# Mathematical Literacy Skills of Prospective Mathematics Teachers in Capita Selecta Course: A Hermeneutic Phenomenology Approach

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**Abstract:** The mathematical literacy ability of students is still relatively low, and they have not been trained optimally. This study aims to analyze the level of mathematical literacy of prospective mathematics teacher students in the Selected Capita of Elementary Mathematics Education II course. The material includes the Pythagorean Theorem, Quadrilaterals and Triangles, Curved Side Spaces, and Comparison. The subjects of the study involved 25 students who were taking the Selected Capita of Elementary Mathematics Education II course. The research method used was qualitative with the Phenomenology Hermeneutic approach. The stages of the Phenomenology Hermeneutic approach are deciding on research questions, identifying pre-understanding, gaining understanding through dialogue with participants, gaining knowledge through dialogue with text, and building trust. Data were collected through descriptions of student answers and selected interviews. The data analysis technique follows the steps of Miles & Huberman. Question number 3 has a literacy indicator, namely interpreting solutions in problem-solving (interpret). The focus of the analysis is on students' answers to question number 3. Three students answered correctly, while one student answered with a few errors. While answers from 20 students contain significant errors, 1 student did not provide an answer. 3 students, who correctly answered question number 3, belong to moderate-ability students. Nevertheless, none of the students from the high-ability group were able to answer perfectly. This shows that students with moderate ability are better at answering question number 3 than students with high ability. Of the 20 student answers with the criteria of many errors, two answer patterns were found, errors in process skills and errors in writing the final answer. Efforts are needed to improve literacy skills through the presentation of literacy questions and learning that supports the development of students' mathematical literacy.

**Keywords:** capita selecta course, mathematical literacy skills, prospective mathematics teacher, hermeneutic phenomenology.

▪ **INTRODUCTION**

Mathematical literacy skills, which are required for students, are a combination of the five competencies that have been established in NCTM (2000). The objectives of learning mathematics include several important aspects, the ability to solve mathematical problems, communicate mathematically, perform mathematical reasoning, connect mathematical concepts, and represent mathematical ideas.

Mathematical literacy skills are abilities that not only understand mathematics but also can use mathematics to solve problems in everyday life. The abilities that students need to have not only limited to the ability to count but also involve the ability to reason logically and critically in solving problems. The problems solved are not only limited to routine questions but include challenges faced in everyday life. This ability is known as mathematical literacy.

An important component of achieving this goal is building literacy education. In the OECD, mathematical literacy is defined as follows, "Mathematical literacy is an

individual's capacity to formulate, employ, and interpret mathematics in a variety of contexts. It includes reasoning mathematically and using mathematical concepts, procedures, facts and tools to describe, explain, and predict phenomena. It assists individuals to recognize the role that mathematics plays in the world and to make the well-founded judgments and decisions needed by constructive, engaged, and reflective citizens". Mathematical literacy refers to an individual's ability to formulate, apply, and communicate mathematical concepts in a variety of contexts. This concept includes mathematical reasoning and the use of mathematical concepts, procedures, facts, and tools to describe, explain, and predict events (Dosinaeng, 2019). Mathematical literacy helps individuals understand the role of mathematics in life, enabling them to make good judgments and make constructive and reflective decisions.

In line with the above-mentioned statements, Ojose (2011) defines mathematical literacy as the ability to understand and apply the basics of mathematics in everyday life. De Lange (2006) also states that mathematical literacy is related to "problems" in the real world, problems that are not entirely about mathematics, but related to certain situations. Mathematical literacy includes three interrelated aspects: spatial literacy, numeracy, and quantitative literacy.

While spatial literacy refers to someone's ability to the three-dimensional world, numeracy includes aspects such as numbers, measurements, geometry, data, uncertainty, and algebra (Kemdikbud, 2020). Then, quantitative literacy refers to the ability to identify and understand quantitative information in everyday life. When prospective teacher students face real-world problems, they require skills and knowledge gained during their studies and from experience to solve them. This process is called mathematization. Mathematization commences with dealing with real problems, identifying their relationship to mathematics, forming mathematical concepts to solve, and finally applying the solutions in real contexts. The mathematical literacy process includes various activities such as exploring, connecting, formulating, determining, reasoning, and mathematical thinking. This thinking process can be divided into three main stages: formulating, using, and interpreting. Therefore, mathematical literacy can be interpreted as a person's ability to effectively formulate, apply, and interpret mathematics in various problem-solving situations in everyday life (Sari, 2015). The mathematical literacy process can be divided into three main stages; formulating real problems, using mathematics, and interpreting solutions (OECD, 2021). A person with good mathematical literacy will be able to process these three stages effectively in solving problems.

