Preservice Primary Teachers' Common Errors in Solving Mathematics Literacy Problems

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Abstract. Understanding the information on the problem presented in the form of pictures is not an easy task for preservice primary teachers to lead to errors. However, preservice primary teachers can also answer correctly if given a mathematical model directly. Preservice primary teachers' errors can be determined using a process point of view in solving mathematical problems. In a qualitative context, this study describes and analyzes the mistakes of preservice primary teachers traced through errors in solving mathematical literacy problems. This research is qualitative research, where analysis is needed to broaden the understanding of the errors that occur when solving mathematical literacy problems. The results showed that preservice primary teachers experienced errors on each indicator in four types of errors when solving mathematical literacy problems. This research found one new type of error, namely carelessness, which is an error with different types of the four types of errors that exist. Further research can be carried out by designing strategies used to improve the ability of preservice primary teachers to solve mathematical literacy problems.

INTRODUCTION

NCTM states that students' ability and skills in solving math problems must be mastered since elementary school and are essential in learning mathematics (1,2). There are five competencies in mathematics learning developed by NCTM, namely problem-solving, communication, reasoning, connections, and representation. By referring to the five competencies in mathematics learning, especially in the ability and skills to solve mathematical problems, mathematical literacy is one of the 21st-century mathematics learning skills.

The Organization for Economic Cooperation and Development (3) defined mathematics literacy as a personal ability to analyze and recognize the implications that mathematics plays in society, to consider excellently verdicts, and to interact in mathematics in accordance with the demands of such an individual's immediate and potential life as a constructive, involved, and introspective individual. Mathematical literacy is interpreted as the capability of an individual to establish, implement and describe mathematics in a variety of contexts, such as the potential to deliver mathematical reasoning and also use ideas, strategies, and evidence to identify, justify or predict phenomenology (4). Mathematical literacy refers to students' knowledge and ability to use and determine mathematical knowledge and skills acquired from class to experience their daily lives to understand the conditions involving mathematics. Because mathematical literacy is one of the most critical life skills, it is a fundamental ability that is just as essential as literacy (5). As a result, mathematics instruction in schools should improve mathematical comprehension and each student's ability to use and use mathematical skills to solve real-world problems or scenarios.

After this, students can understand and integrate basic mathematics in their everyday lives due to studying mathematics (6).

Ability and skills in solving math problems, especially mathematical literacy problems, are not easily mastered by students because they have low information literacy (7). One of the significant aims of educational organizations in schools was to encourage mathematical literacy. Mathematics education is sought schools provide students with mathematical comprehension and the opportunity to use their skills in real-life scenarios outside of the classroom. Mathematical literacy has a distinct identity that distinguishes it from substantive mathematics. Mathematics in classrooms concentrated on substantive substance, while mathematical literacy emphasized how to apply mathematics in daily situations (8). Elementary school students can understand mathematical concepts but cannot apply them to real-life problems or mathematical literacy problems (9). Ability and skills in solving math problems can be influenced by self-concept. The self-concept possessed by these students can cause math anxiety, which will harm students' mathematical literacy (10). Furthermore, the research results related to students' visual reasoning of mathematical literacy show that the use of pictures or diagrams accompanied by written information can play a role in understanding students to solve a given problem. Besides, 60% of junior high school mathematics teachers still have insufficient knowledge of mathematical literacy (11). Furthermore, the data obtained from the research results show that junior high school mathematics teachers better understand the learning process compared to the process of assessing mathematical literacy.

The explanation above shows that the abilities and skills of students and teachers in solving mathematical literacy problems have not been well mastered. Some studies focus on the abilities and skills of students and teachers only in solving mathematical literacy problems. However, only a few studies have discussed the abilities and skills of preservice primary teachers in solving mathematical literacy, especially those focusing on errors in understanding mathematical literacy problems, which provide information only in the form of pictures or diagrams. Therefore, it is imperative to know in advance the abilities and skills of preservice primary teachers to trace the mistakes of preservice primary teachers in solving mathematical literacy problems, which are presented in the form of pictures. The research question to support this condition is how preservice primary teachers' common errors in solving mathematics literacy problems.

METHODS

This research is a qualitative study that describes preservice primary teachers' work in solving mathematical literacy problems. Furthermore, the research focus is on the errors made by preservice primary teachers in solving mathematical literacy problems. Errors in solving mathematical literacy problems were observed using the point of view of error analysis (12) based on Newman Errors Analysis, namely (1) comprehension; (2) transformation; (3) mathematical processing; and (4) encoding which is further described in Table 1.

