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Elementary Students' Mathematical Literacy in Solving Realistic Mathematics through Math Trail Activities

Arif Rahman Hakim*, Kartono, Wardono, Adi Nur Cahyono

Universitas Negeri Semarang, Indonesia
*Corresponding Author: arifrahmanhakim001@students.unnes.ac.id

Abstract. Mathematical literacy is defined as the ability to formulate, use and interpret mathematics in a variety of contexts, including systematic reasoning, using mathematical concepts, procedures, facts, and tools to describe, explain, and predict phenomena to help individuals. One of the things that underlie the low ranking of Indonesian students is weak mathematical literacy is the lack of use of non-routine problems that are made based on real-life contexts, so they can only work on routine questions. This study was conducted to explore mathematical literacy indicators that appear in solving real problems through math trail activities. The research subjects were taken from the ranking of students in the previous class, so that 1 male student, namely S1, and 1 female student, namely S2, were selected, who ranked highest in the class for each gender. S1 shows indicators of mathematical literacy in the form of communication, mathematization, reasoning, and argumentation, designing a strategy, using symbolic, formal, technical language and operation, and using mathematical tools. While S2 is in communication, mathematization, reasoning and argumentation, designing a strategy, representation, formal, technical language and operation, and using mathematical tools.

Key words: Mathematical literacy, Realistic mathematics problem, Math trail

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INTRODUCTION

Mathematical literacy is a basic human need to understand and apply mathematics to everyday life. Mathematical literacy is the ability to apply concepts, procedures, facts, and mathematical tools used to measure individual abilities (Novitasari et al., 2022). Mathematical literacy is also defined as sensitivity to determining mathematical concepts relevant to the problem and being able to understand, analyze, interpret, evaluate and synthesize information obtained from the problems at hand, then model it into mathematical models and determine solutions using mathematical concepts. effective (Suciati et al., 2020). Mathematical literacy is also defined as the ability to formulate, use and interpret mathematics in various contexts, including systematic reasoning, using mathematical concepts, procedures, facts, and tools to describe, explain, and predict phenomena to help individuals (Stacey & Turner, 2015). So, it can be concluded that mathematical literacy ability is the ability to use various things in mathematics in everyday life freely.

Everyday life will not be separated from solving problems that require the use of mathematics. Mathematical literacy can be seen in how students solve real-world problems related to how they apply their mathematical abilities and knowledge (Awaliyah et al., 2016; Osman et al., 2018; Rofiqoh et al., 2016). Thus, students must be able to demonstrate mathematical literacy in solving problems (Chaudhry & Rasool, 2012). Polya revealed that four steps could be applied to problem-solving: understanding the problem, devising a plan, carrying out the plan, and looking back (Ersoy & Bal-Incebacak, 2017).

Based on the 2018 PISA study (OECD, 2019), Indonesia is ranked 71st in mathematics proficiency among 77 participating countries, and more than 70% of Indonesian students still occupy level 1 and below level 1. Skills are still below level 2. Low achievement in mathematics can be caused by not including elements of mathematical literacy in mathematics learning (Karatas & Baki, 2013; Stacey, 2011). One thing that underlies the low ranking of Indonesian students is weak mathematical literacy and the lack of use of non-routine problems based on real-life contexts, so they can only do routine questions (Harahap & Surya, 2017; Kolar & Hodnik, 2021). So, training is needed in the form of habituation to provide students with exercises to develop their problem-solving abilities.

The integration of real-world problems is often complex for students to solve because students still lack "concrete mathematics" learning for students (Barbosa & Vale, 2016). Concrete mathematics will be very much found in the environment outside the classroom. Learning outside the classroom has been proven to increase positive attitudes and motivation to learn mathematics and bring students to realize the applications (Barbosa & Vale, 2016). One of the math activities that carry the concept of learning outside the classroom is Math Trail (Barbosa & Vale, 2016; Cahyono et al., 2015; Edi & Nayazik, 2019; Fessakis et al., 2018; Ismaya et al., 2018; Shoaf et al., 2004). The Math Trail is a journey of discovering mathematics (Shoaf et al., 2004). Math Trail is a mathematics learning activity outside the classroom to explore and observe more deeply and solve real math problems in an outside environment equipped with exploration routes and simple maps to find mathematics (Edi & Nayazik, 2019). Learning activities in the math trail are like playing exploration to find treasure, which aims to explore mathematics in an environment outside the classroom (Fessakis et al., 2018). The trailblazer makes the trail in the math trail then the route that has been made will be followed by the trail walker (Edi & Nayazik, 2019; Shoaf et al., 2004). Based on the problems determined in the math trail activity, it will be possible to know the indicators met from the students' mathematical literacy abilities.

