Proceedings of International Conference on Research in Education (ICRE) 2025, pp. 428-439
ISSN: 3124-4467
27-28 November 2025 - Yogyakarta, Indonesia
https://e-conf.usd.ac.id/index.php/icre
Fakultas Keguruan dan Ilmu Pendidikan, Universitas Sanata Dharma, Yogyakarta

EXPLORING MATHEMATICAL LITERACY FOR PRESERVICE TEACHERS: IDENTIFYING CONTEXTS, CONTENTS, AND ACTIVITIES

Margaretha Madha Melissa
International Education Development Program, Hiroshima University, Japan
Mathematics Education Department, Sanata Dharma University, Indonesia
d250866@hiroshima-u.ac.jp
Received: 27 November 2025; Accepted: 17 December 2025

Abstract
Mathematics preservice teachers need to be well-prepared to teach students, particularly in fostering mathematical literacy, as the Indonesian government currently emphasizes literacy in both reading and mathematics. This study aims to describe preservice teachers' ability to identify mathematical literacy questions in terms of: 1) the context and content of the questions, and 2) the activities that support mathematical literacy. This study employed a quantitative descriptive research design using a survey method. Data were collected through a questionnaire administered to 176 mathematics preservice teachers from two universities in Yogyakarta. The data were analyzed using descriptive statistical techniques, including frequency and percentage distributions, to describe preservice teachers' responses. The findings reveal that 1) preservice teachers were able to identify scientific and personal contexts, but had difficulties in recognizing social and scientific contexts. They successfully identified contents related to space and shape, data and uncertainty, and quantity, but faced challenges with change and relationships. Furthermore, 2) preservice teachers demonstrated the ability to distinguish activities that support mathematical literacy. These findings provide insights for designing appropriate activities to strengthen preservice teachers' ability to identify mathematical literacy questions or design the questions themselves.

Keywords: mathematical literacy, mathematical task, mathematics teacher, numeracy, preservice teacher

Introduction

Mathematics education today emphasizes not only procedural knowledge but also mathematical literacy. In the 21st century, real-world problems are increasingly complex, requiring individuals to understand the role of mathematics in everyday life. This understanding enables individuals to critically evaluate and apply mathematics in ways that support constructive, caring, and thoughtful participation in society. The ability to reason and solve problems mathematically in real-world contexts is referred to as mathematical literacy (Rizki & Priatna, 2019).

Modern society requires more than just content knowledge; it also demands a broad set of skills, including critical thinking, problem-solving, creativity, innovation, communication, collaboration, flexibility, adaptability, initiative, self-direction, social and cross-cultural skills, productivity, accountability, leadership, responsibility, and information literacy (Partnership for 21st Century Skills, 2009; Stacey, 2011; Wijaya, 2016). Mathematical literacy is a key component in developing these 21st-century skills (World Economic Forum, 2016).

Mathematical literacy refers to an individual's capacity to reason mathematically and to formulate, apply, and interpret mathematical concepts and procedures when solving problems in various real-world contexts (OECD, 2019; Bynner & Parsons, 2006; Baba, 2024). It involves using facts, tools, and strategies to describe, explain, or predict phenomena in personal, societal, or occupational contexts. Developing mathematical literacy equips students to become critical thinkers and informed decision-makers, essential qualities in contemporary society (Serin, 2023; Rio & Protacio, 2025).

Preservice teachers (PST) play a crucial role in shaping how mathematical literacy is taught in future classrooms. Their initial training must go beyond content knowledge, helping them understand how to connect abstract mathematical concepts to real-life situations. They must also develop a robust understanding of disciplinary literacy to design lessons that foster students' critical thinking and problem-solving skills (Colwell & Enderson, 2016). When preservice teachers master effective teaching methods and understand the broader applications of mathematics, they are better prepared to guide students. Ultimately, the quality of their preparation and their views on mathematical literacy determine whether students perceive mathematics as merely a set of rules or as a dynamic tool for understanding the world.

However, many preservice teachers still perceive mathematics as abstract and procedural rather than meaningful and applicable. Research indicates that a significant number of preservice teachers continue to see mathematics primarily as a collection of static rules and procedures instead of a dynamic, meaningful tool for solving real-world problems (Hatisaru et al., 2025; Fuentes et al., 2014). This limited perspective often constrains their ability to design learning experiences that connect mathematical ideas to students' real-life experiences. As a result, they may struggle to support the development of students' mathematical literacy, which requires integrating conceptual understanding with authentic problem-solving situations.