TABLE 1. Coding Scheme for Error Types when Solving Mathematical Literacy Problems

Error type	Code	Indicator
Comprehension	C1	What they had been asked to do was wrongly interpreted by the student
	C2	The student could not discern information that was disadvantage
Transformation	T1	Students were found to use a mathematical procedure directly without analyzing it
	T2	Students used math/concepts that are not appropriate to the tasks
	T3	A picture was treated as a literal picture of a situation
Mathematical processing	MP1	Error in calculation
	MP2	Students have used a correct form or procedure but have not completed it.
	MP3	Students do not use the right form or procedure
Encoding	E	This error has been represented in an unrealistic response

The research subjects were preservice primary teachers who made mistakes in solving mathematical literacy problems. Twenty-six preservice primary teachers are asked to solve two maths literacy problems related to geometry. This math literacy problem was given after the preservice primary teachers took the geometry course programmed at the beginning of the learning semester. To investigate the type of error that occurred, only use the data on the preservice primary teachers' worksheet for whom the error occurred. Then, to obtain the percentage of error types, an analysis was performed on the preservice primary teachers' worksheet for two math literacy problems. The analysis was performed by adjusting the indicators for four types of problem-solving errors and dividing them by the total preservice primary teachers who participated in solving math literacy problems.

RESULTS

A total of 26 preservice primary teachers who solved two math literacy problems experienced errors in four types of errors. Based on the coding carried out on each error indicator, the error of the transformation type on the T1 and T2 indicators were the most carried out (96.2%). In contrast, the errors in mathematical processing, especially in the MP2 indicator, were rarely done (11.5%) (see Table 2).

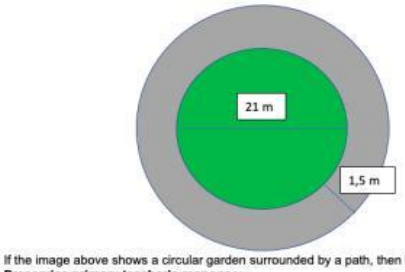
TABLE 2. Types of Student Errors in Solving Mathematical Literacy Problems

Type of Errors	N	%	Indicator Type of Errors	%
Comprehension	26	94,2	C1	94,2
			C2	94,2
Transformation	26	95,5	T1	96,2
			T2	96,2
			T3	94,2
Mathematical Processing	26	61,5	MP1	88,5
			MP2	11,5
			MP3	84,6
Encoding	26	100	E	100

Comprehension

Errors in this type of comprehension occur when preservice primary teachers cannot understand a given mathematical literacy problem. Table 2 shows that the error in this type of comprehension, both on indicators C1 and C2, has the same percentage, 94.2%. The percentage means that the preservice primary teachers cannot correctly interpret the problem given. As a result of the inability to interpret these problems, preservice primary teachers cannot determine information advantages that can be used to solve mathematical literacy problems.

Figure 1 is an example of a preservice primary teachers' worksheet showing errors in comprehension types. In a given mathematics literacy problem, the preservice primary teachers cannot interpret the information given to the mathematics literacy problem. In the worksheet, it can be seen that the preservice primary teachers cannot interpret the problem, so they do not use the appropriate information to determine the solution to the problem. The worksheet also shows that preservice primary teachers use the information in the picture without interpreting it first. In this part of understanding, preservice primary teachers should find that the information in the problem shows the diameter of the park is 21 m, and the width of the path is 1.5 meters. Meanwhile, to understand how to find the path area, it does not directly use information in the form of numbers on the given problem.



If the image above shows a circular garden surrounded by a path, then how wide is the path?
Preservice primary teacher's response:

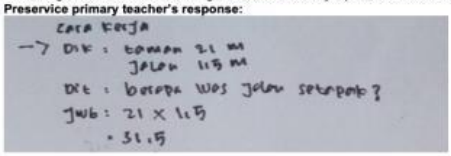
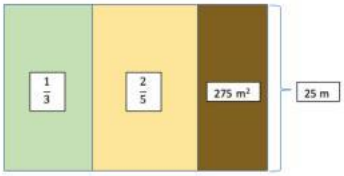


FIGURE 1. Example of Comprehension Error

Transformation

The error in this type of transformation has the percentage of indicators that are not much different, the T1 and T2 indicators with the highest error percentage (96.2%) and the lowest T3 indicators (94.2%). This condition indicates that the preservice primary teachers cannot conduct a deeper analysis of the determination of the strategy used, so that they are unable to model the problem given in a mathematical form. Besides, preservice primary teachers are incapable of developing and using simple methods to solve problems.

