

# Primary school students' mathematical literacy in solving multiple-solution

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## Primary school students' mathematical literacy in solving multiple-solution

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**Abstract:** This study aims to analyze primary school students' mathematical literacy (ML) in solving multiple-solution (MS) problems. We call students ML to solve MS with MS-ML. The research subjects are students from grade four in a Sidoarjo, East Java primary school. The research method used is descriptive qualitative with a case study approach. The instruments used were an MS-ML test and an interview. Interviews were conducted with several students who were selected through the MS-ML category. There are three indicators of MS-ML: the formulating stage, the employing stage, and the interpreting stage. The results of the analysis showed that there were appropriate and inappropriate MS-ML categories. Most students are in the inappropriate MS-ML category. Many students struggle to formulate, employ, and interpret the correct divergent solution. We suggest that one familiarize oneself with divergent ML-MS-based problem-solving in learning and teaching, namely building ML problem-solving with multiple solutions or MS strategies.

**Keywords:** Mathematical literacy, multiple-solution, problem-solving

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## INTRODUCTION

Mathematical literacy (ML) is the ability of an individual to formulate, employ, and interpret mathematics in various contexts (OECD, 2022). In Indonesia, ML is known as numeracy in the 2021 guidelines for strengthening literacy and numeracy in schools (Kemdikbud, 2021). Including primary school students, ML is needed as a foundation for preparing and projecting mathematics in various contexts in 21st-century competencies (Nagasaki, 2015). In this, it is expected that through ML, students can train their reasoning in applying and verifying mathematical concepts presented in a real problem (Yang, Kuo, & Jiang, 2019). In other words, ML is needed so that students not only focus on products or formulas but also use formulas to solve problems (Amir, Septiarini, & Wardana, 2023; Lanya, Zayyadi, & Sulfiah, 2021; She, Stacey, & Schmidt, 2018).

Students with good ML can be seen from the sensitivity of using appropriate mathematical concepts to find the correct problem-solving solution (Hera & Sari, 2015). Meanwhile, the benchmark for student success in solving ML problems can be seen in students' success in formulating and interpreting the problem's surrounding situation (Purnomo & Sari, 2021). In addition, Khikmiyah and Midjan (2017) said that ML can be seen from students' ability to analyze, convey reasons and ideas effectively, and interpret mathematical problems in various forms and circumstances. Therefore, it is essential to pay attention to ML, especially for primary school students, not only the product but also the process of using ML in solving problems.

Unfortunately, the level of ML involving primary school students is still inadequate. Compared to other countries, the ML competitiveness of students in Indonesia tends to be less competitive (Nirmala, 2022). Based on the PISA (Program for International Student Assessment) study, Indonesia's score is still lagging compared to other countries. Students' ML in Indonesia is still low. This was shown in 2018, which obtained a score of 379 from the highest score of 691 and the lowest score of 325 (Schleicher, 2018). Students' ML is low because Indonesia's learning and teaching process differs from its evaluation; the problems presented are not ML-based (Masfufah & Afriansyah, 2021; Suharta & Suarjana, 2018).

Mathematical problems may have multiple solutions (Leavy & Hourigan, 2021). We can measure this by using multiple-solution (MS) based problems. In this, MS is seen as a task that requires students to find multiple correct solutions to solving the problem. MS is also referred to as an assignment that presents an extraordinary challenge for students in solving mathematical problems that are non-routine or unconventional (Große, 2014; Leikin, 2014). This will trigger students to think more logically according to their mindset and knowledge so that students can make mathematical connections to generate new solutions (Haara, Bolstad, & Jenssen, 2017; Leikin, 2014; Schindler & Lilienthal, 2020).

Through MS problems, students will explore creating and using more than one solution or strategy so that students can be trained in their mindset and choose the easier or more relevant way to do it (Stupel & Ben-Chaim, 2017). In addition, MS problems can measure students' level of thinking in solving a problem with various solutions (Verschaffel, Schukajlow, Star, & Van Dooren, 2020). Using MS-based problems will increase students' enthusiasm and curiosity in solving them (Stupel & Ben-chaim, 2017). Therefore, we hope that MS-based ML problems (MS-ML) can be a solution to evaluate students' skills more flexibly and give students leeway in providing more varied solutions.