This study adopts the PISA framework (OECD, 2023; Golla & Reyes, 2022), which conceptualizes mathematical literacy along three dimensions: content (mathematical concepts and skills), context (real-world situations in which mathematics is applied), and activity or process (cognitive actions such as formulating, applying, and interpreting mathematics). In the PISA 2022 framework, mathematical reasoning and problem-solving are assessed through four real-world contexts. The personal context focuses on daily activities and individual self-management, such as financial management, health, or recreation. The work context relates to professional tasks, including measurement, accounting, and work-related decision-making. The social context addresses community issues and large-scale public policies, while the scientific context links mathematics to natural phenomena, health, and technology. These dimensions provide a framework for identifying and analyzing mathematical literacy among preservice teachers.

Previous studies have explored students' mathematical literacy and teachers' practices. For instance, Sulistyani et al. (2024) investigated junior high school mathematics teachers' understanding of problem contexts and content, as well as activities that support mathematical literacy. Jupri and Rosjanuardi (2020) analyzed teachers' understanding of mathematical literacy problems. However, less attention has been given to preservice teachers' conceptions of mathematical literacy. In Indonesia, most research focuses on measuring students' literacy levels rather than understanding how preservice teachers conceptualize literacy-oriented teaching. Some studies, such as Murdy and Ekawati (2021), measured students' mathematical literacy using Indonesian cultural contexts; Aisyah and Juandi (2022) described Indonesian students' mathematical literacy over the last decade; and Fauzi et al. (2024) conducted a case study on mathematical literacy in elementary schools in Bandung.

Preservice teachers' conceptions of mathematical literacy questions are crucial because these conceptions directly influence the types of tasks they select, adapt, or design for classroom instruction. Preservice teachers' understanding of what constitutes a mathematical literacy task determines whether learning activities emphasize meaningful engagement with real-world contexts, reasoning, and interpretation, or remain focused on routine procedural exercises. When preservice teachers hold limited conceptions of mathematical literacy, they may unintentionally design tasks that appear contextual but do not truly engage students in mathematical reasoning or problem-solving (Rianasari & Guzon, 2024). Consequently, students' opportunities to develop mathematical literacy are constrained.

Previous research has identified several conception-related challenges among teachers and preservice teachers. Studies report difficulties in distinguishing authentic real-world contexts from superficial word problems, limited understanding of the variety of PISA contexts, particularly social and scientific contexts and an overemphasis on content-related aspects at the expense of processes such as formulating, interpreting, and reasoning mathematically (Jupri & Rosjanuardi, 2020; Sulistyani et al., 2024). In addition, preservice teachers often focus on identifying mathematical topics (geometry or arithmetic) rather than recognizing how tasks support literacy-oriented activities, such as modeling, argumentation, and interpretation. These conception problems suggest that preservice teachers may recognize mathematical content but struggle to holistically identify mathematical literacy tasks as defined in the PISA framework.

Given this gap, there is a need to explore how preservice teachers conceptualize and identify mathematical literacy tasks, particularly in relation to the contexts, content, and activities emphasized in the PISA framework. This study aims to examine preservice mathematics teachers' understanding of mathematical literacy by describing their ability to identify mathematical literacy questions in terms of: (1) the context and content of the questions, and (2) the activities that support mathematical literacy.

Method

Data for this study were collected using a survey method within a descriptive research design. The survey was administered via Google Form during February and March 2025. The participants comprised 176 preservice mathematics teachers, including 66 students from a private university and 110 students from a public university, both located in Yogyakarta, Indonesia.

The research instrument was a 15-item questionnaire adapted from the instrument developed by Sulistyani et al. (2024), which was designed to examine teachers' understanding of mathematical literacy tasks based on the PISA framework. The original instrument had undergone content validation by experts in mathematics education and was reported to be valid for measuring teachers' understanding of mathematical literacy contexts, content, and activities. The adaptation process in this study involved several stages. First, the original items were reviewed to ensure alignment with the objectives of the present study, particularly the focus on preservice teachers rather than in-service teachers. Second, minor modifications were made to the wording of several items to suit the preservice teacher context while maintaining the original constructs related to context, content, and activities of mathematical literacy. Third, the adapted items were mapped onto the PISA dimensions to ensure conceptual consistency and coverage. The collected data were analyzed descriptively by calculating the percentage of responses for each closed-ended item. A summary of the questionnaire indicators and the corresponding data analysis techniques is presented in Table 1.

