before making a decision. Thus, context should not merely serve as the background of a problem but should be part of the mathematical decision-making process. Problem solving is one of the main means of connecting mathematical knowledge with real life. Through problems, students can understand that mathematical knowledge has a function in solving real-world issues. Problems should have a level of complexity that allows students to use strategies. Students should be given opportunities to try more than one approach and compare the results. This process can help develop flexibility of thinking and the ability to make decisions based on mathematical considerations (Al Ayyubi & Rohmatulloh, 2023; W. Kurniawan et al., 2025).

Reasoning is an important distinction between procedural mathematical ability and mathematical literacy. Students who can perform calculations are not necessarily able to explain why those calculations are needed. Therefore, teachers need to

accustom students to providing reasons (Arifin & Nuh, 2026; Wulandari et al., 2025). Answers such as “because that is the formula” should be developed into explanations that demonstrate understanding of relationships among concepts. This habit can be developed through discussions, open-ended questions, simple proofs, pattern-finding activities, and error analysis. Assessment has a major influence on the direction of learning. If assessment mainly requires memorization and routine calculations, teachers and students tend to devote more attention to those abilities. Conversely, when assessment evaluates the ability to apply concepts in context, interpret data, provide reasoning, and solve problems, the learning process will also be encouraged toward developing these abilities. Therefore, developing mathematical literacy needs to be accompanied by the development of appropriate assessment practices. Mathematical literacy should not be positioned solely as the responsibility of mathematics learning. The ability to use data, perform measurements, read graphs, compare information, and make decisions based on numbers can be applied across educational fields. This integration demonstrates the interdisciplinary nature of mathematics. Students can use mathematical skills when studying natural sciences, social sciences, economics, technology, and even when carrying out projects. Therefore, mathematical literacy can serve as a competency that supports cross-curricular learning.

Technology offers great opportunities to improve the quality of mathematics learning. Visualization and simulation can help students understand concepts that are difficult to imagine directly. However, technology can also create dependence when it is used only to obtain answers. Therefore, the use of technology needs to be accompanied by activities that require students to explain, compare, predict, and evaluate. In other words, technology should be a tool for strengthening mathematical thinking rather than replacing it (Al Ayyubi, Rohaendi, et al., 2025). Teachers have a strategic position in creating learning experiences that support mathematical literacy. Teachers do not merely deliver content but also design situations that enable students to use mathematics. Teachers need to consider the context used, the difficulty of problems, the form of questions, discussion activities, learning media, and assessment methods. Thus, the quality of mathematical literacy implementation is strongly influenced by teachers' ability to transform abstract concepts into meaningful learning experiences. Based on the review findings, several important implications can be identified. First, the curriculum needs to provide sufficient space for developing the ability to apply mathematics in various contexts. Second, teachers need support to develop their ability to design literacy-based learning and assessment. Third, learning resources need to provide diverse problems rather than focusing only on procedural exercises. Fourth, technology can be used selectively to enrich learning experiences. Ultimately, developing mathematical literacy requires changes not only in teaching methods but also in the way the goals of mathematics learning are understood.

CONCLUSION

Based on the literature review, it can be concluded that mathematical literacy is a multidimensional competency that is not limited to numeracy or mastery of mathematical procedures. Mathematical literacy includes the ability to understand problems, formulate situations mathematically, use concepts and procedures, reason, solve problems, use various representations, communicate ideas, and interpret results

according to context. The review shows that mathematical literacy is closely related to critical thinking, problem solving, reasoning, communication, and decision-making. Therefore, mathematics learning should provide students with opportunities to use knowledge flexibly and address problems connected to real life. The implementation of mathematical literacy can be achieved through contextual learning, problem-based learning, Realistic Mathematics Education, project-based learning, data processing, mathematical discussions, the use of technology, and contextual assessment. These approaches can provide students with experiences that demonstrate that mathematics is not merely academic subject matter but a tool that can be used to understand and solve problems in everyday life. The review also shows that the successful development of mathematical literacy is strongly influenced by the quality of learning and the role of teachers. Teachers need to be able to design meaningful problems, ask questions that promote reasoning, create opportunities for multiple solution strategies, and assess thinking processes rather than only final answers. In addition, support for developing mathematical literacy should be provided through the curriculum, learning resources, assessment, and appropriate use of technology.

Thus, mathematical literacy should be positioned as an integral part of educational goals rather than merely an additional ability in mathematics learning. Developing mathematical literacy is important for preparing students to understand quantitative information, deal with complex problems, think logically and critically, and make decisions based on reliable information. These abilities ultimately support not only academic success but also students' effective participation in social, economic, and professional life. This study has limitations because it uses the library research method; therefore, the findings depend on the quality, characteristics, and contexts of the sources analyzed. Future research can develop empirical studies to examine the effectiveness of various learning approaches in improving mathematical literacy and to identify factors that influence the success of its implementation across different educational levels and contexts.

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