Then, one of the influential reviewers for elementary school students is based on gender (Nafi'an, 2011). Gender is essential when reviewing mathematical abilities (Hotipah & Pujiastuti, 2020; Lianawati & Purwasih, 2018; Maulida et al., 2022). Research that has been done by Dewi et al. (2020) shows that there are advantages and disadvantages for male and female students in solving problems. Based on the description above, the purpose of this study is to first show indicators of mathematical literacy that emerge from the two students who occupy the highest rank in the class. Then, the second is to show indicators of mathematical literacy in the realistic problem-solving process carried out by elementary school students based on gender differences in math trail activities.

METHODS

This research is a qualitative descriptive study that is focused on exploring students' mathematical literacy in solving real problems in the Math Trail activity. The subjects of this study were fourth-grade students at MI Jamiyatul Ulum, Grobogan. Math Trail activities are carried out in the area around the school while still prioritizing student safety in solving problems.

Data Collection

The data collection technique is a realistic problem-solving test in Math Trail activities, interviews, and documentation. The problem-solving process involves understanding the problem, planning a solution, solving the problem, and looking back. The stages of the research carried out were after students were found as research subjects, then two realistic math problems were given in the Math Trail activity, which was carried out by a male and female student who ranked at the top of the class for each gender.

Each student has been equipped with a small ruler (30 cm) and a large ruler with a length of 1 meter. All questions related to geometrical shapes are packaged in non-routine problems that require students to measure themselves about things that are known from the problem. After that, students are free to start the Math Trail activities in their preferred order.

Analyzing of Data

Data analysis was done through data reduction, presentation, and conclusions (Miles & Huberman, 1994). The results of student work will be analyzed to see indicators of mathematical literacy, which are also seen to be deepened by interviews. Mathematical literacy indicators are presented in table 2.1.

Table 1. Mathematical literacy indicator (Kusuma et al., 2022)

No.	Mathematical literacy indicators	
1.	Communication	Ability to communicate things based on awareness and understanding of math problems.
2.	Mathematization	Able to convert real-world problems into mathematical form.
3.	Representation	Able to represent real-world problems into mathematical representations in the form of graphs, tables, diagrams, equations, formulas that can explain the problem.
4.	Reasoning and argumentation	Logical thinking to explore and relate problems to mathematics.

5.	Designing a strategy	Able to develop strategies to solve real-world problems using mathematical concepts, facts, principles and procedures.
6.	Using symbolic	Use mathematical symbols to describe real-world problems.
7.	Formal, technical language and operation	Using correct mathematical concepts, facts, principles and procedures to solve problems.
8.	Using mathematical tools	Use a variety of mathematical tools to solve real-world problems precisely and correctly.

RESULTS AND DISCUSSION

The study began by determining the research subjects taken from the rankings of students in the previous class, so that 1 male student, namely S1 and 1 female student, namely S2, was selected for the highest ranking in the class for each gender. Then, students are given a floor plan of the location of the school that has been numbered according to the stop post (see Figure 1). There are 2 problems that each student will solve.