Table 1. Questionnaire Item and Analysis Method

Questionnaire	Quantities	Analysis method
Identity	4 questions	Calculate the percentage of responses for each answer choice
Part 1: Identify the context and content of mathematical literacy questions	8 closed questions	Calculate the percentage of responses for each answer choice
Part 2: Identify the activities to support mathematical literacy	3 closed questions	Calculate the percentage of responses for each answer choice

Findings and Discussion

The survey results indicate that the majority of respondents were preservice mathematics teachers, with 5 students in the 8th semester, 55 students in the 6th semester, and 116 students in the 4th semester, totaling 176 participants. Regarding professional development experience, 122 respondents reported that they had never attended any seminar or training on mathematical literacy, while the remaining participants had previous exposure. In terms of familiarity with the concept of mathematical literacy, only 16 respondents had never heard the term, whereas 160 were already familiar with it. These findings suggest that while most preservice teachers are aware of the concept of mathematical literacy, a significant proportion have had limited practical engagement or training in this area.

In this study, four stimuli were adopted based on the research by Sulistyani et al. (2024). The stimuli are as follows: 1) A picture of the Ampera Bridge is provided, and it is known that the height of a car is 1.5 meters. Participants are asked to estimate the height of the Ampera Bridge and explain how they arrived at their estimate. 2) A bar chart showing Jakarta's climate data is provided, which includes rainfall data (blue bars) and temperature data (red line graph). Each month is represented by a single value indicating temperature. For example, in November, the rainfall is 225 mm, and the temperature is 27°C. Alex claims that 225 mm represents the mode, while Benii claims it represents the mean. Participants are asked to determine who is correct and explain their reasoning. 3) "My Plate" scenario: Sabrina, an adult, plans a meal following Indonesia's Ministry of Health balanced nutrition guidelines, which recommend 150 g of rice (or 300 g potatoes, or 75 g dry noodles) per meal. Given the available foods at home and her portion choices, participants are asked to analyze whether her meal aligns with the guidelines. 4) A graph showing the average height growth of male and female adolescents in the Netherlands in 1996 is presented. Participants are asked to interpret and analyze the data.

The responses related to the mathematical literacy content are presented in the following diagram. This diagram illustrates how participants identified the real-world contexts embedded in the given mathematical tasks.

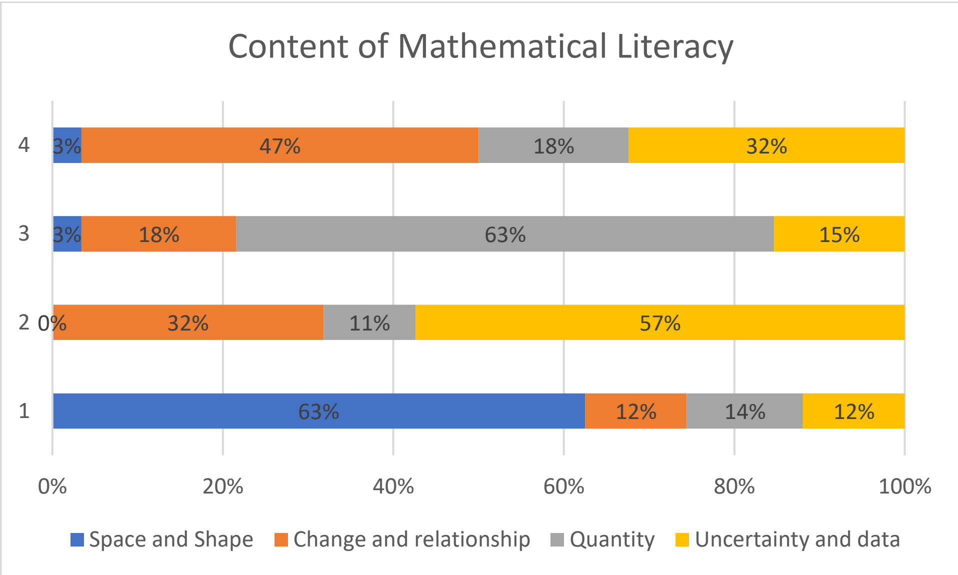

Figure 1. Data on PST Responses to the Content of Mathematical Literacy

Stimulus 1 was categorized under the content domain space and shape, stimulus 2 under uncertainty and data, stimulus 3 under quantity, and stimulus 4 under change and relationship. For Stimulus 1, which required estimating the height of the Ampera Bridge, the majority of preservice teachers accurately identified the corresponding content domain as space and shape. A smaller proportion, however, classified the item as belonging to change, relationship, quantity, or uncertainty and data. The high rate of correct classification may be attributed to the presence of supporting visual information, including an illustration of a car and the bridge, which likely facilitated participants' interpretation of the mathematical features of the task.

