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LITERACY STRATEGIES IN MATHEMATICS LEARNING: A REFLECTIVE REVIEW IN TEACHER EDUCATION

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Abstract
This study aims to explore the experiences of Teacher Professional Education [TPE] students in applying literacy strategies in mathematics learning and evaluate their impact on students' understanding of mathematics concepts and literacy skills. Using a qualitative approach, this study involved TPE students of the Mathematics Education Study Program at Universitas Swadaya Gunung Jati Cirebon in batch 1 of 2023, selected through a purposive sampling technique. Data were collected through interviews and subsequently analyzed qualitatively, following systematic steps that included thematic mapping, pattern searching, category identification, and meaning interpretation. The findings show that the implementation of literacy strategies, such as visualization, discussion, and reading of mathematical texts, positively impacts students' understanding and engagement in mathematics learning. Challenges encountered while integrating literacy strategies include time constraints and the selection of relevant materials. However, a strong desire to learn and a commitment to constant evaluation helped to overcome these obstacles.. To promote future literacy strategies in mathematics education, actions such as teacher training, technology integration, curriculum adjustment, and appropriate reading materials are required.

Keywords: Cross-subject literacy; literacy strategy**,** Teacher Professional Education;

Introduction

In the current era of rapid scientific and technological advancement, education plays a vital role in shaping a generation capable of adapting to these developments and contributing to the progress of national civilization (Anwar, 2018), One strategic effort to support this educational goal is the implementation of mathematical literacy, which extends beyond mastering formulas and calculations. Mathematical literacy involves cultivating students' abilities to think analytically and logically, enabling them to apply mathematical reasoning to solve real-life problems (Indrawati & Wardono, 2019). As such, enhancing mathematical literacy is essential to prepare students not only for academic success but also for effective participation in a complex and data-driven world.

Currently, literacy has become a major conversation on an international scale, as well as in Indonesia, where the government realizes that a responsive and critical young generation is needed to face an increasingly complex world (Zahroh et al., 2020). Literacy as the ability to identify, understand, interpret, create, communicate and calculate, using written and printed materials in various contexts (Hasanah & Silitonga, 2020). Meanwhile, literacy across subjects according to, Vacca, Vacca, and Mraz

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Volume 12 | Number 1 | June 2025|

(Harmon et al., 2012) refers to the ability of individuals to use listening, speaking, reading, writing, and viewing skills to obtain information in a particular discipline (Kulsum, 2016).

In the context of mathematics learning, literacy strategies are increasingly recognized as crucial tools to support students in accessing, processing, and communicating mathematical ideas effectively (Wood & Ashfield, 2008). These strategies include activating prior knowledge, using multimodal texts, providing explicit instruction, modeling, using graphic organizers, developing questioning skills, and encouraging reflection and synthesis (Hattan et al., 2024; Prasansaph, 2024; Samuel, 2025). Studies have shown that literacy integration can enhance students' conceptual understanding and problem-solving abilities (Bicer et al., 2013; Nicolas & Emata, 2018; Xin et al., 2008). However, despite these theoretical insights, the practical application of literacy strategies in mathematics classrooms remains limited and inconsistent.

One of the main problems addressed in this study is the difficulty mathematics teachers face in translating literacy theory into instructional practice (Moleko, 2021). In many cases, prospective teachers struggle to implement literacy strategies effectively, particularly in integrating reading and writing skills into mathematical content. This disconnect results in students being unable to make sense of mathematical texts, apply abstract concepts to real-world situations, or express their reasoning clearly. This issue was chosen because literacy in mathematics is often misunderstood as solely related to reading word problems, while the broader scope such as interpreting graphs, using precise vocabulary, or engaging in mathematical discourse is often overlooked (Chan, 2015; Gomez et al., 2020; Johar & Lubis, 2018).

Moreover, a review of existing literature reveals a notable gap: while the importance of literacy across subjects is well acknowledged, studies specifically examining how literacy strategies are implemented in mathematics learning are still scarce. Most existing research focuses on literacy in language-based subjects, with minimal exploration of how literacy strategies are operationalized within mathematical instruction.

Despite the recognized importance of literacy across subjects, there is a lack of understanding of how to effectively implement these literacy strategies in mathematics learning. Mathematics teachers often experience challenges where students struggle to apply mathematical concepts in different contexts (Baiduri, 2019). Therefore, this study aims to explore Pre-service Teacher Professional Education (TPE) students' experiences in implementing literacy strategies in mathematics learning and evaluate their impact on students' understanding of mathematics concepts and literacy skills. This article discusses in depth the challenges faced by the students as future professional teachers in integrating literacy strategies in mathematics learning, as well as the successes and positive impacts achieved in improving students' understanding of mathematics concepts and their literacy skills. Thus, this research is expected to make a significant contribution to the development of more effective mathematics learning practices in the future.