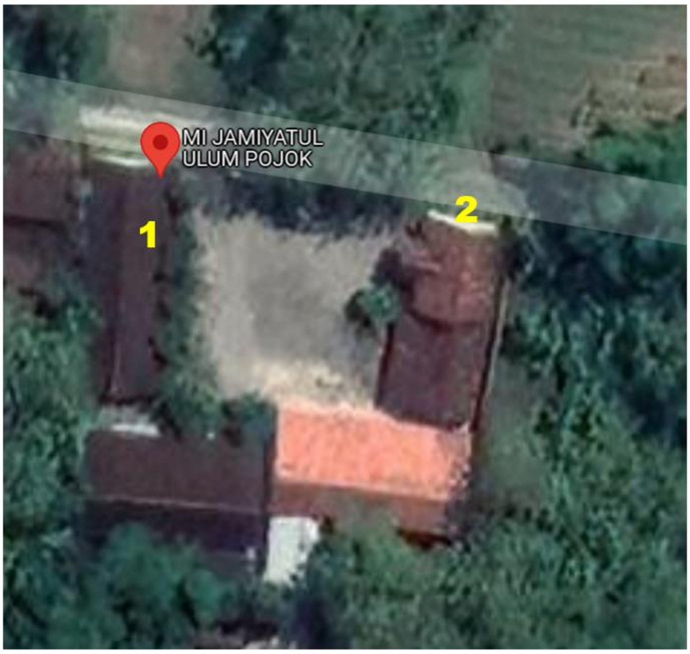


Figure 1. Peta math trail yang berisikan pos pemberhentian tempat permasalahan berada

Mathematical literacy in first problem solving

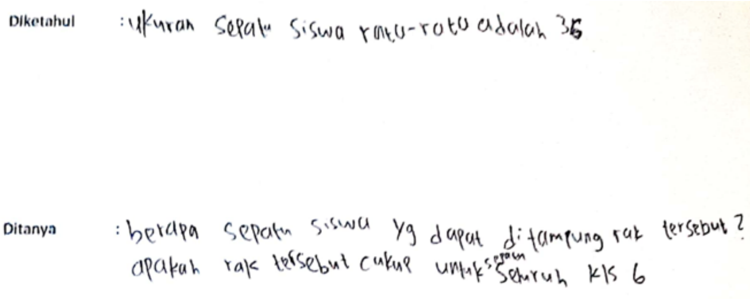
Problem:

Look at the shoe holder in front of grade 6, if the average student shoe size is 36, how many student shoes can the shelf fit? And is the shelf enough for all 6th grade shoes?

From this problem, the results are presented below:

Understanding The Problem

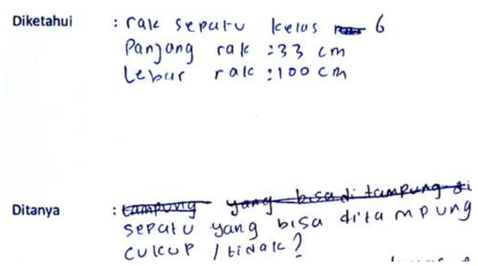
The results of S1's work show that S1 has been able to understand the meaning of the problem and has written down things that are known from the questions, namely by writing down things that are known from the questions. In addition, the S1 also adds the necessary things by directly measuring the length of the shelf and shoes. However, the measurement results of the length of the shoe rack and the length of a shoe were not written in the student work section, which indicates that S1 still has an understanding that what is known from the problem is what is written in the problem. Thus, S1 has used a mathematical tool in the form of a ruler and is indicated to meet the reasoning and argumentation indicators by determining what must be fulfilled to solve the first problem. And can communicate real-world problems in mathematical form.



Translation:
Known: The average student shoe size is 36
Asked: How many student shoes can the rack fit?
Is the shelf sufficient for all 6th graders?

Figure 2. Steps to understand the problem by S1

While the results of S2's work show that the things that must be known from a problem are not only from the problem, but also from their own measurements, as evidenced by writing down the length of the shoe rack and a shoe in the known section. asked in the first problem. However, S2 actually only wrote down only one problem that was asked.



Translation:
Known: Class 6 sepatu shoe rack
Shelf length = 33 cm
Shelf width = 100 cm
Asked: Shoes that can fit enough or not?

Figure 3. Steps to understand the problem by S2

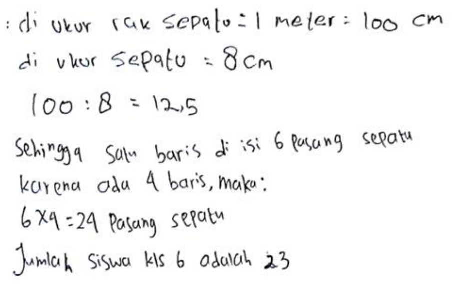
This step shows that Master has used mathematical tools in determining the size correctly and has done reasoning to understand the problem. Both students have also been able to communicate real-world problems into mathematical language in the interview process.

Devising A Plan

The plan that S1 carried out was clearly visible from the work sheet. S1 uses number operations, namely the concept of division to solve problems. Meanwhile, S2 changed the plan in solving the first problem, which initially used mathematical calculations, into a direct experimental method seen from the S2 answer sheet. The planning carried out by the two students showed that logical reasoning had emerged to explore and connect problems with mathematics.