Stimulus 2 corresponds to the uncertainty and data content domain. Most preservice teachers were able to identify this correctly; however, 32% misclassified it as change and relationship. Although the stimulus included both a bar chart and a line graph, this result suggests that some preservice teachers remain insufficiently familiar with tasks involving data representation. Stimulus 3, which presents the "My Plate" scenario, falls under the quantity content domain. A majority of participants (63%) classified the item correctly, yet it is noteworthy that 18%

categorized it as a change and a relationship. This misclassification may be due to the presence of multiple food components within the task, leading some preservice teachers to associate the problem with relationships among variables rather than with quantitative reasoning.

Stimulus 4, which presents data on adolescent growth, displays a graph comparing the average height of male and female adolescents across different ages. Based on this stimulus, the majority of preservice teachers identified the content domain as change and relationship; however, 32% classified it as uncertainty and data. This misidentification likely occurred because the information was presented in a graphical format, leading some participants to associate the task primarily with data representation rather than with patterns of change. The data indicate that preservice teachers were generally able to identify quantity, space, and shape, and uncertainty and data within the given tasks. However, some of them appeared to experience difficulty recognizing content related to change and relationships.

The responses related to the mathematical literacy contexts are presented in the following diagram.

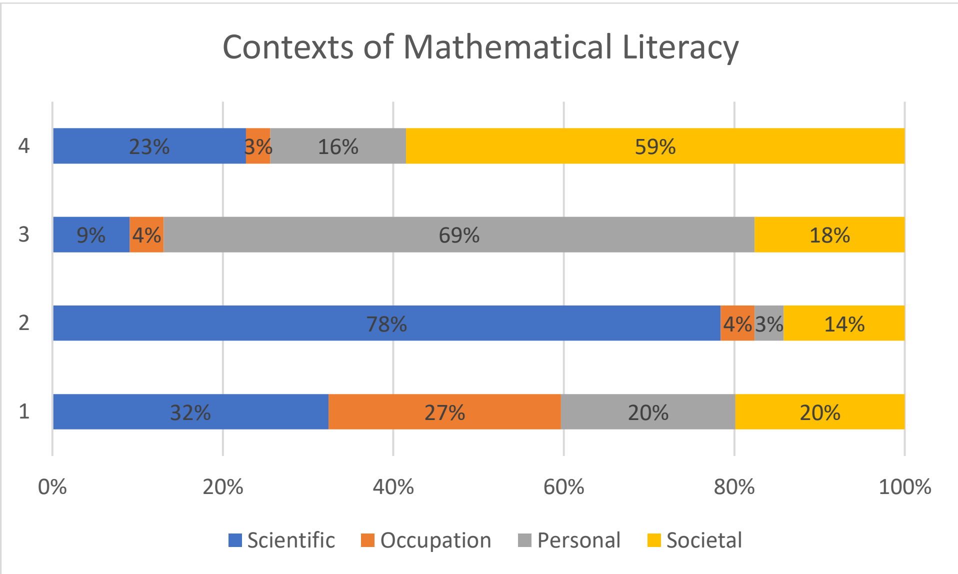

Figure 2. Data on PST Responses to the Content of Mathematical Literacy

Regarding the contexts presented in Figure 2, each stimulus was designed with a specific context classification: Stimulus 1 with a Societal context, Stimulus 2 with a Scientific context, Stimulus 3 with a Personal context, and Stimulus 4 with a Scientific context. The results of the questionnaire analysis indicate that preservice teachers were generally able to classify the context correctly for Stimulus 2 and Stimulus 3. The data show clear variation in preservice teachers' ability to identify the intended contexts in mathematical literacy tasks. Stimulus 2, designed within a Scientific context, was correctly identified by 78% of respondents. Similarly, Stimulus 3, which represented a Personal context, was accurately recognized by 69% of respondents, indicating that the contextual cues in both items were sufficiently explicit and unambiguous.