Hwang and Ham (2021) examined the advantages of learning mathematics by working on varied problems that can improve students' ML. Almarashdi, Mohamed, and Jarrah (2023) stated that MS-ML given to students can be used to measure students' ability to use other alternative solutions. While looking for alternatives, students will do flashbacks to remember previous experiences in solving their problems (Schindler & Lilienthal, 2020).

The results of Shore and Kobiela's (2020) research state that participants working on MS-ML can provide multiple answers, but for non-standard solutions or solutions that students do not commonly write. DeVink, Willemsen, Lazonder, and Kroesbergen (2022) also confirmed in their research that in solving MS, students write non-standard solutions originally, so students create abstract formulations of ideas and provide inaccurate solutions. Concerning ML, students' solutions are inaccurate due to problems in layers of understanding (Ayuningtyas, Amir, & Wardana, 2024).

Some previous study results show that primary school students who are still not skilled in ML because they still have difficulty evaluating information, so students still have difficulty solving it (Ayuningtyas et al., 2024; Hapsari, Saputro, & Sadewo, 2022; Hillman, 2014; Nirmala, 2022; Wijaya, 2016). This MS-based problem will encourage students to build many solutions by writing down different mathematical procedures (Schukajlow & Krug, 2014b). Another study by Hwang and Ham (2021) showed that ML can be improved by working on problems presented in various solution strategies. These existing studies have not discussed the ML of primary school students when given ML. This study analyzes primary school students' ML in solving MS to determine how primary school students' MS-ML. Hence, this study analyzes ML-MS or ML primary school students solving MS problems.

**METHODS**

**Research Design**

The method used in this research is a qualitative research method with a case study design. Qualitative methods are analytically descriptive. Research through case studies is a method used to analyze data from a case to explore human behavior. The data presented is the form of students' ML in solving MS. The observed behavior is the MS-ML case of primary school students. A case study research design was implemented based on Creswell and Guetterman (2019) and Yin (2018), as shown in Figure 1.

