Mathematical Literacy and Mathematical English of Papyuan Pre-Service Mathematics Teacher

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Abstract. *Strengthening the preparation of prospective mathematics teachers in Papua requires attention to both the ability to apply mathematical knowledge and the ability to access and communicate mathematical ideas in English. This study aimed to describe the mathematical literacy and Mathematical English profiles of Indigenous Papuan pre-service mathematics teachers enrolled in an English for Mathematics course. A descriptive quantitative design was employed with 24 students. Data were collected through a mathematical literacy test, a Mathematical English test. Mathematical literacy was categorized as very good for three students (12.50%), good for seven (29.17%), weak for eight (33.33%), and very weak for six (25.00%). Mathematical English ability was categorized as good for three students (12.50%), moderate for eight (33.33%), low for ten (41.67%), and very low for three (12.50%). These descriptive findings suggest that English for Mathematics course design could incorporate mathematical literacy, discipline-specific terminology, mathematical communication, and contextual tasks. Further research is needed to examine relationships between the two competence domains and evaluate the effectiveness of specific instructional approaches.*

Keywords: *Mathematical Literacy, Pre-service Mathematics Teachers, English for Mathematics, Indigenous Papuan students*

Abstrak. *Penguatan kompetensi calon guru matematika di Papua perlu memperhatikan kemampuan menggunakan matematika sekaligus mengakses dan mengomunikasikan pengetahuan matematika dalam Bahasa Inggris. Penelitian ini bertujuan mendeskripsikan profil literasi matematis dan kemampuan Bahasa Inggris matematis mahasiswa calon guru matematika asli Papua pada mata kuliah English for Mathematics. Penelitian menggunakan pendekatan deskriptif kuantitatif pada 24 mahasiswa. Data dikumpulkan melalui tes literasi matematis, tes Bahasa Inggris matematis. Literasi matematis terdiri atas kategori sangat baik sebanyak 3 mahasiswa (12,50%), baik 7 (29,17%), lemah 8 (33,33%), dan sangat kurang 6 (25,00%). Kemampuan Bahasa Inggris matematis terdiri atas kategori baik 3 mahasiswa (12,50%), sedang 8 (33,33%), kurang 10 (41,67%), dan sangat kurang 3 (12,50%). Pembelajaran English for Mathematics perlu mengintegrasikan literasi matematis, terminologi, komunikasi, dan aktivitas kontekstual melalui scaffolding (bantuan) bertahap. Penelitian lebih lanjut diperlukan untuk mengkaji hubungan antara kedua ranah kompetensi tersebut serta mengevaluasi efektivitas pendekatan pembelajaran tertentu.*

Kata Kunci: *Literasi Matematis, Calon Guru Matematika, Bahasa Inggris Matematika, Mahasiswa Asli Papua*

INTRODUCTION

Preparing competent mathematics teachers is a strategic component of sustainable educational development. In Papua, this responsibility is closely connected with strengthening locally grounded human resources while expanding access to international knowledge. Prospective mathematics teachers therefore need more than procedural mastery of mathematical content; they also require mathematical literacy and the ability to access, interpret, and communicate disciplinary knowledge in English. These competencies are increasingly relevant as mathematical resources, scholarly publications, and digital learning environments circulate across linguistic and national boundaries

Mathematical Literacy refers to the capacity to reason mathematically and to formulate, employ, and interpret mathematics in real-world situations. The PISA 2022 framework views mathematical literacy as continuum that can develop through learning experiences. This perspective is particularly relevant to teacher education because prospective teachers are expected not only to solve mathematical problems but also to design learning tasks that connect mathematical ideas with meaningful contexts. However, studies of prospective teachers indicate that conceptual understanding, contextual interpretation, and procedural skills may not develop evenly. Difficulties can arise when students are required to formulate mathematical relationships, interpret unfamiliar situations, or justify solutions rather than merely apply familiar procedures (Aydın, U., & Özgeldi, 2019; Suharta, I. G. P., & Suarjana, 2018)

In Indonesia, mathematical literacy remains an important area for improvement, and teacher education programs have a strategic role in preparing future teachers to foster mathematical reasoning, problem solving, and interpretation. Recent reviews further suggest that prospective teachers' mathematical literacy is shaped by conceptual understanding, self-efficacy, learning experiences, pedagogical preparation, and sociocultural context (Dirgantoro, K. P. S., Kusumah, Y. S., Jupri, A., & Melissa, 2025). Thus, profiling mathematical literacy can provide an initial basis for designing contextual and responsive teacher-education experiences.