In contrast, misinterpretations were observed in Stimulus 4 and Stimulus 1. Although Stimulus 4 was intended to represent a Scientific context, the majority of respondents (59%) instead classified it as Societal. Scientific contexts typically involve issues such as weather or climate, ecology, medicine, astronomy, or genetics (Delima et al., 2022). However, the item in Stimulus 4 presented data related to human height, which may have caused preservice teachers to perceive it as less representative of a scientific phenomenon, leading to confusion.

A similar pattern appeared in Stimulus 1, originally designed within a Societal context. Many respondents categorized it instead as Scientific (32%) or Occupation (27%), with only 20% correctly identifying the Societal context. This misclassification may be attributed to the inclusion of elements related to estimating the height of a bridge, which respondents perhaps associated with scientific or technical domains rather than societal issues. Taken together, these findings suggest that preservice mathematics teachers still experience difficulties in accurately identifying contexts within mathematical literacy tasks, particularly when contextual boundaries are subtle or when the narrative includes overlapping contextual elements.

The second focus of this study concerns activities in mathematics learning that facilitate mathematical literacy. Activity 1 involved the teacher distributing brochures about fuel-efficient cars, which included data on prices and available features. Students were asked to discuss and make a decision regarding which car to purchase in order to maximize fuel efficiency while keeping costs affordable. Activity 2 presented an image of a television along with its dimensions, and students were asked to calculate the area of the television screen. Activity 3 provided data in the form of a pie chart showing greenhouse gas emissions in 2019, and students were tasked with identifying the information conveyed by the chart, including which gas had the greatest impact.

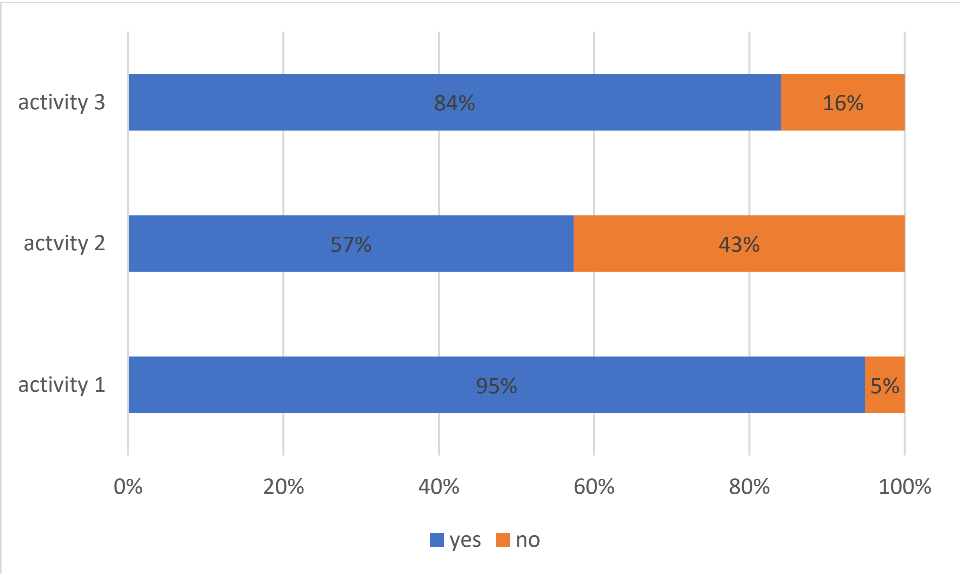

Figure 3. Data of PST responses to the Activities That Support Mathematical Literacy

Based on the data, preservice mathematics teachers demonstrated very strong ability in identifying activities that support mathematical literacy (Positive Recognition). This was particularly evident in Activity 1 and Activity 3, where the correct response was “Yes”. In Activity 1, the accuracy rate reached the highest level at 95%, while in Activity 3, accuracy was 84%. These high percentages indicate that when a mathematics activity is designed with strong literacy characteristics, such as a clear real-world context, preservice teachers are able to recognize it easily and correctly.

However, the most critical finding emerged in Activity 2, where a significant misconception (False Positive) was observed. The correct answer indicated that this activity did not support literacy (“No”), yet 57% of respondents answered “Yes”. This means that more than half of the preservice teachers failed to distinguish between routine/procedural mathematics activities and literacy-oriented activities. They tended to assume that any mathematics activity represented literacy, even if the activity lacked an authentic real-world context or sufficient reasoning processes. Only 43% of respondents were able to correctly identify that the activity did not meet the criteria for mathematical literacy.

