Absis: Mathematics Education Journal
Vol. 7., No.2, Bulan November Tahun 2025, pp. 78-88
ISSN 2686-0104 (print), 2686-0090 (online)
http://journal.univetbantara.ac.id/index.php/absis/index

Developing Mathematical Language Literacy Skills Through the Use of Indonesian in Learning Real Analysis Courses

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Received 22 September 2025; Accepted 25 September 2025; Published 31 December 2025

ABSTRACT

The study's objectives are to: 1) ascertain the extent to which the teaching module aids in learning through the use of Indonesian in the Real Analysis course, and 2) ascertain the features of mathematical language literacy skills following participation in learning through the use of Indonesian in the Real Analysis course. This study used an experimental approach using Posttest-Only Control Design and True Experimental Designs research. Researchers administered an essay test consisting of up to four items to students in the real analysis lecture class in semester VI. The two-tailed significance level is 0.000, where <0.05. This indicates that there is a significant difference, at a probability of 0.05, between the outcomes of the mathematics language literacy skills learned using the Indonesian language actual analysis course teaching module. The mean difference column, which reads 15.31, indicates how much the average or mean of the two groups differed. It is possible to draw the conclusion that students who get instruction using the Indonesian language actual analysis course teaching module have superior mathematical language literacy skills compared to those who receive instruction using standard learning methods.

KEYWORDS

Literacy Skills
Mathematics
Indonesian
Learning
Real Analysis

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1. Introduction

The background of this research is that it begins with the existence of Presidential Regulation of the Republic of Indonesia Number 63 of 2019 concerning the Use of Indonesian Language (Madina et al. 2019). However, due to the emergence of slang terms among teenagers, the use of good Indonesian is decreasing (Dewi et al. 2023). This is certainly true for college students, who are part of a highly productive young society. To achieve the goal of increasing students' Indonesian language awareness, it is important to emphasize the urgency of effective and appropriate Indonesian language learning in the classroom.

The majority of students use slang in everyday life. This becomes even more difficult in classrooms where many foreign-language books and references are used, such as in the Real-World Analysis course. According to Kristayulita (2020) a number of students reported that studying Real Analysis courses using reference books written in English made them more difficult to understand and discouraged them from continuing. They hoped the books would be written in Indonesian (Nasrum and Subawo 2022) He added that students begin practicing reasoning and proving mathematical statements formally in the Real Analysis course. It is very difficult to understand the contents of the textbook. Not only understanding the concepts, but even understanding the definitions is sometimes difficult for students. One of the problems mentioned is the language barrier because students have to read a lot of literature in English (Septiati and Karjanto, 2008). Therefore, students must have good mathematical language literacy skills so they can understand the definitions and even the concepts contained in the course's reference sources. Students must have mathematical language literacy skills because mathematical literacy relates to real-world problems (Zahrah 2024). One of the highest skills is mathematical language literacy. To compete with other countries in today's era, students must possess strong mathematical language literacy skills (Masfufah and Afriansyah 2021). Mohamed, Ghazali, and Samsudin (2020) found that mathematical language is studied academically, using literary devices, and using technological approaches. Helsa, Juandi, and (2024) added that a

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ISSN 2686-0104 (print), 2686-0090 (online)

systematic review of the literature on mathematical proficiency at various levels is needed. Furthermore, Teledahl et al. (2024) showed that assessing students' mathematical writing: syntax, semantics, proofs, expository, descriptive, and others, influences the measurement of mathematical language literacy, especially in the context of writing definitions, theorems, and proofs in Indonesian.

Using Indonesian-language lecture modules and using Indonesian correctly can improve students' mathematical language literacy skills in Real Analysis classes. Focus on the influence of mother tongue on academic achievement in mathematics (Nunes et al. 2022). Teaching modules are curriculum-based learning tools used to achieve specific competencies (Putri, Afifah, and Anwar 2024). Teaching modules, which include learning implementation plans that can be used to direct learning activities to achieve learning objectives (Siloto 2023). The module in question is a learning tool for the Indonesian version of the Real Analysis course, based on mathematical language literacy skills. This module allows students to better understand the definitions and concepts of the Real Analysis course. Thus, the use of Indonesian is used to develop mathematical language literacy skills. Ester, Moraleda, and Morales (2024) compared the mathematical problem-solving performance of elementary school students whose instruction language was the same as their mother tongue vs. a different one. Kuzu (2023) stated that the process of using language (languaging) in mathematics education influences the understanding, interpretation, and construction of mathematical knowledge, especially in classes with different linguistic backgrounds.