Alongside mathematical literacy, English has become an important medium for accessing academic and professional knowledge. In mathematics, English proficiency involves more than general vocabulary because students must understand discipline-specific terminology, grammatical structures, instructions, symbolic representations, and mathematical explanations. Research in multilingual mathematics education highlights that language can either facilitate or constrain students' participation in mathematical sense-making. Therefore, students need to use language not only to recognize mathematical terms but also to understand, reason, explain, and communicate mathematical ideas (de Araujo, Z., Roberts, S. A., Willey, C., & Zahner, 2018; Robertson, S.-A., & Graven, 2020).

The relationship between language and mathematics is also shaped by sociocultural contexts. In multilingual settings, students may draw on multiple languages and multimodal resources to construct mathematical meaning. This perspective is relevant to Papua, where students' educational experiences are shaped diverse linguistic and cultural backgrounds. Accordingly, developing English for Mathematics should not require students to abandon local knowledge while maintaining connections with students' local educational context.

The present study focuses on Indigenous Papuan pre-service mathematics teachers, had a Papuan clan name (*marga*) enrolled in an English for Mathematics course. The study was motivated by the need to obtain an empirical description of students' readiness before designing instructional improvements. This study addresses that diagnostic need by describing students' responses to the English for mathematics course and presenting separate profiles of their mathematical literacy and mathematical English.

METHOD

This study employed a descriptive quantitative design to examine the mathematical English profiles of pre-service mathematics teachers enrolled in an English mathematics course. The inclusion criteria were that students had a Papua clan name (*marga)* and had been born and raised in Papua. The study was conducted from June-July 2026 in the mathematics study program, Universitas Cenderawasih, Papua. The finding were based on quantitative data available from the tests. The mathematical literacy test addressed the ability to understand a problem, formulate a situation mathematically, use relevant concepts and procedures, and interpret the resulting solution in context. This orientation is consistent with the formulate-employ-interpret processes emphasized in the PISA framework (OECD., 2023a, 2023b). Mathematical English test focused on students' understanding of mathematical terminology and English-language mathematical texts and on their ability to communicate simple mathematical meanings. The test results were summarized descriptively using the category frequencies and percentages reported in the study. The mathematical literacy and mathematical English result were examined separately to describe the distribution of participants across the reported performance categories.

RESULT AND DISCUSSION

Mathematical Literacy Profile

Mathematical literacy is broader than computational accuracy. In the PISA framework, it involves reasoning and the processes of formulating, employing and interpreting mathematics in contexts. This conception places emphasis on the movement between real situation and mathematical representations. For prospective teachers, such competence is important because teachers need to recognize mathematical opportunities in everyday situations and transform them into meaningful learning tasks. Studies of teacher

candidates have shown the difficulties may arise when PISA-type tasks require contextual interpretation, conceptual connections, or flexible use of mathematical representations (Aydın, U., & Özgeldi, 2019; Suharta, I. G. P., & Suarjana, 2018).

Yustitia, V., Amin, S. M. (2020) reported recent Indonesian studies further suggest that mathematical literacy among prospective elementary teachers, while Rahmawati, N. K., Waluya, S. B., & Hidayah, (2023) examined prospective teachers with lower mathematical ability may satisfy only some literacy indicators when posing data-oriented problems. These studies support the importance of profiling rather than assuming that enrolment in a mathematics education program automatically guarantees high mathematical literacy

The mathematical literacy test consisted of five main questions set in everyday and educational contexts. Canbazoğlu, H. B., & Tarim (2020) showed the relevance of activity-based practice for improving mathematical literacy and awareness among teacher candidates. Problem-based learning and contextual problem solving have also been used to strengthen the interpretation, reasoning, and communication dimensions of mathematical literacy (Simbolon, 2024).