Literature Review

The concept of literacy has evolved significantly over the years, expanding beyond traditional reading and writing skills to encompass the ability to critically engage with information across diverse disciplines. As educational paradigms shift towards interdisciplinary learning, the integration of literacy strategies across subjects has become increasingly important. This literature review explores the multifaceted role of literacy in education, with a particular emphasis on its application in mathematics instruction. Understanding how literacy is integrated within various subjects, and specifically in

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Volume 12 | Number 1 | June 2025|

mathematics, provides valuable insight into the effectiveness of current pedagogical approaches and the potential for improving student outcomes. By reviewing existing research on literacy across subjects, this section aims to lay the groundwork for exploring how literacy strategies can enhance both content mastery and the development of critical thinking skills in learners.

Literacy across subjects

21st Century Learning is learning that seeks to integrate literacy, knowledge, skills and attitudes, and mastery of technology. Literacy is the most important part of a learning process, students who can carry out literacy activities optimally will certainly get more learning experience than other students (Muliastrini, 2020). Literacy is a person's ability to use potential and skills in processing and understanding information when doing reading and writing activities (Tamaya et al., 2018).

In its development, literacy is not only the ability to read, write, but literacy can be used in various fields of science using various media as a means of communication and meaning formation (Oktariani & Ekadiansyah, 2020). This is in line with various beliefs, that efforts to understand information critically are not only carried out using media in the form of language in a narrow view (Abidin et al., 2021). One of the main goals of cross-subject literacy learning is to produce students who are able to think critically and solve problems, cross-subject literacy is a tool used by teachers to help students achieve these goals (Imanah & Anjariyah, 2025).

In the implementation of mathematics learning in the classroom, mathematical literacy is literally everything; communication, discussion, looking at graphs and many other things in the learning process (Baiduri, 2019). Mathematics uses symbols to represent concepts, vocabulary that has different meanings to our everyday language, and text structures that use concise writing. Literacy integration provides students with opportunities to learn about the uniqueness of language and practice how to make meaning from its content (Imanah & Anjariyah, 2025).

Literacy strategies across subjects

The goal of any subject is to produce thoughtful and well-rounded students, therefore, literacy strategies should be used across all disciplines to ensure that students have the opportunity to learn in an effective way. Learning that applies literacy strategies according to (Beers et al., 2009; Pahl & Rowsell, 2012) needs to have seven characteristics including, monitoring the process of text comprehension at three stages in learning (before, during, and after reading), using multimodal texts during learning, providing clear and explicit instructions by using modeling, using tools such as graphic organizers, developing responses to various types of questions, creating questions, and analyzing, synthesizing, evaluating and reflecting on the text.

In Cross-Curricular Literacy learning, Mathematics TPE students of Universitas Swadaya Gunung Jati are given an understanding that literacy strategies in learning are not subject content, but strategies in the form of steps for implementing learning to better understand content or material. Literacy strategies are carried out in three stages of learning: 1) Before reading, this stage aims to reactivate students' prior knowledge and experience; 2) While reading, this stage aims to learn new information, monitor one's own comprehension, recall known information, and learn new vocabulary; and 3) After reading, this stage aims to encourage connections to other texts and issues and deepen students' understanding of new material and experiences. The eight literacy strategies that can be applied in learning include fostering collaboration, encouraging discussion, using graphic organizers,

ISSN |2355-3669| E-ISSN |2503-2518|
Volume 12 | Number 1 | June 2025|

making connections between texts, think aloud models, visual representation, integrating interesting vocabulary, and encouraging authentic writing skills (Imanah & Anjariyah, 2025).