Overall, these data suggest that preservice teachers possess good competence in recognizing “what constitutes literacy” (correct examples), but remain weak in distinguishing “what does not constitute literacy” (incorrect examples). The response pattern in Activity 2 highlights that the main challenge in current preservice teacher education is not in understanding the definition of literacy, but rather in the ability to differentiate. Without the skill to sharply distinguish between routine tasks and literacy-oriented tasks, preservice teachers risk presenting lessons they perceive as literacy-based, even though they are actually standard procedural exercises.

The findings of this study are consistent with previous research indicating that preservice teachers often possess fragmented conceptions of mathematical literacy. Similar to the results reported by Jupri and Rosjanuardi (2020) and Wijaya (2016), a substantial number of preservice teachers in this study were unable to distinguish between routine procedural tasks and genuine literacy-oriented activities. This misconception was particularly evident in Activity 2, where more than half of the respondents incorrectly identified a purely procedural task as supporting mathematical literacy. Comparable results were reported by Melissa and Kristanto (2024), who found that prospective mathematics teachers tend to demonstrate stronger procedural numeracy knowledge than contextual reasoning and interpretation, suggesting that superficial characteristics of tasks often dominate their judgments.

In terms of content identification, preservice teachers demonstrated stronger performance in recognizing quantity, space, and shape, and uncertainty and data, while experiencing difficulty with change and relationship. This pattern aligns with the findings of Sulistyani et al. (2024) and Fuentes et al. (2014), who reported that teachers tend to focus on static mathematical content rather than on dynamic relationships among variables. The misclassification of Stimulus 4 further suggests that graphical representations alone often lead preservice teachers to associate tasks with data handling, even when the core mathematical idea involves change over time, as also noted by Stacey (2011). Similar misconceptions have been documented in studies on statistical literacy, where teachers commonly interpret graphs as indicators of data analysis rather than representations of variation and change (Watson & Callingham, 2002; Beswick et al., 2012).

Regarding context identification, the confusion between societal and scientific contexts observed in this study reflects the challenges highlighted in the PISA framework (OECD, 2019, 2023), where contextual boundaries are often subtle and overlapping. Without explicit training, preservice teachers may rely on surface features of tasks rather than on the underlying purpose of the context. This finding is consistent with previous studies involving in-service teachers in Indonesia, which reported that teachers often equate mathematical literacy with contextual or word problems and experience difficulty distinguishing between social, scientific, and occupational contexts (Melissa et al., 2024). A similar pattern has also been observed across disciplines, as Limiansih et al. (2023) found that teachers' perceptions of scientific literacy tend to emphasize content mastery rather than contextual reasoning and decision-making.

These findings are further supported by research emphasizing that realistic contexts do not automatically imply authenticity in mathematical literacy tasks. Palm (2008) and Kaiser and Schwarz (2010) highlighted that tasks may appear realistic yet still function as routine procedural exercises, which may explain the false-positive responses observed in Activity 2. Moreover, the difficulty in recognizing social contexts aligns with Skovsmose's (2011) argument that critical and societal dimensions of mathematics are often underrepresented in teacher education programs, leading preservice teachers to overlook the social purposes embedded in mathematical tasks.

Importantly, the findings of this study underscore the necessity of moving beyond descriptive research toward intervention-oriented studies that focus on enhancing preservice teachers' capacity to design mathematical literacy tasks and to develop lesson plans that explicitly promote students' mathematical literacy. As future mathematics teachers, preservice teachers need systematic opportunities to engage in designing, analyzing, and revising literacy-oriented tasks, as well as in constructing lesson plans that integrate meaningful contexts and reasoning processes. Moreover, teacher education programs play a crucial role in ensuring the continuity between preservice preparation and future classroom practice. Prior intervention studies have demonstrated that pedagogical approaches such as Realistic Mathematics Education (RME) and problem-based learning (PBL) can effectively support the development of numeracy and mathematical literacy (Ramadhani & Melissa, 2024; Melissa et al., 2024). Embedding such approaches into preservice teacher education programs may serve as a critical foundation for preparing teachers who are capable of fostering students' mathematical literacy in classroom practice.