Table 1 Mathematical Literacy Test

Task Observable	Scoring Criteria (Maximum Score)
Q1: Formulates calculations for drinking water needs, minimum packages, and total cost	Mathematical representation, procedure, and answer accuracy; (score = 6)
Q2: Develops and applies	Q2: a travel-cost model and determines the maximum travel distance (score = 6)
Q3: Calculates	Accuracy of interpretation and evidence-based reasoning; (score = 6)
Q4: Formulates and determines the maximum affordable quantity	Model formulation, and budget-based reasoning; (score = 6)
Q5: Calculates interprets, and evaluates a recommendation	Data interpretation, evaluation, and justification; (score = 6)

The mathematical literacy profile shows substantial variation. Three students (12.50%) were categorized as very good, seven (12.50%) as good, eight (33.33%) as weak, and six (25.00%)as very weak. Thus, 10 students (41.67%) were in the good or very good categories, whereas 14 students (58.33%) were in the weak or very weak categories. The larger proportion in the lower two categories indicates that strengthening mathematical literacy remains a significant need within this group.

The distribution is consistent with the broader literature indicating that prospective teachers do not form a homogeneous group in mathematical literacy. Aydın, U., & Özgeldi, (2019) found that contextual PISA tasks can reveal difficulties that are less visible in routine mathematical work. Likewise, Utomo (2023) showed that prospective teachers with different levels of mathematical ability may meet only some literacy indicators when posing problems. The present results should therefore be read as evidence oof different levels of readiness for contextual mathematical activity rather than as a judgement of students' overall mathematical ability.

The implication become more pronounced when mathematical literacy is required in English. A student may need to identify relevant information, formulate a mathematical relationship, select a strategy, and interpret the answer while simultaneously processing unfamiliar language. If either mathematical formulation or language comprehension is weak, the combined task can become more demanding.

The lower proportion of students' in good and very good categories also supports the need for contextual and activity-based teacher education. Rather than relying predominantly on symbolic exercises, learning on symbolic exercises, learning experiences can include short authentic problems, data interpretation, mathematical explanations, and opportunities to compare multiple representations. Such activities can gradually move students from recognizing mathematical information toward formulating, employing, and interpreting mathematics, which is central to the PISA conception of literacy (OECD., 2023a, 2023b)

Mathematical English Profile

Mathematical English can be conceptualized as the use of English for understanding and communicating mathematical meanings. It includes terminology, instructions, descriptions of mathematical relationships, and discourse practices such as explaining, comparing, arguing, and justifying. Research on English learners in mathematics emphasizes that language and mathematics are intertwined: language proficiency influences access to classroom participation, while participation in mathematical discourse provides opportunities to develop academic language (de Araujo, Z., Roberts, S. A., Willey, C., & Zahner, 2018)

The Mathematical English ability test comprised three groups of tasks focusing on mathematical vocabulary the interpretation of mathematical statements, and communication of mathematical ideas in English. The task used trigonometric table, evaluate mathematical statements, correct-false statements in englis and explain mathematical relationship in complete English sentence. A language-responsive approach does not mean replacing mathematics with language instruction. Rather, it makes the language demands of mathematical activity visible and provides structured opportunities for students to use language while doing mathematics (Erath, K., Ingram, J., Moschkovich, J., & Prediger, 2021).

Table 2 Mathematical English Test

Task Observable	Scoring Criteria (Maximum Score)
Q1: Math Vocabulary Completes the trigonometric table and identifies the English terms sine, cosine, and tangent	Correctness of the three English mathematical terms (score = 3)
Q2: Reading comprehension Identifies true/false	Comprehensible English and Appropriate mathematical vocabulary (score = 5)
Q3: Calculates interprets, and evaluates a recommendation	Data interpretation, evaluation, and justification; (score = 6)

In English for mathematics instruction, the possible use of Indonesian or local language could be explore as an instructional option, particularly when students

encounter unfamiliar mathematical concepts or terminology.

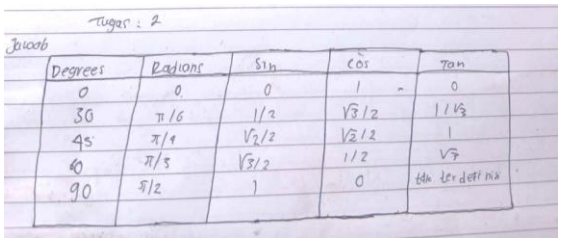


Figure 1 Students Answer in Expressing mathematical terms in English

Nevertheless, the present study did not investigate participants' language preferences or the role of local language preferences or the role of local languages in their mathematical learning. Therefore, this possibility should be treated as a proposed instructional consideration that requires further investigation rather than a finding established by the current data.