Literacy strategies in mathematics

In mathematics learning, literacy does not only refer to the general ability to read and write, but also includes the ability to understand and interpret mathematical language, symbols, and representations (Hayati & Kamid, 2019). Mathematical literacy enables students to formulate, use, and interpret mathematics in various contexts, as well as recognize the role of mathematics in everyday life to make well-reasoned and reflective decisions (Büscher, 2018; Manfreda Kolar & Hodnik, 2021). Considering the distinctive structure of mathematical language consisting of symbols, diagrams, tables, and graphs literacy strategies in mathematics aim to help students navigate this specialized language and understand abstract ideas through structured support. Several effective literacy strategies that support students' mathematical understanding (Moschkovich, 2018) include: activating prior knowledge to connect new concepts with previous experiences; using graphic organizers such as Venn diagrams or tables to organize thoughts and identify patterns; implementing the think-aloud strategy, where teachers verbalize their thinking process while solving problems so students can grasp metacognitive problem-solving approaches; and promoting mathematical discussions and collaboration to enhance communication skills and conceptual understanding. In addition, the use of visual representations such as models and drawings is highly helpful in bridging abstract numbers with contextual meaning (Pape & Tchoshanov, 2001; Tversky, 2013). Developing mathematical vocabulary is also crucial, especially since many mathematical terms have meanings that differ from everyday language (e.g., mean, product, difference). Finally, engaging students in authentic mathematical writing—through journals, explanations, or reflections—encourages them to clarify and consolidate their understanding. By integrating these literacy strategies into mathematics instruction, teachers not only enhance students' mathematical literacy but also support the development of critical thinking and problem-solving skills across disciplines.

Methodology

Research design and approach of the study

This study used a qualitative approach to gain an in-depth understanding of the experiences of teacher professional education students in applying literacy strategies in mathematics learning. According to (Aspers & Corte, 2019), qualitative research is a research method used to investigate, describe, and explain the special qualities or characteristics of social influences that are difficult to explain quantitatively (Tahir et al., 2023). After the data were collected, the researchers conducted an in-depth analysis to identify patterns, themes, and meanings that emerged from the data. This analysis involved the processes of data coding, pattern searching, and meaning interpretation.

Research site and participants

The subjects of this study were students of the Teacher Professional Education (TPE Prajabatan) mathematics education of Universitas Swadaya Gunung Jati Cirebon batch 1 in 2023. Participants were selected using purposive sampling technique, which is the selection of samples based

ISSN |2355-3669| E-ISSN |2503-2518|
Volume 12 | Number 1 | June 2025|

on one main criterion. The students selected were those who had taken cross-curricular literacy courses and had practical experience in secondary schools participating in mathematics teaching, thus having experience relevant to the subject of this study.

Data collection and analysis

To collect data in this study, interview techniques were used. Interview is a data collection technique by asking questions to informants related to the research topic directly, this is useful when researchers want to know experiences or opinions about something in depth (Fiantika et al., 2022). Interviews were chosen as a data collection method because they are effective in gaining an in-depth understanding of respondents' experiences, thoughts and attitudes related to the implementation of literacy strategies in mathematics learning.

The data collected through interviews were analyzed qualitatively. Qualitative analysis allows researchers to understand the complexity of the context and explore thematic patterns in the data. The analysis process will involve steps including thematic mapping, searching for patterns, identifying categories and interpreting the meaning of the data collected. Through this approach, it is hoped that an in-depth understanding of the experiences, perspectives and challenges faced by teacher professional education students in implementing literacy strategies in the context of mathematics learning can be obtained. To ensure the validity and reliability of the data, the researchers conducted validation by involving peer debriefing or by engaging participants in the data interpretation process (member checking). This validation ensured that the findings produced were trustworthy and highly relevant to the context of the study.

Results

TPE students' experiences in implementing literacy strategies in mathematics learning

From reflective interviews with TPE Mathematics students at Universitas Swadaya Gunung Jati Cirebon, the application of literacy strategies in mathematics learning has a positive impact on student understanding and participation. To support these findings, the researchers [R] also conducted an interview with a TPE student [S]. The following is an excerpt from the interview, which aims to explore the student's experience in implementing literacy strategies in mathematics learning,

R: Thank you for taking the time to talk with me. Could you share your experience in applying literacy strategies during mathematics instruction at school?
S: Sure. I found that literacy strategies were very helpful. For instance, when I used visual aids like diagrams or graphs, students understood concepts like fractions and ratios more quickly.
R: Interesting. Did you also use other forms of literacy besides visual ones?
S: Yes, I often used group discussions and gave open-ended questions. Through discussions, students became more active and willing to express their ideas. I also asked them to read short mathematical texts, such as word problems, and then summarize the main idea.
R: How did these strategies affect the students' understanding?
S: Quite significantly. For example, students who were usually passive became more engaged. They started asking questions and explaining their answers in their own words. I noticed they also found it easier to solve contextual problems.