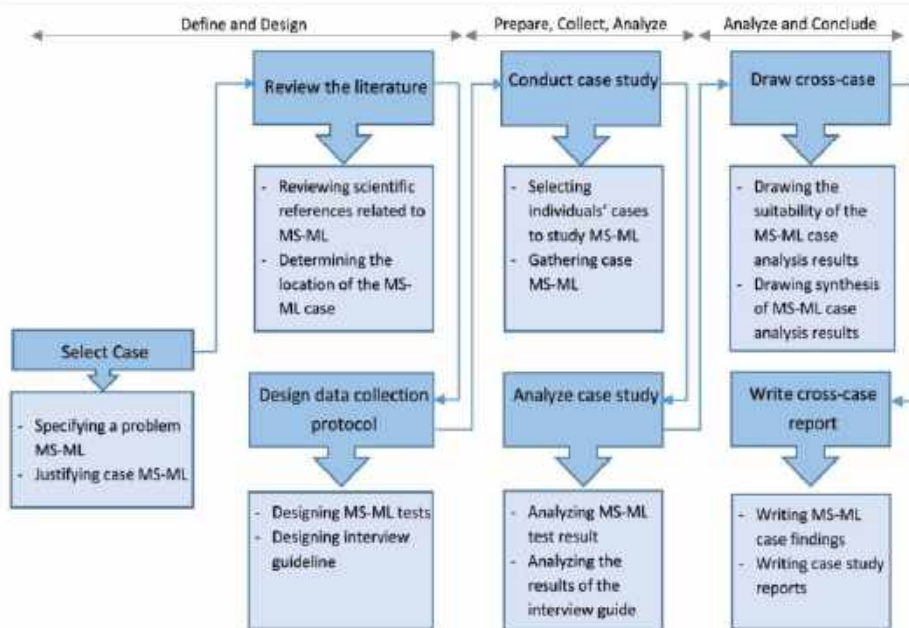


FIGURE 1. Case study research design

The case study research design followed three main stages: define and design; prepare, collect, and analyze; and analyze and conclude. In the first stage, starting with defining and designing, starting with selecting a case, namely by specifying a suspected problem related to MS-ML and justifying the existence and condition of the case. The literature review was carried out by reviewing cases and analyzing the problems, relevance, and indicators of MS-ML theoretically and empirically in the field. Next, design a data collection protocol, including the MS-ML test and interview guidelines. In the second stage, preparation, collection, and analysis are oriented toward the specified MS-ML case conduct and analysis. A search, selection, and determination of subjects that meet the MS-ML case criteria are carried out at this stage. The results of written tests and interviews are analyzed for the specified subjects. In the third stage, analysis and conclusion begin with a cross-case draw, namely drawing the suitability of the results of written tests and interviews using thematic analysis to obtain drawing synsets for MS-ML. Finally, write down the MS-ML case findings as a study report.

### Participant

This study involved 19 fourth-grade students in the Sidoarjo district, East Java, Indonesia. The characteristics of this school have implemented the values of independent learning and Minimum Competency Assessment from the Ministry of Education, Culture, Research, and Technology in Indonesia. The demographic characteristics of the research participants are shown in **Table 1**. We chose to conduct research at the fourth-grade level because this level is a stage where students have begun to think divergently in finding varied solutions, which is a requirement for solving MS. So, students can provide ML-solving processes with various solutions or strategies in solving MS.

**TABLE 1.** Demographic characteristics of participants

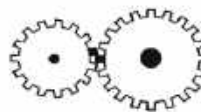
Demographic Characteristics	Aspects	Student Total
<i>Sex Differences</i>	Male	10
	Female	9
<i>Range Age</i>	10 years	12
	11 years	7
<i>Math Score</i>	<50	3
	50-75	12
	75-100	4

### Material

In this study, we used MS-ML test instruments and interview guidelines. The MS-ML instrument contained one essay question about the gear problem, as shown in **Table 2**. After students did the MS-ML test, the researcher interviewed several students using a purposive sampling technique. Students were grouped based on the MS-ML category, namely appropriate and inappropriate MS-ML. One student each was selected to be interviewed to represent the MS-ML answer category. The interview was conducted to provide several questions regarding the solution that students provided on the answer sheet. Some aspects that researchers asked students during the interview included 1) the material of the problem given, 2) the standard solution that students provide, 3) student difficulties in the process of working, 4) other solutions that can be given besides the standard solution, 5) the reason why choosing the solution chosen, 6) student interpretation of the results that have been obtained.

**TABLE 2.** *MS-ML Instrument*

The two types of two gears differ in size, so their number of teeth is also different. The small gear has 15 teeth, while the large gear has 20 teeth. The two gears are juxtaposed together, as shown in the side image.



Each gear has one tooth marked; then, both gears are rotated. When will the marked teeth come together for the first time?

Sources : (Deis & Julius, 2017)

Data analysis was carried out by reducing, presenting, and concluding. Meanwhile, data credibility uses source triangulation. The sources needed to justify data credibility are documents of MS-ML test results, interview results, and observations. All data sources were analyzed for student ML based on student mathematical activities in solving MS. Mathematical activities are focused on MS-ML activities, including the formulating stage, employing stage, and interpreting stage, as shown in **Table 3**.