The state of the art and novelty of this research is a change in the way students use Indonesian. In campus learning, many foreign-language books and references are used. One of these is the Real Analysis course. The first course students study is Real Analysis, where they practice reasoning and formally demonstrating mathematical statements (Nasrum and Subawo 2022). Proving theorems in abstract domains is the subject of this course (Widya Herliana Dewi Rambe et al. 2024). According to Idawati and Fatimatuzzahra (2024) Indonesian must be used correctly in academic settings. However, in the Real Analysis course, the source text is in a foreign language, making it increasingly abstract. The use of Indonesian in the Real Analysis course, supported by teaching modules, can help develop students' mathematical language literacy skills.

The research questions are: 1) how does learning through the use of Indonesian in the Real Analysis course, assisted by teaching modules, affect the development of mathematical language literacy skills? 2) what are the characteristics of mathematical language literacy skills after participating in learning through the use of Indonesian in the Real Analysis course.

The urgency of this research lies in the rapid decline in the use of Indonesian among students. Classroom instruction often uses books and references in foreign languages, including the Real Analysis course. This demotivates students. Students want the books to be written in Indonesian. Understanding not only concepts but also definitions is sometimes challenging for students. Therefore, it is crucial for students to acquire good mathematical literacy skills through the use of Indonesian in Real Analysis courses.

2. Method

This research is a quantitative research with the research method being an experimental method with the form of research being True Experimental Designs and the research design being Posttest-Only Control Design (Sugiyono 2018).

Table 1. Posttest-Only Control Design Research Design

	Class	*Treatment*	*Posttest*
R	Experiment	X	O_1
R	Controls	-	O_2

The research procedures to be carried out are as follows. 1) The first stage in this research process is to analyze the learning objectives and achievement indicators of the Real Analysis course. At this stage, clear learning objectives and achievement indicators are obtained based on the lecturer's RPS reference and are listed based on the order of material in the Real Analysis course. 2) The second

ISSN 2686-0104 (print), 2686-0090 (online) Vol. 7., No. 2, Bulan November Tahun 2025, pp. 78-88

stage is to design the research instrument. Here the researcher designs the instrument to be used in the research in the form of a posttest of mathematical language literacy skills for students. 3) The third stage is to design a teaching module for the Indonesian language real analysis course based on mathematical language literacy skills. With this stage, a teaching module is formed which is an Indonesian version of the reference book used by the lecturer and also contains indicators of mathematical language literacy skills. 4) The fourth stage is to validate the research instrument and teaching module. At this stage, the researcher validates the research instrument with a validator who is an expert in his field and in accordance with his knowledge. The research instrument in the form of a posttest question on mathematical language literacy skills and a teaching module for the Indonesian language real analysis course based on mathematical language literacy skills were examined for their validity with the aim of obtaining a valid instrument and teaching module used for the next research process. The validators are 3 lecturers consisting of 2 lecturers from the Indonesian Language and Literature Education study program and 1 lecturer from the Mathematics Education study program at UPGRI Pontianak. 5) The fifth stage is to conduct a trial of the instrument, namely the mathematical language literacy ability test questions. This stage is carried out to obtain a research instrument that is feasible and reliable for use in the next research stage. This trial was conducted in one of the Real Analysis course classes in semester VI of the Mathematics Education study program at UPGRI Pontianak. 6) The sixth stage is analyzing the validation results of the instrument and teaching module, as well as the trial of the mathematical language literacy test questions. At this analysis stage, if the instrument and teaching module are valid and reliable, the researcher will proceed to the next research stage, namely revising the research instrument and teaching module. However, if the instrument and teaching module are neither valid nor reliable, the researcher will repeat the research stage process, namely before designing the research instrument. 7) The seventh stage is revising the research instrument and teaching module. This stage is carried out based on the validation and trial results conducted in the previous stage. The researcher makes revisions based on the validator's notes on the validation sheet and the results of the test instrument questions. 8) The eighth stage is the provision of treatment. At this stage, two classes will be selected using Cluster Random Sampling to be used as samples in the study, where previously normality and homogeneity testing of the population was carried out for research sampling. One class will be given learning using the Indonesian language real analysis course teaching module based on mathematical language literacy skills, which is then called the experimental group. The other class will not be given learning using the Indonesian language real analysis course teaching module based on mathematical language literacy skills. In other words, this group is only given learning using the regular learning model. Furthermore, this second group is called the control group. Both groups of classes are given learning through the use of Indonesian in class not only as the language of instruction but the entire lecture where the only difference is assisted by the teaching module (experimental group) and not assisted by the teaching module (control group). 9) The ninth stage, after the completion of the treatment in both groups, a posttest will be given containing mathematical language literacy ability test questions to measure the mathematical language literacy skills of students in each group. 10) The tenth stage is analyzing the research results. At this stage, a hypothesis test is conducted using a t-test based on the test results for each indicator of mathematical language literacy. This hypothesis test is conducted to determine whether, for each indicator of mathematical language literacy, the class taught using the Indonesian language real analysis course module based on mathematical language literacy skills has better abilities than the class taught using conventional learning. 11) The final stage is drawing conclusions. The research procedures are shown in Figure 1.