ISSN |2355-3669| E-ISSN |2503-2518|
Volume 12 | Number 1 | June 2025|

R: Were there any challenges in applying these literacy strategies?
S: Yes, there were. The biggest challenge was time management. Sometimes, discussions on a single topic would take longer than expected. Also, I had to adapt the material to suitable reading resources or visuals. But since we studied cross-curricular literacy strategies during our coursework, I got used to preparing them in advance.
R: How would you assess your own abilities after using these strategies?
S: I feel more confident. These strategies help me deliver material in a more engaging and understandable way. I also feel that I can evaluate students' understanding more thoroughly—not just their final answers, but also their thinking process and how they explain it.
R: That's great. Do you have any suggestions for implementing these strategies in the future?
S: I think future teacher trainings should include more on literacy strategies. Also, it would be helpful to have access to reading materials or media that support implementation, so we can apply them more effectively in class.

Based on the interview transcript, the literacy strategies used include the use of visualization, discussion, presentation, open questions, and reading mathematical texts. A person's ability in literacy, especially in mathematics lessons, if they are able to interpret information, solve everyday problems, explain numerical, graphical, and geometry, and are able to communicate using mathematical language not only includes written communication but also orally. The results of applying these strategies show an increase in students' understanding of the material taught, their ability to solve mathematical problems, and improve their mathematical communication skills.

In addition, applying literacy strategies such as group discussions, graphic organizers, visual representations, and fostering collaboration help to improve students' understanding and engagement in mathematics learning, increase their learning motivation, and make mathematics learning more interesting and fun. These strategies were chosen because they are considered appropriate to the characteristics of the material being taught and effective in helping students understand mathematical concepts better. The application of literacy strategies also brings benefits to TPE students in the mathematics teaching process. TPE students find it easier to deliver material by using various creative and interesting literacy methods, and can more effectively facilitate discussions and interact with students.

The use of literacy strategies also helps TPE students to evaluate students' understanding more comprehensively, as they can see how students respond to mathematics texts, present their thoughts in writing or orally, and actively participate in discussions. Although there are some challenges in applying literacy strategies in mathematics learning, such as requiring readiness in planning and implementing learning activities involving various literacy strategies, a high spirit of learning and continuous evaluation can help overcome these obstacles. Thus, applying literacy strategies in mathematics learning can be an effective approach to improve students' understanding, communication skills and motivation to learn mathematics.

Challenges in integrating literacy strategies in mathematics learning

Based on the experiences of TPE students, there are a number of challenges faced in integrating literacy strategies in mathematics learning. One of the main challenges is time constraints, where limited time for mathematics learning makes it difficult to incorporate additional literacy strategies

ISSN |2355-3669| E-ISSN |2503-2518|
Volume 12 | Number 1 | June 2025|

without compromising the understanding of mathematics concepts that must be achieved. Another challenge is the difficulty in selecting materials that are relevant and appropriate to students' level of understanding and needs. Selecting math texts that are appropriate for students' needs and the material being studied can be a challenging task. Sometimes the materials available may be too complex or not suitable for students' needs. These findings are consistent with the results of the interviews conducted, as presented in the following excerpt.

R : Could you share some of the challenges you face in integrating literacy strategies into mathematic teaching?
S : Sure. One of the main challenges I face is time constraints. The time allocated for mathematics learning is already quite tight, so it's difficult to include additional literacy strategies without compromising the students' understanding of the essential mathematical concepts.
R : Could you explain further? For example, what types of literacy strategies are difficult to incorporate?
S : For instance, activities like reading mathematical texts or reflective discussions. These are excellent for deepening students' understanding, but they require careful time management so they don't interfere with the main flow of the lesson.
R : How about material selection? Is that also a challenge?
S : Yes, definitely. Choosing materials or math texts that are suitable is not easy Sometimes the available texts are too complex for students, or they don't match the topic being taught. So often have to adapt or even create my own materials.
R : And what about the students' own literacy skills?
S : That's also a challenge. Not all students are used to reading or writing about math. Some struggle to understand texts or express mathematical ideas clearly. Improving their literacy skills requires additional time and support.
R : Every class has students with different learning needs. Is that also an issue?
S : Absolutely. In large classes, it's especially challenging to tailor literacy strategies to individual learning styles and needs. But I try to overcome that by using varied methods and giving students some flexibility to choose what works best for them.
R : Despite these challenges, do you still see literacy strategies as important?
S : Yes, I still believe they're very important. With creativity, support from the school, and collaboration with fellow teachers, literacy strategies can make mathematics learning more meaningful and enjoyable. Sharing ideas with other teachers helps a lot too.