Figure 2 is an example of a preservice primary teachers' worksheet showing errors in this type of transformation. In the mathematics literacy problem given, the preservice primary teachers did not conduct a deeper analysis to determine the procedure to solve the problem, likewise using concepts to support specified procedures. The transformation error shown in Figure 2 shows that the preservice primary teachers can understand the information given, namely, adding up all the parts to get the length. To get the area, the preservice primary teachers perform the multiplication procedure of the length obtained by the width that already exists in the problem information. However, when modeling into mathematics, there is a misconception, namely, directly adding up all the information given to the problem. In this transformation section, preservice primary teachers should find the right strategy to solve the given problem by first finding the area width already known. By knowing the width, preservice primary teachers can find the overall width of the area.



If the image above shows Father's plot of land distributed to his three children, how much land is the father's plot?
Preservice primary teacher's response:

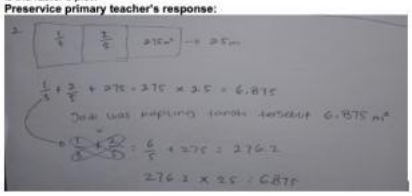


FIGURE 2. Example of Transformation Error

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Mathematical Processing

Errors in this type of mathematical processing have very far different percentage indicators. The MP1 indicator (88.5%) and MP3 (84.6%) have a high percentage, while the MP2 indicator has a meager percentage (911.5%). It is clear from the preservice primary teachers' worksheet (see Figure 3) that very few preservice primary teachers solve problems using the correct formulas or procedures. MP2 indicator is different from the high percentage of the MP1, and MP3 indicators, which are caused by errors in calculations, and the procedures used to solve the problem are not correct. Besides, two preservice primary teachers showed different errors in solving problems. The preservice primary teacher does not experience errors in the comprehension and transformation types, but the errors are initiated in the mathematical processing type.

Furthermore, errors that occur are not included in the MP1, MP2, and MP3 indicators determined. If observed further (see Figure 4), errors that occur in the preservice primary teacher are caused by "carelessness" in the process of solving problems, namely errors in writing numbers. This shows that the error in the form of "carelessness" dramatically affects the following type of error and results in errors in the final answer. To strengthen the condition of "carelessness", short questions were asked to preservice primary teachers. The following are examples of the questions and answers given.

> Researcher: Are you sure about this completion process? (Points to answer sheet)
> Preservice primary teacher: (while looking at the answer sheet) When I solved this problem, I was sure, but now I realized that there was an error caused by carelessness in using the information in the problem.

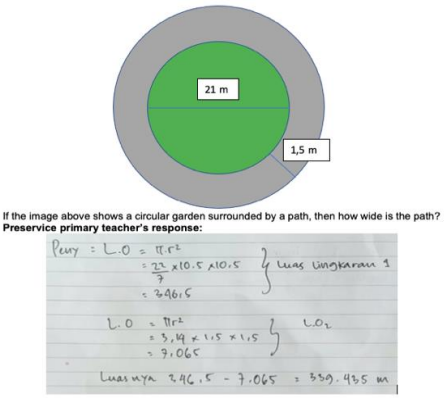

FIGURE 3. Example of MP Error (Careless)

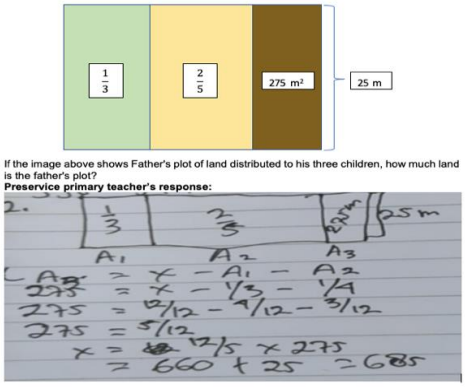

FIGURE 4. Example of MP Error

Encoding

Error in encoding type has a percentage of 100%, which means that all preservice primary teachers experience errors in solving math literacy problems (see Figure 5). Even though the type of transformation of preservice primary teachers is correct, if there is an error in the mathematical processing type, the encoding type error also experiences an error. In this type of encoding error, it can also be seen that all preservice primary teachers experience errors in solving math literacy problems as a whole, both in the first and second problems.