Absis: Mathematics Education Journal
ISSN 2686-0104 (print), 2686-0090 (online)

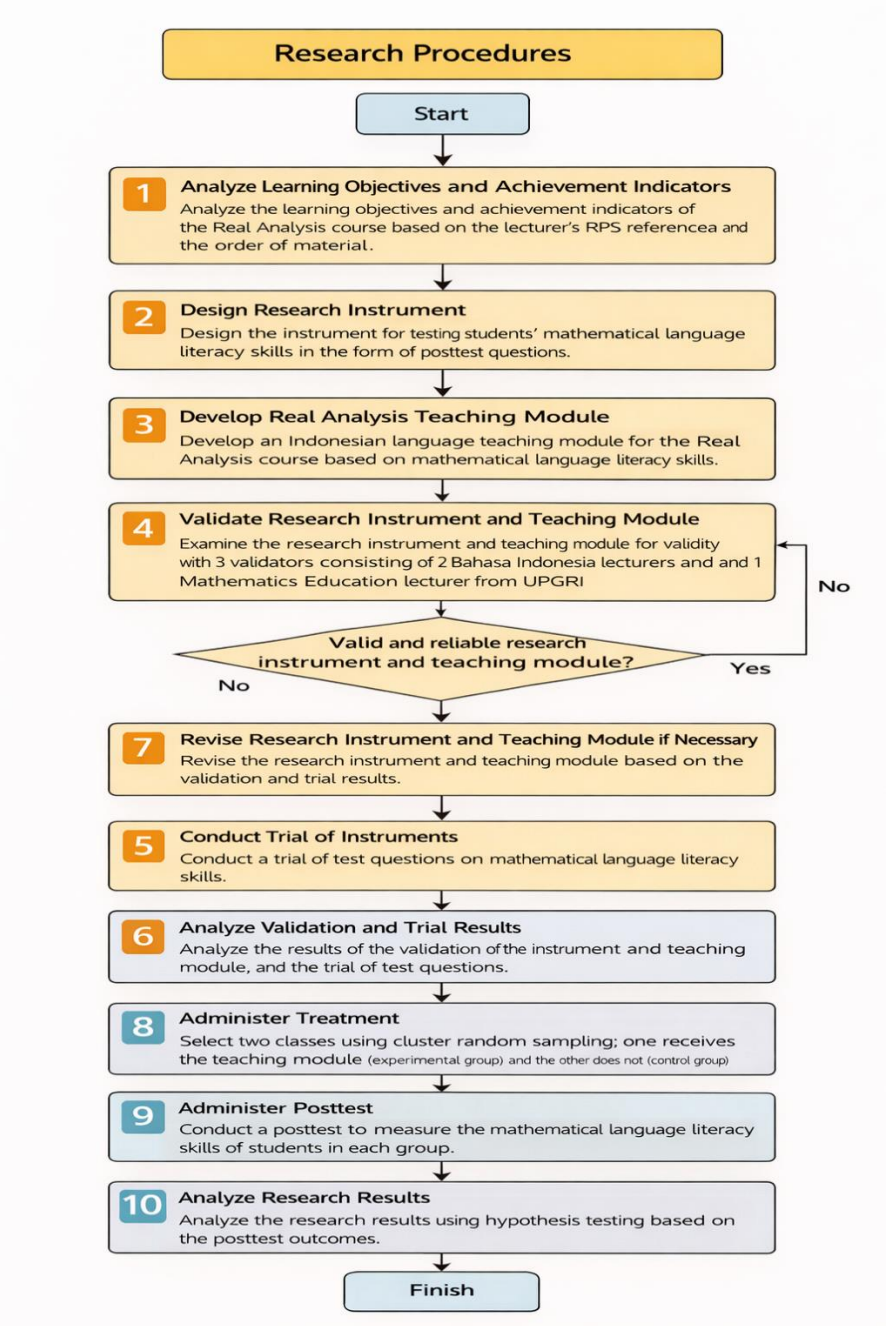

Figure 1. The research procedures

3. Results and Discussion

This research is a quantitative research with the research method being an experimental method with the form of research being True Experimental Designs and the research design being Posttest-Only Control Design (Sugiyono 2018). The steps of quantitative research are outlined as follows: 1) The first stage in this research process is to analyze the learning objectives and achievement indicators of the Real Analysis course. At this stage, clear learning objectives and achievement indicators are obtained based on the lecturer's RPS reference and listed according to the order of material in the Real Analysis course. 2) The second stage is to design the research instrument. Here the researcher designed the instrument to be used in the research in the form of a posttest question on mathematical language literacy skills for students. Students must have mathematical language literacy skills because mathematical literacy is related to real problems (Zahrah 2024). One of the highest skills is mathematical language literacy. To compete with other countries in today's era, students must possess strong mathematical language literacy skills (Masfufah and Afriansyah 2021). 3) The third stage is

designing a teaching module for the Indonesian-language real-world analysis course based on mathematical language literacy skills. This stage creates a teaching module that is an Indonesian-language version of the reference book used by the lecturer and also includes indicators of mathematical language literacy skills. A teaching module is a curriculum-based learning tool used to achieve specific competencies (Putri, Afifah, and Anwar 2024). Teaching modules, which include learning implementation plans that can be used to direct learning activities to achieve learning objectives (Siloto 2023). 