**TABLE 3.** *MS-ML Indicators*

MS-ML Activities: Descriptors	MS-ML Indicators
<i>Formulating stage:</i> Formulating situations mathematically	- Identifying variables in real-world problems to mathematical structures. - Using understanding in solving math problems.
<i>Employing stage:</i> Using mathematical concepts, facts, procedures, and reasoning	- Applying effective and sustainable multi-procedures to provide mathematical solutions, conclusions, or generalizations. - Writing the procedure used to determine the result of the mathematical solution. - Assembling the information in the problem to determine the mathematical solution used, processing the information, or multi-step argumentation.
<i>Interpreting stage:</i> Interpreting, applying, and evaluating mathematical results	- Interpreting the results obtained in various situations or appropriate uses and evaluating two or more representations of a situation. - Providing an explanation based on the context of the problem being solved.

Sources: (OECD, 2022)

## 2 Data Analysis

Data analysis will be carried out using the research data that has been collected by reducing and categorizing the data. Based on the research results on MS-ML in research participants, there are two grouping categories, appropriate and inappropriate MS-ML, as shown in **Table 4**.

**TABLE 4.** *Achievement of student work*

MS-ML Category	Total number of students	Coding	Percentage
MS-ML inappropriate	18	S1	95%
MS-ML appropriate	1	S2	5%

From Table 4, 18 (95%) of students are in MS-ML inappropriate because they can only write one answer or solution as they have learned during learning. In contrast, students categorized as correct MS-ML are only 1 (5%) of the total research participants. S1 and S2 represented the inappropriate and appropriate MS-ML categories, respectively.

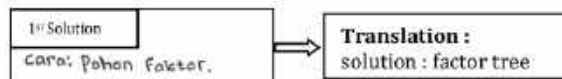
**RESULTS**

Based on the research results by students, it can be stated that primary school students who are presented with MS-ML problems are categorized into two categories. The first category is students who give MS-ML inappropriately, and the second category is students who can provide MS-ML appropriately.

**Category MS-ML inappropriate (S1)**

**Formulating stage**

In the 1<sup>st</sup> solution, according to OECD, S1 identified the problem variables. It used his concept understanding in solving MS by writing the formulating stage using a solution as a factor tree. S1 chose to use a factor tree based on his understanding of the context for the ML-solving process. In the formulating stage, S1 only wrote the type of solution used in the process of working, which can be seen in **Figure 2**. As for the 2<sup>nd</sup> and 3<sup>rd</sup> solutions, S1 skipped the formulating stage and directly performed the completion process at the employing stage.

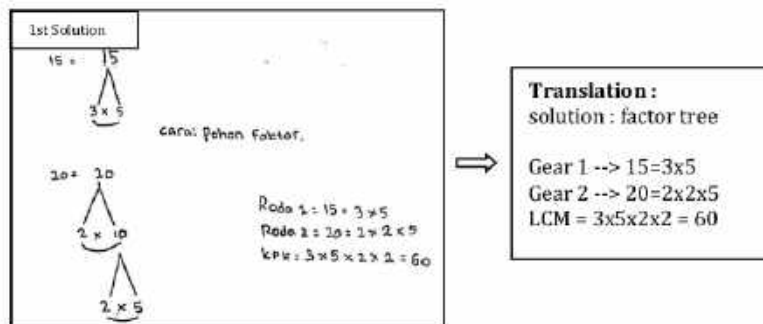


**FIGURE 2.** Formulating stage by S1

**Employing stage**

At the employing stage of the formula, S1 began to connect the pieces of information in the MS problem to get the results of the mathematical solution he chose. In the 1<sup>st</sup> solution, S1 solves the factor tree by finding the least common multiple (LCM) of number 15 and number 20. After calculating with the factor tree, S1 calculates the LCM of numbers 15 and 20 using the factor tree. After using the factor tree, S1 found the final result, number 60.

For the 2<sup>nd</sup> solution, S1 wrote the solution with multiplication. The multiplication in the answer column is stacking multiplication and sequential multiplication of  $2 \times 5$ ,  $5 \times 3$ , and  $5 \times 4$ . Then, 3<sup>rd</sup> solution, S1 wrote the addition of the number 15, which was arranged twice, and the result was added with the number 15 multiplied by the number 2. This can be seen in **Figure 3**.