Carry Out The Plan

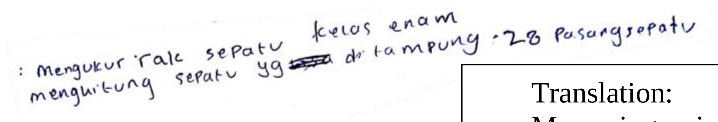
S1 performs a complete calculation starting from dividing the length of the shelf by the length of a shoe and then getting the number of shoes that fit in a row of shoe racks. It should be noted that the result of the division written by S1 is 12.5 which is then rounded down to 12 so that one row of shelves can accommodate 6 pairs of shoes. This shows that S1 has understood the concept of decimal numbers. This is reinforced by the results of the interview which revealed that the reason was rounded down, because all students had to wear a pair of shoes, it was not possible to only wear one shoe. S1 has been seen to fulfill formal indicators, technical language, and operation by using number operations in problem solving and mathematizing problems from the real world. S1 is also able to communicate the results of the work in the interview session.



Translation:
Measured shoe rack length = 1 meter = 100 cm
Measured shoe width = 8 cm
100 : 8 = 12.5
So that one row is filled with 6 pairs of shoes
Since there are 4 rows, then:
6×4=24 pairs of shoes
The number of 6th grade students is 23

Figure 4. Proses carry out the plan oleh S1

A very different thing is seen in the S2 answer sheet which shows that there are no visible mathematical calculations. The lack of understanding of the problem by S2 is shown by simply writing down the problem "Enough/not enough shoes that can fit?". So that what S2 is aiming for is only about enough or not enough. The way S2 solves this problem is to take a shoe of size 36, then try on the shoe rack how many shoes can fit in one row, and get 7 shoes in one row. So that one shelf can accommodate 28 shoes. Here there is an error that was revealed in the interview session that there was an accident in writing "28 pairs of shoes" and the correct one was "28 shoes". Solving this problem shows that S2 prefers to use the empirical method and finds it difficult to apply mathematical knowledge to the real world context, this is reinforced by the results of the work that if there are 7 shoes in a row, it means that there is a shoe that does not have a pair.



Translation:
Measuring a sixth grade shoe rack
Counting the shoes that can fit = 28 pairs of shoes

Figure 5. Proses carry out the plan oleh S2

Looking Back

At the end of the answer sheet, both have written the conclusion of the two groups' actions. However, based on the answer sheets and interviews, the two groups admitted that they did not carry out the re-checking process after getting the solution to the problem, so there were no indicators of mathematical literacy that were met in this looking back process.

Based on the problem-solving process, it was found that the indicators of mathematical literacy seen in S1 and S2 for steps to understand the problem were Using mathematical tools, reasoning and argumentation, and communication. In preparing plans for S1 and S2, indicators of mathematical literacy are shown in the form of reasoning, argumentation, and communication. In the carrying out the plan step, it appears that S1 fulfills the indicators of mathematical literacy in the form of formal, technical language and operation, mathematizing, reasoning and argumentation, and communication. While S2 only appears to bring up indicators of mathematical literacy in the form of reasoning, argumentation, and communication. The step of looking back shows that S1 and S2 did not re-check their answers, so there was no visible indicator of mathematical literacy met in this step.

Mathematical literacy in the second problem solving

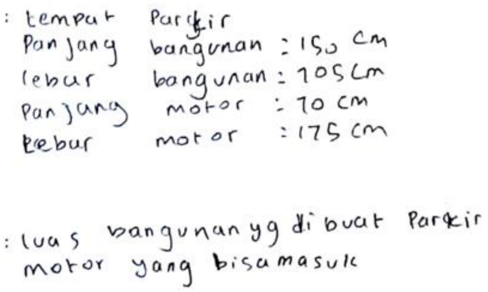
Problem:

Look at the room on the north side of the MI Jamiyatul Ulum office; if you want to build a parking lot, how big is the building area? And how many motorcycles can fit in?