In the first stage, formulating problems involves the process of constructing, simplifying, and compiling a mathematical model of the problem at hand. At this stage, real problems are represented in mathematical form, which requires an understanding of relevant mathematical information and concepts. The information is then connected with mathematical concepts to form a mathematical model of the problem. In the second stage, the mathematical model formed is used to find solutions through a process called utilizing mathematics. Mathematical concepts, facts, and procedures are applied to obtain mathematical solutions, which will later be reinterpreted into their original context and validated for correctness.

Students' mathematical literacy remains low (Widjaja, 2011; Fatwa, Septian, & Inayah, 2019; Muzaki & Masjudin, 2019; Masfufah & Afriansyah, 2021; Purnomo & Sari, 2021; Amelia, et.all, 2023; Zahrah, 2024). Also, the field data indicate that

mathematical literacy ability has not been optimally developed, (Fatwa, Septian, & Inayah, 2019). The supporting facts also show that students are only able to apply the taught concept without priorly analyzing and interpreting the mathematical concepts (Warmi, 2019; Jeheman, Gunur, & Jelatu, 2019). Furthermore, the survey conducted by PISA in 2022 reported that Indonesian students' mathematical literacy ability increased 5 ranks. However, if seen from PISA survey in 2018, the overall ability decreased. This significant challenge must be responded by the educators to facilitate the improvement of mathematical literacy and to integrate this literacy during the learning and teaching process.

From this explanation, the prospective teachers are required to possess excellent literacy to facilitate the development of students' mathematical literacy during classroom instruction. As teachers are demanded to be creative in learning process (Afriansyah, 2017), prospective teachers should have creativity in designing lessons that support the development of students' mathematical literacy ability.

Having literacy ability will surely assists mathematic prospective teachers in gaining deeper mathematics concepts and eventually can apply these concepts in real life. This is actually in line with the definition of mathematical literacy as individual ability in formulating, applying, and interpreting mathematics in certain contexts (OECD, 2019). Moreover, the ability of mathematical literacy is also critical in facing 21st-century challenges that include technology mastery and data analysis (Stacey, 2010).

To prepare prospective teachers for integrating literacy into mathematics instruction, they must be trained and optimized to ensure that they can effectively apply mathematic literacy in teaching. If prospective teachers have strong mathematical literacy skills, they have a solid base for improving students' mathematical literacy. This can be facilitated by Teacher Education Institutions (LPTK), which play a crucial role in enhancing mathematical literacy skills for prospective teachers. By implementing this training, LPTK can produce teachers who are capable of equipping students with essential mathematical literacy skills (Prabawati, 2018).

The Selected Capita of Elementary Mathematics Education II course is compulsory subject for mathematics education students in Indonesia Education Institute Garut (IPI Garut). This subject focuses on mathematics topics in Junior High School and aims to provide deep knowledge and understanding of essential school mathematics materials. This course also supports the fulfillment of TPACK components, specifically Content Knowledge (CK), teacher's ability in comprehending relevant topics and certain content areas.

To understand and explore school mathematics materials and the learning models used, students must have mathematical literacy ability. This skill is trained in forms of integrating this ability during the classroom. The topics covered in Selected Capita of Elementary Mathematics Education II course are important mathematics topics in Junior High School as in line with Curicculum 2013.

In this study, the test materials for prospective mathematics teachers cover the Pythagorean Theorem, Quadrilaterals and Triangles, Curved Side Spaces, and Proportions. The research question for this study is How is the mathematical literacy ability of prospective mathematics teachers in the Selected Chapters of Elementary Mathematics Education II course? The findings of this study are expected to provide

descriptions the real conditions of students' mathematical literacy, which can be reference as the further research on mathematical literacy among prospective mathematics teachers.