4) The fourth stage is validating the research instrument and teaching module. At this stage, the researcher validated the research with validators who are experts in their fields and in accordance with their expertise. The research instrument, in the form of a post-test on mathematical language literacy skills and a teaching module for the Indonesian language real analysis course based on mathematical language literacy skills, were examined for their validity with the aim of obtaining valid instruments and teaching modules for use in further research processes. The validators were three lecturers: two lecturers from the Indonesian Language and Literature Education study program and one lecturer from the Mathematics Education study program at UPGRI Pontianak. The values or results of the validation given by the validators can be seen in Table 2, and the criteria can be seen in Table 3.

Table 2. Validity of Assessment Results by Material Experts and Media Experts

Research Instrument	Validator			Average Total Score	Criteria
	1	2	3		
Material	89,6	77,6	71,2	79,5	Valid
Media	75,0	83,3	75,0	77,8	Valid

Table 2. Product Validity Criteria

Average	**Validity Criteria**
80 < *Skor* ≤ 100	Sangat Valid
60 < *Skor* ≤ 80	Valid
40 < *Skor* ≤ 60	Cukup Valid
20 < *Skor* ≤ 40	Kurang Valid
0 < *Skor* ≤ 20	Tidak Valid

(Hodiyanto, Darma, and Putra 2020)

The assessment results for the material validation included 25 statements and the media validation results included 11 statements. Table 1 shows the assessment results from the three material experts and media experts with an average percentage of 78.6, with valid criteria. Although the material and media validation results were categorized as valid, several revisions were made by the validators. Based on the input and suggestions provided, the researcher revised the validators' suggestions. These results are relevant to the research conducted by (Rachmi, Suharti, and Hidayat 2024), The results of the validity test for the teaching module as a whole obtained a very valid category so that the learning device is suitable for use. The teaching materials to be developed have been validated by material experts and research module experts conducted by (Arigiyati, Kusmanto, and Widodo 2019). Furthermore, the same thing is shown by the research results (Ermaida, Kamid, and Yantoro 2021) The module for preparing mathematics learning assessment instruments is valid.