<p>2<sup>nd</sup> Solution</p> $\begin{array}{r} 15 \\ 4 \\ \hline 60 \end{array} \times$ <p><math>2 \times 3 = 10</math></p> <p><math>3 \times 3 = 15</math></p> <p><math>5 \times 4 = 20</math></p>	<p>3<sup>rd</sup> Solution</p> $\begin{array}{r} 1 \\ 15 \\ 15 \\ \hline 30 \end{array} + 15 \times 2 = 60$
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FIGURE 3. Employing stage by S1

## Interview transcript 1

- Researcher : Do you know what material the question is taken from?  
 S1 : Yes, about LCM  
 Researcher : What is the solution to solve the LCM problem?  
 S1 : Using factor tree  
 Researcher : Can you use other than the factor tree?  
 S1 : I don't think so  
 Researcher : Then what is the 2<sup>nd</sup> solution? What solution did you write?  
 S1 : In the 2<sup>nd</sup> solution, I wrote the solution by multiplication  
 Researcher : Yes, then, for the 3<sup>rd</sup> solution?  
 S1 : I wrote the solution in the form of stacking addition, and then there is multiplication too  
 Researcher : Why did you write the solution?  
 S1 : I multiply it so that the column is not empty

Transcript 1 shows that S1 has understood the problem given well. However, S1 still cannot give MS correctly because S1 feels that there is only one solution in the material. It causes S1 to be unable to write other solutions correctly. Even the procedures written down also do not produce the correct answer. In this 2<sup>nd</sup> solution and 3<sup>rd</sup> solution, S1 did not fulfill all indicators of ML and solution, and also, the results he wrote were not correct. S1 could not provide another solution correctly, so S1 wrote another solution randomly. By writing another solution randomly and the results obtained are incorrect, then what is written by S1 is included in the MS-ML inappropriate category.

**Interpreting stage**

In the previous stage, S1 got the result of solving the factor tree, namely number 60. The interpreting stage in OECD is writing the interpretation of the results obtained under the MS that has been completed. In the interpreting stage, S1 wrote the word that should be written for each problem presented in ML, which is equipped with the word 'so' at the end of the solution. This can be seen in Figure 4. With the explanation of 'so', it can be seen that the student has understood the result of the solution he wrote down.

<p>1<sup>st</sup> Solution</p> <p><u>Jadi untuk mencapai angka 60 roda satu membutuhkan 4 kali putaran. Untuk mencapai angka 60, sedangkan untuk roda dua membutuhkan 3 kali putaran untuk mencapai angka 60.</u></p>
<p><b>Translation :</b>          So to reach number 60, wheel 1 needs 4 turns to reach number 60, while wheel 2 needs 3 turns to reach number 60.</p>

FIGURE 4. Interpreting stage by S1



From these results, it can be stated that S1 can formulate and find the results of the employing stage correctly, and S1 has also written an explanation of the results obtained under the formula of the solution he wrote. The explanation written in the interpreting stage contains a detailed explanation of the final result of the problem-solving process questioned in the given problem. There were 18 (95%) students gave answers from MS-ML with complete ML indicators. These students have fulfilled the indicators of ML in the 1<sup>st</sup> solution but still have not given MS-ML appropriately in the 2<sup>nd</sup> solution and 3<sup>rd</sup> solution.

### Category MS-ML appropriate (S2)

#### Formulating stage

In the 1<sup>st</sup> solution, S2 wrote the formulating stage, as usual, using a solution as a factor tree. The factor tree is a problem-solving procedure usually used to solve LCM problems in general. S2 chose to use a factor tree based on the experience he gained in class for the solution process in MS-ML. In the formulating stage, S1 only wrote down the type of solution used in the process of working, which can be seen in **Figure 5**. During the formulating stage for the 2<sup>nd</sup> solution and 3<sup>rd</sup> solution, S2 did not write the formula because S2 still doubted whether the solution he used was correct or not.