From this problem, the results are presented below:

Understanding The Problem

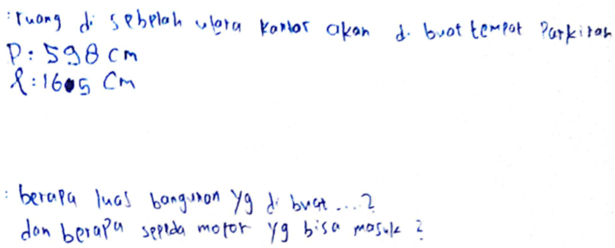
In this problem, it can be seen that S2 writes things that are known in full, while S1 is limited to only writing down the size of the space that can be made, without showing the size of the motor in what is known. Then, the S2 group did not use the correct question words in writing the things that were asked differently from the S1 group.



Translation:
Parking lot
Building length = 150 cm
Building width = 705 cm
Motorcycle length = 70 cm
Width of motorcycle = 175 cm

Building area for parking
Motorcycle that can enter

Figure 6. Steps to understand the problem by S2



The space to the north of the office will be made a parking lot
$p = 598\ cm$
$l = 165\ cm$

What is the area of the building made?
And how many motorcycles can fit in?

Figure 7. Steps to understand the problem by S1

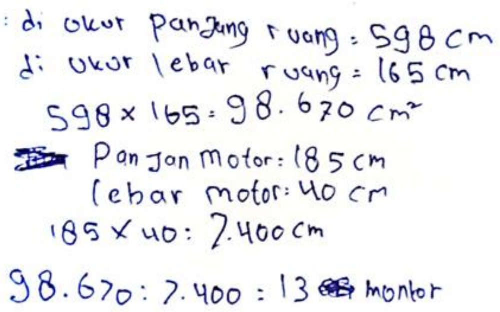
S1 has used mathematical symbols to replace length and width. The S1 has also demonstrated the mathematization of real-world problems. Measure directly using measuring tools and reasoning things needed to understand real-world problems using mathematics. S2 also seems to do the same thing but does not use symbols in writing things known from the problem.

Devising The Plan

Both students have the same problem-solving plan, namely by using the concept of division operations to find how many motorbikes can be loaded. The difference that can be seen is that S1 uses the concept of area, while S2 divides each side by the length and width of the motorcycle. Both students have demonstrated the process of mathematization, reasoning and argumentation, and designing a strategy in this step.

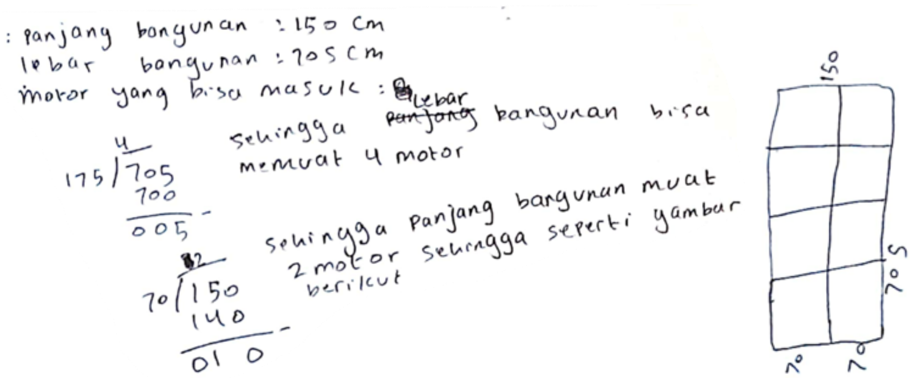
Carrying Out The Plan

The results obtained from the two groups have a relatively significant difference. Namely, S2 gets a motorbike that can be loaded as many as 8 motorbikes, while S2 has 13 motorbikes. Seeing the two students' similar problem-solving plans and implementations, basic things need to be considered. The two groups' most striking thing in problem-solving was the measurement of motorbikes. S1 only gets a width of 40 cm, while S2 writes a size of 70 cm. In the interview session, it was explained that what S1 measured was the bicycle from the rear side, while S2 measured the steering wheel of the motorcycle so that it got a longer measurement. This shows that the S2 can better project dimensions in the real world so that the motorcycle can fit into the room properly.