The validation results by the validator on the media and materials obtained several improvements to the media and materials provided. After providing suggestions and input for improvement, the experts also assessed the posttest questions on mathematical language literacy skills and the teaching module for the Indonesian language real analysis course based on mathematical language literacy skills using the material and media validation instrument. The three experts stated that the posttest questions on mathematical language literacy skills and the teaching module for the Indonesian language real analysis course based on mathematical language literacy skills could be used

Absis: Mathematics Education Journal
ISSN 2686-0104 (print), 2686-0090 (online)

with the condition of improvement. Then the data or scores that had been obtained from the validation instrument sheet were calculated. The scores obtained were valid for the material and media. In addition, the posttest questions on mathematical language literacy skills and the teaching module for the Indonesian language real analysis course based on mathematical language literacy skills must be improved before being distributed to the research sample during the treatment. After improvements were made to the posttest questions on mathematical language literacy skills and the teaching module for the Indonesian language real analysis course based on mathematical language literacy skills and were also declared valid, the next research step could be continued.

Next step 5) The fifth stage is to conduct a trial of the instrument, namely the mathematical language literacy ability test questions. This stage is carried out to obtain a research instrument that is feasible and reliable for use in the next stage of research. This trial was conducted in one of the Real Analysis courses in semester VI of the Mathematics Education study program at UPGRI Pontianak. 6) The sixth stage is to analyze the results of the validation of the instrument and teaching module as well as the trial of the mathematical language literacy ability test questions. At this analysis stage, if the instrument and teaching module are valid and reliable, the researcher will proceed to the next stage of research, namely revising the research instrument and teaching module. However, if the instrument and teaching module are not valid or reliable, the researcher will repeat the research stage process, namely before designing the research instrument. 7) The seventh stage is to revise the research instrument and teaching module. This stage is carried out based on the results of the validation and trials conducted in the previous stage. The researcher made revisions based on the notes from the validator on the validation sheet and the results of the instrument trial questions. 8) The eighth stage is the provision of treatment. At this stage, two classes will be selected using Cluster Random Sampling to serve as samples in the study. One class will be given learning using the Indonesian language real analysis course teaching module based on mathematical language literacy skills, which will then be referred to as the experimental group. The other class will not be given learning using the Indonesian language real analysis course teaching module based on mathematical language literacy skills. In other words, this group will only be given learning using the regular learning model. This second group will then be referred to as the control group. The following is documentation of the implementation of the treatment for the experimental and control classes in Figure 1.



Figure 1. Documentation of the Implementation of Experimental and Control Class Treatment in the Real Analysis Lecture Class

Next step 9) The ninth stage, after the treatment is completed in both groups, a posttest will be given containing mathematical language literacy test questions to measure the mathematical language literacy skills of students in each group. The following is the documentation of the implementation of the experimental and control class treatments in Figure 2.



Figure 2. Documentation of Posttest Questions for Experimental and Control Classes in Real Analysis Lecture Class

Next, 10) The tenth stage is to analyze the research results. At this stage, a hypothesis test is conducted using a t-test based on the test results on each indicator of mathematical language literacy. This hypothesis test is conducted to see whether for each indicator of mathematical language literacy, the class given learning using the Indonesian language real analysis course teaching module based on mathematical language literacy skills has better abilities than the class given learning using regular learning. The results of the test that the researcher has conducted on semester VI students in the real analysis lecture class in the form of 4 essay questions with a total of 29 students each, the average posttest score of the experimental class is 83.07 and the average posttest score of the control class is 70.00. Before conducting the hypothesis test with the t-test, normality and homogeneity tests were conducted with the sample results coming from a normally distributed population where the Sig value was obtained > 0.05 (0.064 > 0.05) and a homogeneous sample where the Sig value was obtained > 0.05 (0.061 > 0.05). Therefore, the hypothesis test was then carried out with the t-test. Based on calculations using the independent sample t-test with SPSS, the results are shown in table 3.