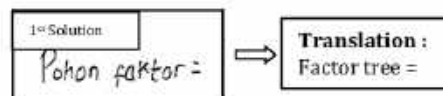


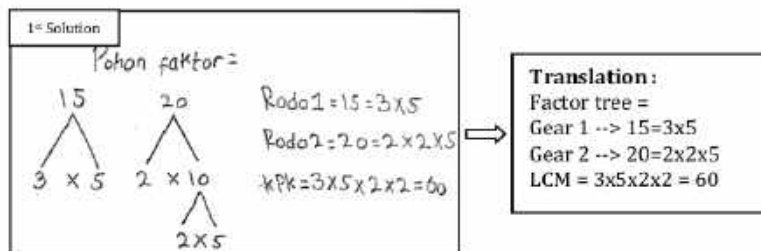
FIGURE 5. Formulating stage by S2

#### Employing stage

After the formulating stage, then proceed with the employing stage. Based on OECD, the employing stage contains the procedural mechanism of the solution provided by the student. At this stage, S2 looks for the LCM of number 15 and number 20 using a factor tree. Through calculations with the factor tree, the final result by S2 is number 60. This can be seen in **Figure 6**.

In writing another solution, S2 wrote the 2<sup>nd</sup> solution by multiplying the number of wheel teeth in the MS-ML problem, namely number 15 and number 20. The two numbers are multiplied by others that can produce the number 60. S2 multiplies number 15 by number 4 and number 20 by number 3, resulting in number 60. For the 3<sup>rd</sup> solution, S2 wrote the ordered addition of numbers 15 and 20, which were summed repeatedly. For number 15, S2 repeated addition 4 times to get the number 60 result. As for number 20, S2 repeated addition 3 times to get the number 60 result.

S2 can find the correct result from the other solution he wrote down by writing down the other solution. S2 stated that the simple solution that came to his mind was confirmed through the interview with S2 (see interview transcript 2). From the solutions written by S2, it can be stated that S2 has provided other solutions correctly, so S2 is included in the category of students with the MS-ML appropriate.



2nd Solution	3rd Solution
$\begin{array}{r} 15^2 \\ 4 \\ \hline 60^x \end{array}$ $\begin{array}{r} 20 \\ 3 \\ \hline 60^x \end{array}$	$\begin{array}{r} (15) \quad 1x \\ (15) \quad 2x \\ 30 \quad \rightarrow \\ (15) \quad 3x \\ 45 \quad \rightarrow \\ (15) \quad 4x \\ 60 \quad \rightarrow \end{array}$ $\begin{array}{r} (20) \quad 1x \\ (20) \quad 2x \\ 40 \quad \rightarrow \\ (20) \quad 3x \\ 60 \quad \rightarrow \end{array}$

FIGURE 6. Employing stage by S2

## Interview transcript 2

- Researcher : How can you develop the solutions you gave in the 2<sup>nd</sup> and 3<sup>rd</sup> solution?  
 S1 : I based on the result of the 1<sup>st</sup> solution, which is number 60  
 Researcher : Why did you base it on the number 60?  
 S1 : Because the answer produced in the 1<sup>st</sup> solution is 60  
 Researcher : So you wrote it without formulating it and looked for the number 60?  
 S1 : Yes, I tried to write another solution to find the number 60 with a simpler solution  
 Researcher : Can you explain the solution you wrote in the 2<sup>nd</sup> solution?  
 S1 : For the 2<sup>nd</sup> solution, I multiplied the number in the given problem with another number that can produce the number 60  
 Researcher : Then, the 3<sup>rd</sup> solution?  
 S1 : I repeat the addition to each number until, I find the result 60  
 Researcher : Why don't you write your explanation in the answer column?  
 S1 : I didn't have time because the time was up

From the transcript of interview 2, S2 stated that he wrote other solutions based on the results of the 1<sup>st</sup> solution. That way, S2 used various solutions to produce the number 60 again with different solutions. From the solutions written in the 2<sup>nd</sup> solution and 3<sup>rd</sup> solution, only S2 himself can explain the meaning of the work steps he wrote. This is due to the absence of information included in the answer column. If the researcher does not conduct an interview, the researcher also does not understand the solution written by the student in the answer column.