Based on the interview transcript, it is evident that integrating literacy strategies into mathematics teaching presents a range of complex challenges. One of the main issues highlighted by the participant is time constraints. The limited time allocated for mathematics lessons makes it difficult to incorporate additional literacy strategies without compromising students' understanding of essential mathematical concepts. Strategies such as reading mathematical texts and engaging in reflective discussions are acknowledged as valuable for deepening students' comprehension, yet they require careful time management to avoid disrupting the core flow of instruction.. In addition, there are challenges in improving students' literacy skills. Some students may have difficulty in reading, writing or talking about math concepts in detail. Improving students' literacy skills requires additional time and support. Also, not all students have the same learning styles and needs, so tailoring literacy strategies to

ISSN |2355-3669| E-ISSN |2503-2518|
Volume 12 | Number 1 | June 2025|

individual needs can be challenging, especially in large classes. Despite these challenges, pre-service TPE students believe that with creativity, collaboration with fellow teachers and support from the school, the integration of literacy strategies in mathematics learning can be more effective and beneficial to students' development.

Success in improving students' mathematics concept understanding and literacy skills

This study produced significant findings from the experiences of teacher professional education students in applying literacy strategies in mathematics learning. Below is the interview transcript that further elaborates on this.

R : Could you tell me your thoughts on the application of literacy strategies in mathematics learning during your TPE experience?
S : Sure, Ma'am. In my opinion, literacy strategies are very helpful in improving students' understanding of mathematical concepts. When students are encouraged to read math texts, engage in discussions, and write their own explanations, they understand the material better instead of just memorizing formulas.
R : Interesting. Did you observe any changes in students' attitudes or engagement during the lessons?
S : Yes, definitely. Students became more active and engaged. They were more enthusiastic about learning, especially when I used activities like group discussions or mind mapping. They found the lessons more enjoyable because they weren't monotonous.
R : How about the impact on other skills, such as communication or collaboration?
S : These literacy strategies also strengthened students' communication and collaboration skills. During discussions, they learned to express their opinions and listen to their peers. I also noticed improvements in how they presented their thoughts verbally.
R : And what about their general literacy skills, like reading and writing?
S : There was a significant improvement, Ma'am. Students became more careful when reading problems or texts, and when asked to write explanations, they could express their ideas more clearly. Even some of the previously passive students started to gain confidence in speaking in front of the class.
R : Do you think this strategy only works for high-achieving students?
S : Not at all, Ma'am. In fact, with literacy strategies, students of varying abilities can develop. These strategies are flexible and can be adjusted—for example, by providing texts that match their level or facilitating guided discussions.
R : Lastly, what advice would you give to teachers who want to implement literacy strategies in math teaching?
S : I would say teachers need to be creative and willing to try diverse approaches. Don't be afraid to experiment with new strategies, because students today respond better to active and contextual

Most TPE students stated that literacy strategies were effective in helping students understand mathematics concepts. Active participation of students during learning, improved numeracy literacy skills to improved learning outcomes, literacy strategies have been proven to help students in understanding mathematical concepts better. Students' positive response to the use of literacy strategies also reflects their more active engagement in learning. Literacy not only teaches students

ISSN |2355-3669| E-ISSN |2503-2518|
Volume 12 | Number 1 | June 2025|

reading and writing skills but also trains them in communication and collaboration which includes sharing ideas, listening to others' views and working together on group projects. This shows that the use of literacy strategies not only improves their understanding of mathematical concepts, but also strengthens their social and emotional skills through discussion and collaboration activities. In addition, the application of literacy strategies also has other positive impacts, such as improving students' literacy skills in general. This can be seen from the improvement of students' ability to read, write, speak and listen, as well as their ability to analyze mathematical texts and use resources to support the understanding of mathematical concepts. Thus, literacy strategies not only help students in understanding math materials but also improve their overall literacy skills.