Table 3. Results of the Independent Sample T-Test with SPSS

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
nilai	Equal variances assumed	3.667	.061	16.916	56	.000	15.31034	.90508	13.49724	17.12345
	Equal variances not assumed			16.916	54.599	.000	15.31034	.90508	13.49622	17.12447

Based on table 3, it shows that the Sig. (2-tailed) value is 0.000, which is <0.05. This means that there is a significant difference in the results of mathematical language literacy skills given learning with the Indonesian language real analysis course teaching module based on mathematical language literacy skills at a probability of 0.05. 11) The final stage is drawing conclusions. The magnitude of

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ISSN 2686-0104 (print), 2686-0090 (online)

the difference in the average or mean of the two groups is shown in the Mean Difference column, which is 15.31. Because it is a positive value, it means that the experimental group has a higher Mean than the control group. Based on these results, it can be concluded that the mathematical language literacy skills given learning with the Indonesian language real analysis course teaching module based on mathematical language literacy skills are better than the mathematical language literacy skills of students given regular learning. The results of this study are in line with research conducted by (Ningsih and Rochmawati 2014) there is a significant difference between student learning outcomes with and without the use of modules. Raden M. H. K. Negara, Suherman, and Yayat (2019) modules that are in accordance with the curriculum can improve learning outcomes. In line with Harianja and Utami (2023) the influence of module use on student learning outcomes after module implementation. The following is a display of the e-learning module for the Indonesian language real analysis course based on mathematical language literacy skills, presented in Figure 3.

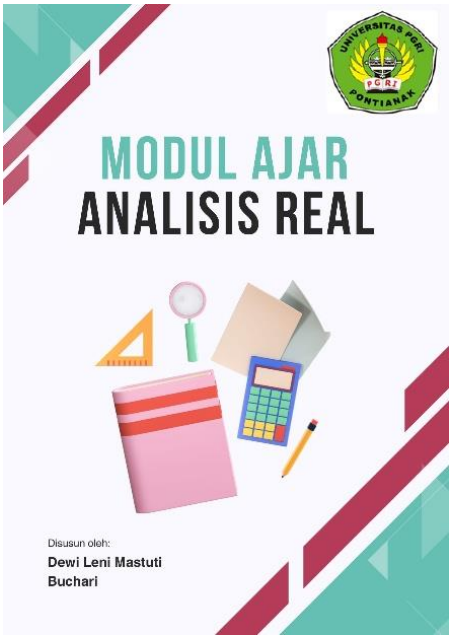

Figure 3. Display of the Teaching Module for the Indonesian Language Real Analysis Course Based on Mathematical Language Literacy Skills

Furthermore, in this study, the characteristics of mathematical language literacy abilities were analyzed and obtained after participating in learning through the use of Indonesian in the Real Analysis course, which was in the average category of 83.30 students being able to solve problems on posttest questions related to mathematical language literacy abilities in the experimental class. The findings indicate that learning in the Real Analysis course using Indonesian as the language of instruction, supported by a teaching module based on mathematical language literacy, resulted in an average achievement of 83.30, indicating that students' mathematical language literacy abilities were in the high category. This suggests that the integration of Indonesian-language instruction with structured teaching modules can effectively support students in understanding, expressing, and solving mathematical problems using appropriate mathematical language.

This study was limited to a single institution and involved a relatively small sample size, which may restrict the generalizability of the results. In addition, the measurement of mathematical language literacy was based solely on posttest data, so changes in students' abilities before and after the intervention could not be directly compared. Future studies are recommended to involve larger and more diverse samples across multiple institutions and to employ pretest–posttest designs to better capture improvements in mathematical language literacy. Further research may also explore the application of Indonesian-language teaching modules across different mathematical courses and examine their long-term impact on students' mathematical communication skills.

4. Conclusion

Based on the results and discussion, it can be concluded that the mathematical language literacy skills provided by learning with the Indonesian language real analysis course teaching module are better than the mathematical language literacy skills of students provided with regular learning. Lecturers are advised to use Indonesian strategically in explaining abstract concepts in Real Analysis. The use of mother tongue has been proven to help students understand complex mathematical technical terms, as well as gradually strengthening mathematical language literacy skills. It is necessary to develop bilingual teaching materials (Indonesian and formal Mathematics) that explicitly clarify the relationship between mathematical terms and their narrative explanations. This can help students build a more conceptual understanding, as well as strengthen mathematical communication skills.

Acknowledgment

Thank you to the Directorate of Research, Technology, and Community Service, Directorate General of Higher Education, Research, and Technology for funding the Beginner Lecturer Research (PDP) in the 2025 Fiscal Year, LPPM Universitas PGRI Pontianak as a facilitator and the Mathematics Education Study Program as a partner in this Beginner Lecturer Research (PDP).

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