▪ **METHOD**

This study aims to analyze the mathematical literacy of prospective mathematics teachers. It examines the mathematical literacy of prospective mathematics teachers in Selected Capita of Elementary Mathematics Education II course. This research uses qualitative method using Phenomenology Hermeneutic approach. The phenomenology hermeneutic approach consists of 5 stages (Alsaigh & Coyne, 2021). These stages include determining the research question, identifying pre-understanding (before data collection, gaining understanding through dialogue with participants (interview and journal notes), gaining understanding through dialogue with texts (transcribing and analyzing data), and building trust.

The primary instruments in this study are students' answers analysis and selectively chosen interviews. The instruments used in this study were a mathematical literacy essay test consisting of 4 questions and interview guidelines. These test instruments had been both theoretically and empirically validated. To validate the instruments theoretically, 4 expert mathematics lecturers were involved, while empirical validation involved pilot testing using SPSS 24. The result of validation showed that all four questions were valid, and the reliability of instruments was classified as moderate/ sufficient. The four test questions covered each of four indicators of mathematical literacy ability. Question 1 contains indicator of formulating real-world problem in problem-solving (Formulate), questions 2 assesses the indicator of applying mathematics concepts in problem-solving (Employ), question 3 evaluates the indicator of interpreting solution in problem-solving (Interpret), and question 4 contains indicator of evaluating solution in problem-solving (Employee).

Selected and in-depth interviews were conducted to collect further information. These interviews aimed to obtain information related to the student's experiences in understanding mathematical literacy in Selected Capita of Elementary Mathematics Education II course. To verify the accuracy of students' responses, the selected interviews were transcribed, which focused on students' relevant information to the research objectives and problems.

The participants of this study were prospective mathematics teachers enrolled in the Selected Capita of Elementary Mathematics Education II course during the 2022/2023 academic year in the Mathematics Education Study Program at a university in Garut. A total of 25 students were taken as sample using purposive sampling method, consisting of 23 female students, and 2 male students.

The research data were analyzed by using Miles & Huberman (1992), that include several stages such as data reduction, data presentation, and conclusion drawing. From the answer patterns obtained, a total of 20 students responded question 3 with frequent error criteria in interpreting solution in problem-solving. These 20 students' answers were analyzed based on error pattern in answering the question as explained in Newman theory (1977), which categorized into: Reading error, Comprehension Error, Transformation Error, Process Skill Error, Encoding Error. This analysis follows the Newman error indicators as refined by Clemen (1980).

▪ **RESULT AND DISSCUSSION**

For the purposes of testing the hypothesis using individual completeness tests, classical completeness tests, average difference tests and simple linear regression. After the data is obtained, it must be tested for normality, homogeneity of variance, and initial average similarity test before proceeding to hypothesis testing.The normality test is used to determine whether the sample comes from a normally distributed population or not. Based on the calculation results One-Sample Kolmogorov-Smirnov test shows that the normality of the initial data Sig. = 0.116 <0.05 and the normality of the final data Sig. = 0.116 > 0.05, then H0 is accepted, which means that the sample comes from a normally distributed population. The homogeneity of variance test is intended to determine whether the two classes sampled have the same variance or not. Based on the calculation results Test of Homogeneity of Variancesshows initial homogeneity Sig.= 0.372 > 0.05 and final homogeneity Sig.= 0.58 > 0.05 then H0 is accepted which means that the variances of the two classes are homogeneous. Based on calculations t-test for Equality of Meansthe value of Sig. = 0.753 > 0.05 then H0 is accepted which means that the initial average of mathematical creative thinking skills in the two classes is not significantly different.

Based on the prerequisite tests, namely the normality test, homogeneity of variance, and the initial average similarity test, it can be concluded that the data from all groups come from populations that are normally distributed, have a homogeneous variance and the same initial mean. Therefore, hypothesis testing can be done.

Mathematical literacy tests were given to 25 students who enroll Selected Capita of Elementary Mathematics Education II course. The research subjects were categorized as students with high and moderate literacy ability, based on the grades in Selected Capita of Elementary Mathematics Education I in previous semester. Students who received grade A were categorized into high-ability group, while those who got grade B as moderate-ability group. Based on this categorization, 12 students were classified as high-ability group, and 13 students as moderate-ability group.