Translation:
Measured room length = 598 cm
Measured room width = 165 cm
$598 \times 165 = 98670\ cm^2$
Motorcycle length = 185 cm
Motorcycle Width = 40 cm$185 \times 40 = 7400\ cm$
$98670 \div 7400 = 13$ motorcycle

Figure 8. The process of carrying out the plan by S1



Building length = 150 cm
Building width = 705 cm
Motorcycle that can enter =

The width of the building can fit 4 motors
The length of the building can contain 2 motorcycles, so it looks like the following picture

Figure 9. The process of carrying out the plan by S2

In this step, S1 and S2 have shown their way of mathematizing real-world problems, reasoning, and argumentation, using formal, technical language and operations. Especially for S2, it can be seen that adding a mathematical model representation clarifies the results of the solution.

Looking Back

At the end of the answer sheet, both have written the conclusion of the two groups' actions. However, based on the answer sheets and interviews, the two groups admitted that they did not carry out the re-checking process after getting the solution to the problem, so there were no indicators of mathematical literacy that were met in this looking back process.

Based on the problem-solving process, it was found that the indicators of mathematical literacy seen in S1 and S2 for steps to understand the problem were Using mathematical tools, reasoning and argumentation, and communication. Specifically, S1 is seen using mathematical symbols in solving problems. In preparing plans for S1 and S2, indicators of mathematical literacy are shown in the form of reasoning, argumentation, and communication. In the carrying out the plan step, it appears that S1 and S2 meet the indicators of mathematical literacy in the form of formal, technical language and operation, mathematizing, reasoning and argumentation, and communication. Especially for S2, it looks like it also raises an indicator of mathematical literacy in the form of representation. The step of looking back shows that S! and S2 did not re-check their answers, so there was no visible indicator of mathematical literacy met in this step.

There is a fundamental weakness of both gender groups in solving problems in the real-world context of Math Trail activities. The lack of intensity of contextual problem recognition with direct experiments leads to a lack of sensitivity about what is known about a problem (Widada et al., 2019). In addition, flexibility in applying mathematical concepts in real-world contexts is one of the consequences of the lack of problem-solving skills training (Ludwig & Jablonski, 2019). S1 tends to be more observant in understanding the problem and can write down things that are known in more detail. However, S2 can adjust the real context in understanding the problem. Then, it was revealed in the interview that S2 read the questions up to 5 times to understand the problem, while S1 only needed to read the questions three times.

Furthermore, at the planning stage, it was seen that S1 carried out planning faster, thus making them have more time for the next stage. On the other hand, S2 takes longer to plan problem-solving, so it takes longer in the later stages. However, S2 tends to be more careful in measuring to be more precise for the real context by giving some more room for moving access of certain objects.

S1 is more systematic and faster at the planning stage in solving problems. On the other hand, S1 tends to be slower in solving problems. Then, in the review stage, it was revealed from the interview session that Masters tended to carry out the review process more by examining the calculations done. In comparison, S1 admitted that he did not carry out the process of looking back after writing down the results of the settlement. In line with (Lestari et al., 2021), which explains that male students tend to be less careful after getting a solution.

CONCLUSION

Based on the problem-solving process, it was found that the indicators of mathematical literacy seen in S1 and S2 to understand the problem were using mathematical aids, reasoning and argumentation, and communication. In the devising a plan, indicators of mathematical literacy are displayed in both students are reasoning, argumentation, and communication. In the carrying out the plan, it appears that S1 meets the indicators of mathematical literacy in the form of formal, technical language and operations, mathematics, reasoning and argumentation, and communication. While S2 only brings up mathematical literacy indicators in the form of reasoning, argumentation, and communication. A step looking back shows that S1 and S2 did not re-check their answers, so there is no visible indicator of mathematical literacy that is fulfilled in this step.

In terms of gender, in the problem-solving process, it was found that the indicators of mathematical literacy seen from male and female students to understand the problem were using mathematical aids, reasoning and argumentation, and communication. In particular, male students were seen to use mathematical symbols in solving problems while female students tended to use empirical experiments to get answers. In preparing the plan, female students have shown indicators of mathematical literacy in the form of reasoning, argumentation, and communication. Meanwhile, male students showed indicators of mathematical literacy in the form of formal, technical language and operations, mathematics, reasoning and argumentation, and communication. Especially for female students, it seems that there has been an indicator of mathematical literacy in the form of representation. A retrospective step shows that both genders did not re-examine their answers, so there are no indicators of mathematical literacy met in this step. Both students have advantages and disadvantages in solving outdoor problems through mathematical activities. However, there are still indicators of mathematical literacy that have not indicated the completion of the two students' real problems on the trail math activities.

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