**Interpreting stage**

After getting the result from finding the result through the factor tree, S2 wrote the word 'so' in the interpreting stage as the last stage of the solution he wrote. The interpreting stage is written to explain the meaning of the number 60 in the problem being solved. S2 wrote this interpreting stage to make it easier to interpret the results that have been obtained. The writing of the interpreting stage of the 1<sup>st</sup> solution can be seen in **Figure 7**. While in the 2<sup>nd</sup> solution and 3<sup>rd</sup> solution, students did not have time to write because of the limited time in working on it.

1 <sup>st</sup> Solution
<p>Jadi untuk mencapai angka 60 roda satu membutuhkan 4 kali putaran untuk mencapai angka 60            Sedangkan untuk roda dua membutuhkan 3 kali putaran untuk mencapai angka 60.</p>
<p><b>Translation :</b>            So to reach number 60, wheel 1 needs 4 turns to reach number 60, while wheel 2 needs 3 turns to reach number 60.</p>

FIGURE 7. Interpreting stage by S2

In this study, there was only 1 (5%) student who could provide answers with the correct MS. Of the three explanations given, one answer fulfilled the three ML indicators. In addition, two other solutions only write about other solutions that can be used to get the final result that has been found in the previous solution. From the answers written by S2, who can write the correct MS. Although S2 was able to provide the correct MS, the MS given by S2 was not written in detail according to the ML indicator. In the 2<sup>nd</sup> solution and 3<sup>rd</sup> solution, there is only the process of using the formula without any formulation or interpretation written in the answer column.

The results of data analysis can be synthesized that there are appropriate and inappropriate MS-ML categories based on each stage of formulating, employing, and interpreting by primary school students. S1 and S2 represent each category of inappropriate and appropriate MS-ML. At the formulating stage, S1 identified the connectedness of information in a one-way manner and limited understanding, resulting in only the wrong 1<sup>st</sup> solution formulation. This is different from S2, which can identify the connectedness of information by formulating varied solutions and a deeper understanding to produce 1<sup>st</sup> solution, 2<sup>nd</sup> solution, and 3<sup>rd</sup> solution formulations. At the employing stage, S1 tends only to apply mono procedures, which are incorrect. In contrast, S2 applies procedures that are multi-procedures. Finally, at the interpreting stage, S1 performs limited interpretation of results or evaluation of solutions. Meanwhile, S2 interpreted the results or evaluated the solution thoroughly based on the context of the ML problem. Hence, **Table 5** shows the comparison of appropriate and inappropriate categories.

**TABLE 5.** MS-ML category comparison of S1 and S2

MS-ML Inappropriate (S1)	MS-ML Appropriate (S2)
- Identifying information connection with convergent and incorrect solution formulations.	- Identifying information connection with divergent and correct solution formulations.
- Conducting limited understanding.	- Conducting deep understanding.
- Applying mono-procedures.	- Applying multi-procedure procedures.
- Interpreting the results or evaluating the limited solutions based on the ML problem context.	- Interpreting the results or evaluating the overall solution based on the ML problem context.

## DISCUSSION

We found two MS-ML categories with different characteristics at each stage of formulating, employing, and interpreting in primary school students. The two categories are appropriate and inappropriate MS-ML. Appropriate MS-ML is a category that has formulated varied or divergent solutions, employing multi-procedures and interpreting comprehensively based on the ML problem context. Whereas, inappropriate MS-ML is a category that tends to formulate a single or convergent solution that leads to incorrect solutions, resulting in employing mono-procedures and interpreting not comprehensively based on the context of ML problems. We found that most students were in the inappropriate MS-ML category. This is because many students still cannot formulate divergent MS-ML solutions correctly. Correct means that in providing multiple solutions or solutions other than the standard solution written down, students employ and interpret solutions with correct results and interpretations. This is also the case in research conducted by Shore and Kobiela (2020), which states that students in their study also provide MS answers with incomplete solution writing. This is also supported by several studies by Muzaki and Masjudin (2019), which state that the research results show that ML is still low. Another study by Faiziyah, Hanan, and Azizah (2022) stated that students' ML in creative thinking to solve MS-based problems is still not optimal. It can be seen from the results of student answers that they still cannot write entirely from the formulating, employing, and interpreting stages.