According to the results of mathematical literacy test, the researchers analyzed the responses from each participant by providing the general description of participants performance on each indicator. The findings are as follows:

From first indicator/ question 1 that is formulating the real-world problems in problem solving, it was found that only 4 students who perfectly answered the question. Other 4 students were able to formulate the problem with minor errors. Furthermore, 5 students provided incomplete formulation of the real-world problem. Even, 12 students were incorrect in formulating real-world problems. It can conclude that a lot of students did not meet the indicator in question 1.

The second indicator or question 2 is about applying mathematics in problem solving (Employ). A total of 21 students provided perfectly answers, and 4 students answered with minor error. In question 2, all students met the indicator.

The third indicator or question 3 is interpreting solution in problem-solving (Interpret). 3 students could perfectly provide correct answers. 1 student could interpret correctly despite minor errors. Unfortunately, 20 students interpreted solution with significant errors, and 1 student were not able to provide answer on question 3. In brief, there are many students who could not fulfill the indicator in question 3.

In fourth indicator or question 4 is to evaluate solutions in problem-solving (Employee). There were 9 students who evaluated solution with minor errors. 13 students

could evaluate solution but with some errors, and 3 student evaluated solution with abundant errors. In question 4, it can be said that many students could not still achieve the indicator.

In this study, the focuses of analysis are only on students' answers on mathematical literacy on question 3, which is the third indicator, interpreting solution in problem solving (Interpret). An interesting finding to be analyzed is that the three students who perfectly answered the question 3 were from moderate-ability group, whereas none of high-ability students provided correct answer. Additionally, the researchers will also analyze the answer patter from 20 students, who answered the question with significant errors in interpreting solution in problem-solving.

The further analysis was conducted to the three subjects who provided perfect answer in question no. 3. These three students were from moderate-ability group and would be labelled as S1, S2, and S3. Despite the moderate literacy ability, they could perfectly response the question no 3. Below is the excerpt from S1's response to the Question 3.



**Figure 1.** Excerpt from S1's response to the question 3

Based on Figure 1, S1 was able to answer the question 3 perfectly. S1, S2, and S3 had fulfilled the indicator of interpreting solution in problem-solving (Interpret). The three students continued to interview stage to explore their ability in responding and to clarify the accuracy of their answers given during the mathematical literacy written text.

According to the result interviews, S1, S2, and S3 were able to clarify their answers correctly and precisely, which was consistent with their written responses on the mathematical literacy test. The three students had high learning motivation during the Selected Capita of Elementary Mathematics Education II. This motivation arose because their previous grade on Selected Capita of Elementary Mathematics Education I were not satisfactory. This condition forced them to study even harder in Selected Capita of Elementary Mathematics Education II. Motivation that they had became the main factor in learning. Motivation will make someone to work harder and never surrender to improve the learning result (Rahman, 2021). Furthermore, motivation ensures continuity, guides

direction, and foster the enthusiasm in learning (Oktiani, 2017). Below is the excerpt from S2's interview.

*R:*  *What was your weakness in Selected Chapter of Elementary Mathematics Education I in previous semester?*

*S2:*  *Honestly, I could not understand the story question, Mam. It is also easy for me to forget the math formula. In the first semester, I was still adaptation process because I was still surprised with the learning environment, particularly the learning model used was only material presentation.*

*R:*  *What efforts have you been made in Selected Chapter of Elementary Mathematics Education II so you can be better from previous semester?*

*S2:*  *I studied harder, and try to fix my learning weakness, because I want to be better person in second semester, Mam.*

Furthermore, for the question 3, with the indicator of interpreting solution in problem-solving (Interpret), which discusses the Curved Side Space material. S1, S2, and S3 had good understanding about this material. These three students were able to mention the formulas used in solving the problem correctly. This is another reason why S1, S2, and S3 were able to solve the question perfectly. Below is an excerpt of S3's interview.