Prediger, S., & Neugebauer (2023) reported positive effects of language-responsive instruction on conceptual understanding, while Sharma, S., & Sharma, (2023) synthesized evidence supporting explicit language support, classroom interaction, and pedagogical practices for English language learners. These perspectives are also relevant to the context of mathematics teacher education, particularly in light of previous findings on the varying levels of mathematical literacy and English proficiency among pre-service mathematics teachers (Panjaitan, 2024, 2025). For the participants in this study, such support can take the form of sentence frames of explanations, glossaries embed in mathematical texts, and repeated practice in describing solution steps.

Importantly, the course should avoid equating English-only production with successful learning. For Indonesians can serve as bridges during difficult conceptual transitions while English is progressively introduced for mathematical reading, writing, and presentation.

Table 3 Distribution of Students Mathematical English Categories

Math-Eng categories	n	Percentages
Good	3	12.50
Moderate	8	33.33
Low	10	41.67
Very Low	3	12.50
Total	**24**	**100.00**

The pattern suggest that mathematical English should be taught as general English vocabulary. Students need to understand how words operate in mathematical propositions and how verbal descriptions connect with symbols, diagrams, tables, and procedures. Research on academic language in mathematics similarly argues that language is part of sense-making and should not be treated as a separate layer added after content learning (Robertson, S.-A., & Graven, 2020). In multilingual contexts, students may also need explicit opportunities to compare meanings across languages and representations, particularly when mathematical terms have no direct everyday equivalent.

Contextual and culturally responsive teacher education

Teacher education becomes more meaningful when mathematical ideas are connected to authentic contexts and when students' backgrounds are treated as resources.

Dirgantoro, K. P. S., Kusumah, Y. S., Jupri, A., & Melissa (2025) conclude from a systematic review that teacher education programs need stronger contextual and activity-based approaches to mathematical literacy. Research on integrating cultural artifacts and traditions from remote regions also suggests that local contexts can support the development of mathematical literacy when they are deliberately connected to mathematical tasks (Kurniawan, H., Purwoko, R. Y., & Setiana, 2024). For Indigenous Papuan students, the implication is not that every mathematical task must be culturally specific, but that learning should provide opportunities to connect global disciplinary knowledge with local experience.

This perspective is important for English for Mathematics because the course has a dual access function. It can help students communicate mathematics in English and can simultaneously expand their ability to access international resources. The goal is therefore not linguistic conformity for its own sake. The goal is increased academic agency: students should be able to read mathematical resources, interpret unfamiliar terminology, communicate mathematical reasoning, and decide when and how different linguistic resources can support understanding.

Interpreting the combined profile: interest is not the same as readiness

Research on multilingual mathematics learning has repeatedly shown that language can become an including or excluding factor depending on how instruction is designed (Robertson, S.-A., & Graven, 2020). The appropriate response is therefore not to simplify the mathematics until it loses its cognitive value, but to provide linguistic and representational support that allows students to engage with meaningful mathematical thinking.

The present study should not be interpreted as demonstrating a statistical association between the two competence domains. No correlation coefficient or predictive model was calculated, and the sample was not designed for inferential testing. The value of the combined profile is pedagogical: it shows that the course should be designed around the possibility that students will need support in both mathematical reasoning and disciplinary language at the same time. Such a design is consistent with the literature on language-responsive mathematics instruction and prospective-teacher preparation (Dirgantoro, K. P. S., Kusumah, Y. S., Jupri, A., & Melissa, 2025; Erath, K., Ingram, J., Moschkovich, J., & Prediger, 2021).

These implications are also consistent with related evidence from the Indonesian mathematics-education literature. Studies have documented differences in students' mathematical literacy across learner characteristics and task types, reinforcing the need to attend to process indicators rather than scores alone (Anastasya, C., Pujiastuti, H., & Setiani, 2024; Sabila, D., Fadillah, S., 2023).

Research on teachers' understanding of mathematical literacy further suggests that familiarity with contextual literacy problems

cannot be assumed automatically, which strengthens the case for explicit professional preparation (Jupri, A., & Rosjanuardi, 2020).