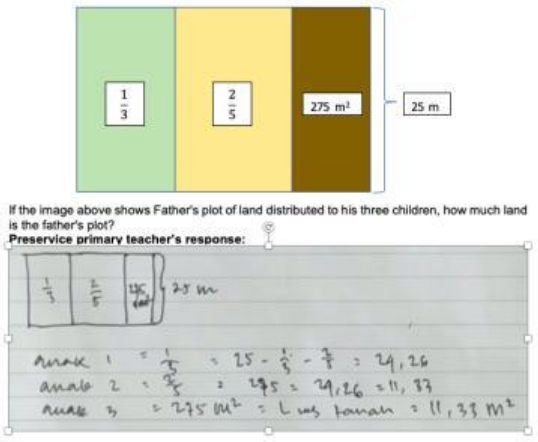

FIGURE 5. Example of Encoding Error

DISCUSSION

This study aims to describe the errors of preservice primary teachers better when solving math literacy problems. The results of the data analysis show that the tendency for errors begins with the comprehension type. Errors in this type of comprehension indicate the characteristics of the error made, namely, being unable to understand the keywords used in the question. This condition is in line with the results of research which show that one of the sources of errors in solving problems is understanding questions (13,14). Besides, errors are an inability to integrate real-life problems into understanding the problems given. This condition results in not using the information on the problem to be used in solving a given mathematical literacy problem. Other studies have found that if teachers can use real-life problems, it can be a starting point that encourages students to understand better the problems given (5). Even though preservice primary teachers cannot use the information on the problem given on the answer sheet, there are no doubts that can be seen from the scribbled answers in solving the mathematical literacy problem. This condition shows that the preservice primary teachers believe that they have understood the problem given.

Contrary to the research results, which states that the self-confidence of preservice teachers about mathematics literacy is still below average (15). Despite this fact, the belief that preservice primary teachers have in solving math literacy problems leads to mistakes. However, the belief that they have can be the initial capital for preservice primary teachers because, as mathematics teachers, they must plan to learn. It is stated that literacy can support mathematics learning (16).

Errors in this type of transformation indicate the characteristics of the errors carried out; namely, they did not carry out a deeper analysis of the given problem. This condition results in the inability to use concepts and methods to solve the given mathematical literacy problems. Other studies have found that if students can develop their models or methods, they can solve mathematical literacy problems (5). In line with the research results, which states that a teacher must be able to choose the right strategy to solve mathematical literacy problems (9).

Errors in this type of mathematical processing show the characteristics of the errors carried out, namely, not using forms or procedures to solve the right problem. In mathematical processing in this study, it was found that there were errors that were not in the three predetermined indicators. The error that occurs is carelessness, in which two participants do not experience errors in the comprehension and transformation types. However, in research, this wild type of error only occurs in mathematical processing situations. In fact, carelessness is very likely to occur in four types of errors (17).

Errors in the type of encoding indicate the characteristics of the error being committed, namely, the appearance of the answers that are not following what they should be. Errors in encoding types are strongly influenced by the three types mentioned above of errors, namely comprehension, transformation, and mathematical processing. In research, if there is an error in just one type, it can result in an error in the encoding type. This resulted in all participants experiencing errors in the type of encoding because the

conclusions drawn by all participants experienced errors in line with (18). They stated that student errors in determining conclusions marked encoding errors.

CONCLUSION

Based on the analysis and discussion results, the solving of mathematical literacy problems carried out experienced errors in all four types. This condition shows that more profound errors can be found by analyzing the process when solving mathematical literacy problems. Besides, the research found errors with a new type, namely, carelessness. Error in the type of carelessness indicates that even though the comprehension, transformation, and mathematical processing types are correct when there is an error on the wild type afterward, the final result still experiences errors and results in errors in the last type, namely encoding. Then, the analysis and discussion results also show that there is a relationship between errors that occur in solving mathematical literacy problems. If an error occurs starting in the comprehension type, then an error occurs on all subsequent error types.

Further research that might be done is designing strategies for preservice primary teachers in solving math literacy problems, especially in types of comprehension errors. This type of error can be decisive for solving a given problem appropriately. So, more attention is needed to pay attention to error comprehension types. Besides, because of the high percentage of errors in the types of transformation errors, it is necessary to carry out further research on participants who do not experience comprehension type errors by scaffolding them in learning to use the right concepts in solving mathematical literacy problems.

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