*R:*  *What concept did you use to solve the problem in question no 3?*

*S3:*  *The concept I used was cylinder volume.*

*R :*  *Can you mention the formula of volume of cylinder?*

*S3:*  *Sure, Mam. The formula is $V = \pi r^2 t$.*

*R :*  *What steps did you take in solving the problem in question no 3?*

*S3:*  *Firstly, I found the radius by using the circumference of the circular base of the cylinder. Then, I applied the volume of a cylinder formula. After the volumes of both cylinders are found, I compared them to find the larger one.*

From the statements, it can be concluded that S1, S2, and S3, were able to solve the problem in question 3 perfectly due to their high level of motivation in learning Selected Capita of Elementary Mathematics Education II and their good understanding of Curved Side Space material.

The subsequent things that were analyzed in this finding was the response patterns found from 20 students, answering question 3 with significant errors in interpreting solution in problem-solving. These twenty students consisted of 11 students from high-ability group, and 9 students from moderate-ability group. Their responses were analyzed using the error patterns observed in answering the question no 3, based on Newman (1977) theory. These errors include Reading Error, Comprehension Error, Transformation Error, Process Skill Error, and Encoding Error. This analysis follows Newman's error indicators as proposed by Clemen (1980). The following is the bar chart illustrating the error pattern made by 20 participants in responding question no 3, which focuses on mathematical literacy indicator of interpreting solution in problem-solving (interpret).

As seen from Figure 2, from 11 students with high-ability group, 6 students performed errors in process skill, particularly in the indicator related to calculation. Below is an example of a student's answer that show a process skill error:
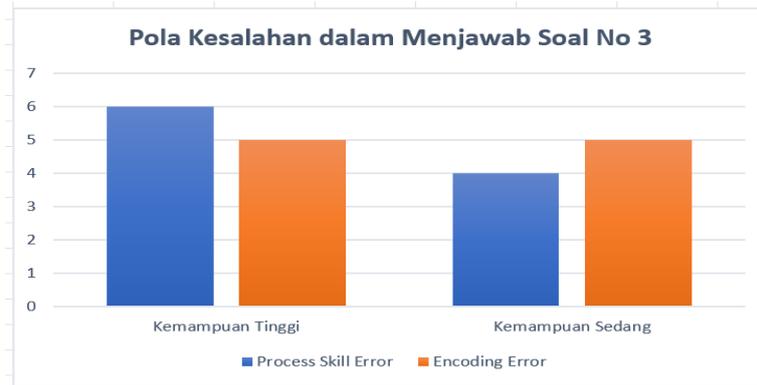
**Figure 2.** Error pattern in answering question no 3



**Figure 3.** Excerpt of a high-ability student's answer with process skill error on question number 3

The answer from Figure 3 demonstrates that the student made an error in using the formula of cylinder volume, particularly in finding the height of the cylinder. The height was replaced by the formula for the lateral surface area of cylinder, which is in the shape of a rectangle made of cardboard.

A total of five students made errors in writing the final answer (Encoding Error), specifically in the indicator where students created mistakes due to their carelessness or lack of accuracy in determining the radius of the cylinder's base. The following is an excerpt from one student who made mistakes in writing the final answer (Encoding Error):



**Figure 4.** Excerpt of a high-ability student's answer with encoding error on question number 3

Figure 4 shows that the student's answer considers that both cylinders have the same base area, but they have different height. Without calculating first, the student quickly concluded that the cylinder with the largest volume is the one with greater height.

Of 9 students from moderate-ability group in answering question no 3, there were found 2 patterns. Four students made errors in process skill error, particularly in the indicator where students made errors in calculation. Below is an excerpt of student's response in making errors in process skill:
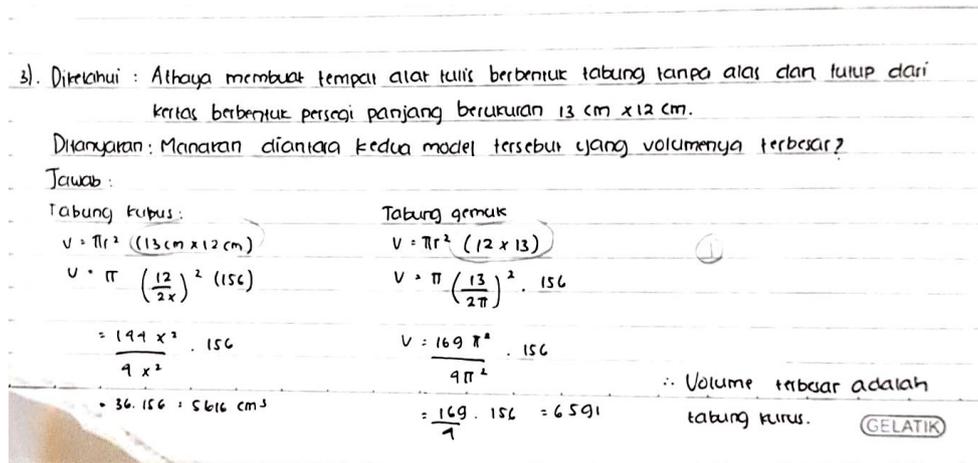