MS-ML will require students to provide multiple solutions in the solution process. This MS-based problem trains students to find solutions besides those they usually use to solve the problems provided (Leavy & Hourigan, 2021). Other solutions can help students solve the problems provided with each student's mindset, so each student has a different solution (Almarashdi et al., 2023; Stupel & Ben-chaim, 2017). In MS answers, there are standard solutions and non-standard solutions. In the standard solution, students can explain the solution they wrote. In contrast, for the non-standard solution, students go directly to the solution strategy without writing the type of solution they give (Große, 2014; Leikin, 2014).

It was found that even though students understood the purpose of the problem given, students gave MS-ML answers that were inappropriate and not detailed for each stage. Students still cannot write MS-ML appropriately in the multiple solutions they give. This happens because students are not used to solving MS-ML, so they are still confused about formulating other appropriate solutions (DeVink et al., 2022). In addition to educators who have not accustomed students to solving MS-ML problems, Bingolbali (2019) stated that in primary school mathematics textbooks, there are still few that present questions or problems that have multiple solutions in solving them. Students still cannot provide solutions to problems in other ways in a structured manner, making it easier for them to solve a problem (Schleicher, 2018). Hence, students must be familiarized with this MS-ML problem.

Another category is MS-ML appropriate. Students in this category show that they have used mathematical reasoning related to real life and their experiences (Haara et al., 2017). Students' problem-solving levels will be better if the problems presented describe real-life experiences (Kolar & Hodnik, 2021). Through MS-ML assignments, students can unleash their potential to generate various new solutions to mathematical problems (Mahlaba, 2020; Verschaffel et al., 2020). That way, students should be able to think of solving problems with multiple topics and feel that 'Aha! I have experienced this' (Schindler & Lilienthal, 2020).

MS-based problems can be passed on to students through experience, knowledge, and initial competence so that students can solve a problem with various solutions (Achmetli, Schukajlow, & Rakoczy, 2018). Prior knowledge is also essential in solving problems because each student will have different answers to the questions presented. This is caused when students make different assumptions, so they have different ways of solving problems and will not necessarily get the same results (Schukajlow & Krug, 2014a). Therefore, the importance of students' prior knowledge is helpful to bring up students' understanding in digesting the problem so that it can produce various solutions.

## CONCLUSION

The study findings show appropriate and inappropriate MS-ML in primary school students. Appropriate MS-ML is a category that tends to formulate varied or divergent solutions, resulting in employing multiple procedures and interpreting them comprehensively based on the context of the ML problem. Whereas, inappropriate MS-ML is a category that tends to formulate a single or convergent solution that leads to the wrong solution, resulting in employing mono-procedures and interpreting not comprehensively based on the context of ML problems. Most of the students were in the inappropriate MS-ML. This was caused by errors in the formulating stage, leading to the failure of the employing and interpreting solution stages. The solutions given by students mostly still use convergent or standard solutions. On the other hand, the limitation of the study can be stated regarding the involvement of sample size participants and limited data collection areas, so that the MS-ML category can be seen as preliminary findings that are still possible to change or there are other more specific findings. Thus, the suggestion for the study is to enlarge the sample size and explore MS-ML cases in other elementary schools, but at least based on the findings of this study. It can also be suggested that

educators or practitioners at the primary school level familiarize ML problem-solving-based learning and teaching with various MS solutions or strategies so that students can have the appropriate MS-ML category and avoid inappropriate MS-ML, which is different in learning and teaching, namely building problem-solving.

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# Primary school students' mathematical literacy in solving multiple-solution

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