From the language perspective, mathematical language develops through meaningful disciplinary interaction rather than isolated terminology; mathematical language has also been shown to be connected with mathematical development (Farrugia, 2022; Kung, M., Schmitt, S. A., Zhang, C., Whiteman, S. D., Yang, F., & Purpura, 2019). For students who need more intensive support, structured language scaffolding and discourse opportunities can provide access to higher-level mathematical participation (Sacco, D. M., Spies, T., & Pfannenstiel, 2022).

Instructional implications for English for Mathematics

The first implication is the importance of diagnostic entry profiling. Before complex English-medium mathematical tasks are introduced, instructors can identify students' strengths in mathematical literacy, terminology, reading, and communication. The purpose is not to label students permanently but to determine an appropriate starting point. Students in the low or very low groups can receive more explicit modeling and guided practice, while students with stronger profiles can be given more open-ended explanation, problem posing, and presentation tasks.

The second implication is gradual scaffolding. A feasible sequence begins with key terminology and simple mathematical statements, continues to guided reading of short texts and instructions, then moves to contextual problems, and finally asks students to explain strategies and justify results in English. Sentence frames can support early production.

The third implication is integration of mathematical representations. Students should repeatedly move between verbal descriptions, symbols, tables, graphs, diagrams, and written explanations. Such movement is particularly valuable for students whose English proficiency is still developing because mathematical representations can function as additional semiotic resources. Translanguaging research similarly highlights the importance of multimodal and multilingual resources in supporting meaning-making in English-medium mathematics (Tai, 2020, 2021, 2022)

The fourth implication is contextual problem solving. Tasks can draw on familiar situations from students' everyday lives and local environments while still targeting mathematical processes such as formulating, employing, and interpreting. The aim is not to localize every task artificially, but to provide meaningful contexts in which students can connect prior knowledge with formal mathematical discourse. This direction is consistent with research emphasizing culturally responsive and contextual approaches in prospective-teacher mathematical literacy development (Dirgantoro, K. P. S., Kusumah, Y. S., Jupri, A., & Melissa, 2025; Kurniawan, H., Purwoko, R. Y., & Setiana, 2024).

The fifth implication concerns the possible use of digital learning tools. Platforms such as Google Classroom, Padlet, and Mentimeter may be considered as complementary options for distributing

mathematical learning materials, facilitating short written explanations, and collecting students' responses. Their implementation should take into account students' access to technology, instructional objectives, and classroom conditions. Since the present study did not examine digital platform use, these suggestions represent possible instructional arrangements rather than evidence-based conclusions about platform effectiveness. Further studies are needed to evaluate their feasibility and potential contributions to English for Mathematics learning.

The sixth implication concerns the balance between local and global knowledge. English for Mathematics can help Indigenous Papuan students access international textbooks, research articles, open educational resources, and professional communities. At the same time, global access should be connected to students' existing knowledge and identities. A culturally responsive approach does not isolate students from international mathematical discourse; it equips them to enter that discourse with greater confidence while retaining the ability to interpret and adapt knowledge to local educational needs.

Finally, opportunities for professional mathematical communication may be considered in the future development of English for Mathematics instruction. Activities such as explaining mathematical solutions, asking questions, providing feedback, presenting mathematical ideas, and designing short learning tasks in English could be explored as possible learning experiences for prospective mathematics teachers. However, the present study does not establish whether these activities can improve students' productive mathematical communication. Their implementation and potential contributions should therefore be examined through further instructional research and evaluation

CONCLUSION

In mathematical literacy, ten students (41.67%) were in the good or very good categories, while fourteen (58.33%) were in the weak or very weak categories. In mathematical English, eleven students (45.83%) were in the moderate or good categories, while thirteen (54.17%) were in the low or very low categories.

The study is limited by its small purposive sample and its contextual, non-experimental design. The findings should therefore not be generalized to all prospective mathematics teacher in Papua. Future research should involve larger samples and investigate changes overtime, relationships between mathematical literacy and mathematical English, and the effectiveness of specific language-responsive or culturally responsive instructional interventions. Such studies could build on the present profile to develop and test a more systematic English f mathematics model for teacher education in Papua

ACKNOWLEDGMENT

The authors express their gratitude to the Lembaga Penelitian dan Pengabdian Masyarakat of Universitas Cenderawasih

Fakultas Keguruan dan Ilmu Pendidikan (FKIP), Pendidikan Matematika for supporting the implementation of this research. The study was funded through the PNBP BLU Universitas Cenderawasih

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