Discussion

Overall, the findings from the data show that implementing literacy strategies in mathematics learning has a significant positive impact, both in improving students' understanding of mathematical concepts and in improving their literacy skills in general. This confirms the importance of using literacy strategies as an effective learning approach in the context of mathematics learning. The use of discussion methods can increase students' math learning motivation and have a significant impact on students' math learning outcomes (Mustamin, 2019). Graphic organizers also have a significant role in helping students map the comprehension process of reading or information (Laksono et al., 2018). Learning outcomes are not only related to increased knowledge, but also involve the development of skills, attitudes, understanding, self-esteem, interests, character, and self-adjustment abilities (Abidin, 2017). Students feel more engaged, enthusiastic, and find varied learning to be fun. Involving students actively and together in the learning process can be an effective solution to improve understanding and mastery of Mathematics concepts (Wijaya, 2023). Then, assessment or evaluation is developed to thoroughly measure the process of student activities from the beginning of the learning process to the final stage, the entire assessment process aims to provide a complete picture of the development of student competencies (Arifin et al., 2021). The application of literacy strategies in mathematics learning requires innovation, creativity and careful planning from teachers. The success of the learning process is inseparable from the teacher's ability to develop learning models, for this reason, the learning models that teachers choose and develop should encourage students to learn by optimally utilizing their potential (Abidin, 2017). TPE students emphasize the importance of developing varied and interesting learning so that students do not feel bored during the learning process. This can be achieved by thoroughly integrating literacy strategies in mathematics learning, such as the use of mind maps, additional text reading and the use of supporting technology such as learning apps and videos. Respondents also highlighted the need for careful planning in determining the type of literacy strategy that suits the needs of the students and the material being taught.

The most important lesson learned from the experience of implementing literacy strategies in mathematics learning is the importance of making students the main subject in learning. This encourages students to be more actively involved in the learning process and improves their understanding of mathematical concepts as well as overall literacy skills. Teachers need to understand that the integration of literacy strategies is not only relevant in the context of language or literature, but also important in understanding and communicating mathematical concepts better.

The success of the education system according to (Sahlberg, 2011). can be measured through several factors, such as standardization in the learning and teaching process, emphasis on process rather than outcome, collaboration between government policy and professional presence, and the

ISSN |2355-3669| E-ISSN |2503-2518|
Volume 12 | Number 1 | June 2025|

realization of a diverse vision of education that provides opportunities for children to continue learning, explore creativity and nurture human values (Ramdani et al., 2019). To increase the use of literacy strategies in mathematics learning in the future, it is good to provide adequate training and support to teachers in developing and implementing literacy strategies, integrating educational technology in learning, adjusting the curriculum to facilitate project-based learning, using formative evaluation that focuses on visual representations, and involving the out-of-school community in the learning process. (Pope, 2023) asserts that the use of technology in mathematics learning should provide opportunities for students to understand and master mathematical concepts and principles through exploration, investigation, feedback, observation of patterns, analysis of change, and understanding of relationships with technological support (Putrawangsa & Hasanah, 2018). In addition, it is necessary to adjust to students' learning styles and provide a variety of relevant reading materials to help students understand mathematical concepts better. Thus, the use of literacy strategies in mathematics learning can be improved to provide a more meaningful and effective learning experience for students.

Conclusion and Recommendations/Implications

Based on the experiences of TPE students in implementing literacy strategies in mathematics learning, it can be concluded that the application of literacy strategies has a positive impact on students' understanding of mathematical concepts and their literacy skills. Through the use of across-subject literacy strategies, TPE students can increase student participation, strengthen mathematical communication skills, and boost learning motivation. The findings also show that literacy strategies involving visualization, discussion, presentation, and reading mathematical texts have proven effective in helping students better understand mathematical concepts and improve their overall literacy skills.

Although faced with several challenges, such as time constraints, difficulties in selecting appropriate materials, and differences in students' learning styles, a high spirit of learning and continuous evaluation helped overcome these obstacles. Therefore, the integration of literacy strategies in mathematics learning can be considered an effective approach to improving students' understanding, communication skills, and learning motivation.

Based on these findings, a recommendation is made for providing adequate training and support for teachers in developing and implementing literacy strategies in mathematics learning. Such training can help teachers better understand how to integrate literacy strategies into teaching and provide the necessary skills and knowledge to support students' literacy skills development. Additionally, integrating educational technology into mathematics learning and providing various relevant reading materials is important for reinforcing the understanding of mathematical concepts. For future research, it is suggested to expand this study by exploring other literacy strategies that can be applied in mathematics learning, and conducting further studies on the impact of technology use in supporting the implementation of literacy strategies in mathematics education. Further research could also focus on developing training models for teachers to ensure that literacy strategies are implemented consistently and effectively at different educational levels.

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ISSN |2355-3669| E-ISSN |2503-2518|
Volume 12 | Number 1 | June 2025|

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ISSN |2355-3669| E-ISSN |2503-2518|
Volume 12 | Number 1 | June 2025|

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