Conclusion

In conclusion, this study shows that preservice mathematics teachers generally demonstrate adequate foundational understanding of mathematical literacy, particularly in identifying content domains such as space and shape, quantity, uncertainty, and data, as well as recognizing activities with explicit real-world contexts. Nevertheless, important challenges persist in identifying content related to change and relationship, distinguishing between overlapping contextual domains—especially societal and scientific contexts—and differentiating routine procedural activities from authentic literacy-oriented tasks. These findings indicate that preservice teachers tend to rely on surface features of tasks rather than on deeper reasoning, dynamic relationships, and contextual purposes that characterize mathematical literacy. Thus, while preservice teachers possess initial awareness of mathematical literacy, they require targeted support within teacher education programs to strengthen their ability to critically analyze, design, and implement mathematical literacy tasks and lesson plans that genuinely foster students' mathematical reasoning, problem-solving, and real-world decision-making skills.

References

Aisyah, & Juandi, D. (2022). The description of Indonesian student mathematics literacy in the last decade. *International Journal of Trends in Mathematics Education Research, 5*(1), 105–110. https://doi.org/10.33122/ijtmer.v5i1.114

Baba, T. (2025, April). *Between mathematics and literacy* [Paper presentation]. Indonesian Education Coreference (KOPI), Universitas Muhammadiyah Jember, Indonesia.

Beswick, K., Callingham, R. & Watson, J. (2012) The nature and development of middle school mathematics teachers' knowledge. *Journal of Mathematics Teacher Education*, *15*, 131–157. https://doi.org/10.1007/s10857-011-9177-9

Bynner, J., & Parsons, S. (2006). *New light on literacy and numeracy* (Research report). National Research and Development Centre for Adult Literacy and Numeracy, Institute of Education, University of London. https://dera.ioe.ac.uk/id/eprint/22309/1/doc_3186.pdf

Colwell, J., & Enderson, M. C. (2016). When I hear literacy: Using pre-service teachers' perceptions of mathematical literacy to inform program changes in teacher education. *Teaching and Teacher Education*, *53*, 63-74. https://doi.org/10.1016/j.tate.2015.11.001

Delima, N., Supriyadi, E. I., & Aminah, M. (2025). Geogebra-assisted learning, doing, and repeating (LDR) model to develop community numeracy skills. *Kalamatika: Jurnal Pendidikan Matematika*, *10*(1), 67-78. https://doi.org/10.22236/KALAMATIKA.vol10no1.2025pp67-78

Fauzi, I., Chano, J., & Wu, C. C. (2025). Mathematical literacy of Indonesian elementary school students: A case study of Bandung school. *Journal of Curriculum and Teaching, 14*(2), 58–72. https://doi.org/10.5430/jct.v14n2p58

Fuentes, S. Q., Bloom, M. A., & Peace, H. (2014). Preservice elementary teachers' perspectives about the roles of conceptual understanding and factual/procedural knowledge in learning and teaching mathematics and science. *Journal of Mathematics Education at Teachers College*, *5*(1), 57-65. https://doi.org/10.7916/jmetc.v5i1.645

Golla, E. F., & Reyes, A. G. (2020). PISA mathematics literacy framework vis-à-vis the Philippine K to 12 mathematics curriculum. In M. U. Balagtas & M. A. C. Montealegre (Eds.), *Challenges of PISA: The PNU report* (pp. 57–100). Philippine Normal University and Rex Institute for Student Excellence, Inc.

Hatisaru, V., Johnston, O., Collins, J., & Rott, B. (2025). New insights into the beliefs of secondary pre-service teachers about mathematics. *Eurasia Journal of Mathematics, Science and Technology Education*, *21*(8), Article em2675. https://doi.org/10.29333/ejmste/16656

Jupri, A., & Rosjanuardi, R. (2020). Analysis of teacher understanding of mathematical literacy problems. *Jurnal Pengajaran MIPA*, *25*(1), 1-6. https://doi.org/10.18269/jpmipa.v25i1.21690

Kaiser, G., & Schwarz, B. (2010). Authentic modelling problems in mathematics education—Examples and experiences. *Journal für Mathematik-Didaktik 31*, 51-76. https://doi.org/10.1007/s13138-010-0001-3

Limiansih, K, Sulistyani, N, & Melissa, M.M. (2024). Persepsi guru SMP terhadap literasi sains dan implikasinya pada pembelajaran sains di sekolah. JPM: Jurnal Pendidikan MIPA, *14*(3), 786-796. https://doi.org/10.37630/jpm.v14i3.1858

Melissa, M. M., & Kristanto, Y. D. (2024). Profil pengetahuan numerasi mahasiswa calon guru matematika [Profile of prospective mathematics teachers' numeracy knowledge]. *JOHME: Journal of Holistic Mathematics Education*, *8*(1), 116-129. https://doi.org/10.19166/johme.v8i1.8324