**Figure 5.** Excerpt of a student's answer from the moderate-ability group with process skill error on question number 3

The student's answers shown in Figure 5 show that he made errors in applying the formula for the volume of a cylinder, particularly in determining the height of the cylinder. The height of the cylinder was replaced with the formula for the lateral surface area of the cylinder, which is in the shape of a rectangular sheet made of cardboard.

Furthermore, five students made errors in writing their final answers (Encoding Error), specifically due to carelessness or lack of accuracy in determining the radius of the cylinder's base. Below is an excerpt of one student's answer who made an error in writing the final answer (Encoding Error):
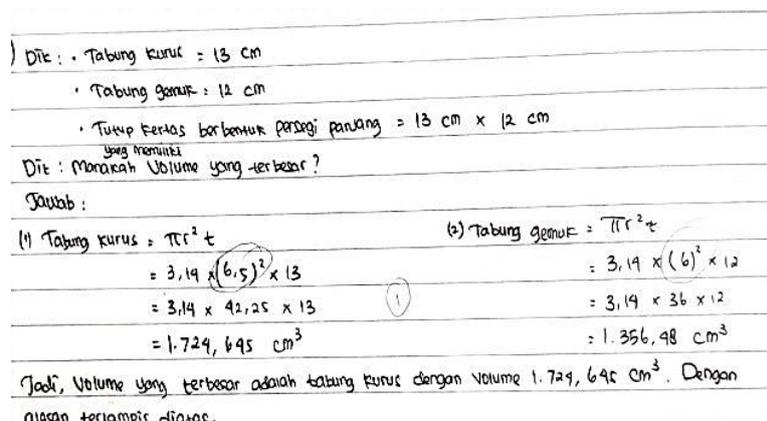


**Figure 6.** Excerpt of a student's answer from the intermediate group with encoding error on question number 3

Figure 6 shows that the student's answer is incorrect in determining the radius of the base of the cylinder. The radius is incorrect because the student considered that the circumference of the base was the diameter of the circular base of the cylinder.

From the analysis of the answers provided by 20 students from both the high-ability and intermediate-ability groups on question number 3, it was found that students made errors in the same pattern, with process skill errors accounting for 50%. This percentage is relatively high and in line with the findings of Octaviana (2017), who reported that process skill errors reached 88%. Fatahillah, Wati, & Susanto (2017) also stated that process skill errors were the most common among all error types. These errors occurred due to miscalculations (Murtiyasa & Wulandari, 2020), procedural mistakes (Abdullah, Abidin, & Ali, 2015), and a lack of carefulness (Rohmah & Sutiarso, 2018).

This study also found that errors in writing the final answer accounted for 50%. This percentage indicates that the number of students who made mistakes in writing their final answers is still quite significant. This finding is also consistent with the research of Octaviana (2017) and Mulyadi, Riyadi, & Subanti (2015). Errors in this process were caused by students' lack of precision and confusion (Pranyata, 2019).

▪ **CONCLUSION**

The conclusion of this study is that mathematical literacy skills in the Selected Chapters of Elementary Mathematics II are still relatively low. Students with moderate mathematical abilities are more effective in solving question number 3 compared to students with high abilities. From the 20 student answers to question number 3, where students made many errors in interpreting problem-solving solutions, two error patterns were identified; errors in process skills and errors in writing the final answer.

For further research, it is recommended to focus more on research to examine the root of the problem of why students' literacy skills are still low. It is also recommended that an effort is needed to improve students' mathematical literacy skills through literacy-based questions and presentation of learning that supports the development of mathematical literacy skills.

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