Melissa, M. M., Laila, E. N., Ningrum, M. P., & Kusuma, O. R. (2024). Problem-based learning (PBL) model to improve numeracy skills and self-confidence of middle school students. *Journal Focus Action of Research Mathematic (Factor M)*, *7*(2), 190–205. https://doi.org/10.30762/f_m.v7i2.2622

Melissa, M.M., Sulistyani, N, & Limiansih, K. (2025). Identifikasi persepsi literasi matematika guru SMP di Yogyakarta: Tantangan dan peluang. *Kadikma*, *16*(1),1-12. https://doi.org/10.19184/kdma.v15i1.48480

Murdy, R., & Ekawati, R. (2021). Levels of students' mathematical literacy using Indonesian culture context. *JRPIPM (Jurnal Riset Pendidikan dan Inovasi Pembelajaran Matematika)*, *5*(1), 1-19. https://doi.org/10.26740/jrpipm.v5n1.p1-19

OECD. (2019). *PISA 2018: Insight and interpretation*. OECD Publishing.

OECD. (2023). *PISA 2022 results (Volume I): The state of learning and equity in education*. OECD Publishing. https://doi.org/10.1787/53f23881-en

Palm, T. (2008). Impact of authenticity on sense making in word problem solving. *Educational Studies in Mathematics Journal*, *67*, 37–58. https://doi.org/10.1007/s10649-007-9083-3

Partnership for 21st Century Skills. (2009). *P21 framework definitions*. https://files.eric.ed.gov/fulltext/ED519462.pdf

Ramadhani, N. N., & Melissa, M. M. (2025). *Enhancing numeracy in statistics with Realistic Mathematics Education (RME)*. In *Proceedings of the 8th International Symposium on Mathematics Education and Innovation (ISMEI 2024)* (pp. 120–131). Atlantis Press. https://doi.org/10.2991/978-2-38476-434-1_11

Rianasari, V. R., & Guzon, A. F. H. (2024). Investigating preservice secondary mathematics teachers' skills in posing realistic mathematics tasks. *Jurnal Elemen*, *10*(3), 533–545. https://doi.org/10.29408/jel.v10i3.25607

Rio, M. D., & Protacio, J. V. (2025). Explanatory sequential study on word problem-solving and mathematical cognitive skills of college students: Implications for STEM competencies development. *Educational Process: International Journal*, *18*, Article e2025506. https://doi.org/10.22521/edupij.2025.18.506

Rizki, L. M., & Priatna, N. (2019). Mathematical literacy as the 21st century skill. *Journal of Physics: Conference Series*, *1157*(4), Article 042088. https://doi.org/10.1088/1742-6596/1157/4/042088

Serin, H. (2023). The significance of mathematical literacy in today's society. *International Journal of Social Sciences & Educational Studies*, *10*(2), 396-402.

Skovsmose, O. (2011). An invitation to critical mathematics education. Sense Publishers. https://doi.org/10.1007/978-94-6091-442-3

Stacey, K. (2011). The PISA view of mathematical literacy in Indonesia. *IndoMS-JME: Indonesian Mathematical Society Journal on Mathematics Education*, *2*(2), 95-126. https://www.neliti.com/publications/62932/the-pisa-view-of-mathematical-literacy-in-indonesia

Sulistyani, N., Melissa, M. M., & Limiansih, K. (2024). Pemahaman guru matematika SMP terhadap konteks dan konten soal serta aktivitas yang mendukung literasi matematika. *JKPM (Jurnal Kajian Pendidikan Matematika)*, *10*(1), 25-36. http://dx.doi.org/10.30998/jkpm.v10i1.24991

Watson, J., & Callingham, R. (2022). Statistical literacy: A complex hierarchical construct. *Statistics Education Research Journal*, *2*(2), 3-46 https://doi.org/10.52041/serj.v2i2.553

Wijaya, A. (2016). Students' information literacy: A perspective from mathematical literacy. *IndoMS-JME: Indonesian Mathematical Society Journal on Mathematics Education*, *7*(2), 73–82. https://www.neliti.com/publications/64749/students-information-literacy-a-perspective-from-mathematical-literacy

World Economic Forum. (2016, March). *New Vision for Education: Fostering social and emotional learning through technology*. https://www3.weforum.org/docs/WEF_New_Vision_for_Education.pdf