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Students' Mathematical Literacy in Problem Based Learning (PBL) Model with Indonesian Realistic Mathematics Education (PMRI) Based on Math Trail

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Abstract

This study is motivated by the low mathematical literacy results of VIII grade junior high school students in Cirebon Regency. The effort to improve this is by using the PBL model with PMRI approach based on Math Trail. The purpose of this study was to analyse: 1) the quality of the PBL model with PMRI-based Math Trail approach to the mathematical literacy of VIII grade students of SMPN 1 Depok, 2) the mathematical literacy of VIII grade students of SMPN 1 Depok after applying the PBL model with PMRI-based Math Trail approach. This research uses mixed method research with sequential explanatory design. This research was conducted at SMP Negeri 1 Depok, Cirebon Regency. The results showed that the Problem-based learning (PBL) model with the Indonesian Realistic Mathematics Learning (PMRI) approach based on Math Trail on the mathematical literacy of VIII grade students of SMP Negeri 1 Depok is qualified. Based on the analysis of answers and interviews conducted, it is obtained that students who are classified as High Mathematical Literacy (LMT) are able to fulfil six indicators of mathematical literacy, namely identifying mathematical aspects in problems, translating problems into mathematical language, designing solution strategies, applying mathematical concepts, interpreting solution results, and explaining the reasons behind the results. Learners with Moderate Mathematical Literacy (LMS) were able to fulfil three indicators of mathematical literacy, namely identifying mathematical aspects in problems, translating problems into mathematical language, designing a solution strategy. Meanwhile, students with Low Mathematical Literacy (LMR) were only able to fulfil one mathematical literacy indicator correctly, namely the indicator of identifying mathematical aspects in problems.

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INTRODUCTION

Entering the 21st century, competition in various fields is becoming increasingly fierce. The quality of education is often used as a barometer of a country's development. The ability of students to solve maths, science and reading problems and their applications in everyday life is used as an illustration of the quality of education. 21st century education has the 4C concept of creativity and innovation, critical thinking and problem solving, communication and collaboration: The capacity of individuals to reason mathematically and formulate, use and interpret mathematics to solve problems in a variety of real-world contexts, including concepts, procedures, facts and tools to describe, explain and predict phenomena is called mathematical literacy (OECD, 2021).

A person can be said to be mathematically literate when they are able to understand the role or use of mathematics in everyday life as well as use mathematics to make appropriate decisions as a constructive, caring and thinking 21st century citizen. A mathematically literate person is characterised by: (1) being able to formulate situations mathematically; (2) being able to apply mathematical concepts, facts, procedures and reasoning; and (3) being able to interpret, apply and evaluate mathematical results (OECD, 2021). Therefore, educators and students are expected to have mathematical literacy skills and be able to adapt to the development of information and communication technology.

One of the abilities that needs to be possessed by current and future generations is mathematical literacy (Nurlaili et al., 2022). Mathematical literacy is very important for students to have because it can help students understand the concepts learned, as well as the benefits of these concepts in real life, namely students can use efficient methods in problem solving, make judgments related to rational results, and analyse situations and draw conclusions (Genc & Erbas, 2019). Understanding the role of mathematics in real life is important for each individual so that the need to be a constructive, caring and logical thinking member of society can be fulfilled because each individual can evaluate and consider the appropriate use of mathematics (Agusdianita & Karjiyati, 2021). This makes mathematics one of the lessons measured in determining the competence of students.

Based on Permendikbudristek Nomor 17 (2021) AKM is a measurement of reading literacy and numeracy (mathematical literacy) competencies that must be possessed by students. Numeracy or mathematical literacy is the ability to think using mathematical concepts, procedures, facts and tools to solve everyday problems in various types of contexts that are relevant for individuals as citizens of Indonesia and the world.

The government has implemented several new policies in education ranging from differentiated learning, independent curriculum, Pancasila Learner Profile Strengthening Project (P5). Not only that, the government also prepared AKM with training modules to improve numeracy competence for teachers, guidelines for strengthening literacy and numeracy in schools to improve the quality of education in Indonesia. However, the literacy achievement of students from the results of Indonesia's participation in international comparative studies is still low compared to the mathematics literacy of students from other countries. This can be seen from the mathematics literacy achievement of students based on the Programme for International Students Assessment (PISA) results in the following table.

Table 1. Mathematical Literacy Achievement of Students Based on PISA Results

Year	Material Presented	Indonesia Ranking	Total Countries	Score
2000	Maths	39	41	367
2003	Maths	38	40	360
2006	Maths	50	57	391
2009	Maths	61	65	371
2012	Maths	64	65	375
2015	Maths	63	70	386
2018	Maths	73	79	379

In mathematics, the average PISA test scores of Indonesian students fluctuate. The lowest average score was obtained in PISA 2003, at 360. The highest average score was achieved in PISA 2006, at 391. (Penilaian Pendidikan Badan Penelitian et al., n.d.). The latest data from the 2018 PISA survey places Indonesia 73rd out of 79 participating countries with a score of 379, which is below the OECD average score of 489. This proves that Indonesia's results in the PISA survey are still not maximal, similar incidents are still repeated, meaning that it is still at the same predicate at the lower level.

Similar conditions occur in students of SMP Negeri 1 Depok, Cirebon Regency in learning the topic of sets and relations, 53 out of 58 students observed still have difficulty in solving problems and a small number of students can work on problems as in the following figure.

Baskara mengambil 5 nomor kupon undian berupa 5 angka pertama bilangan asli. Fahmi mengambil 10 nomor kupon undian berupa 10 angka pertama bilangan genap. Tentukan bentuk relasi seperti apa yang dapat dibuat? Sajikan relasi tersebut dalam bentuk diagram panah, lalu tentukan: domain, kodomain dan range!

Figure 1. Initial Observation Question

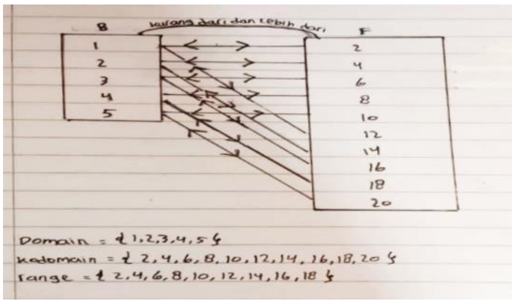

Figure 2. Students' Answers to the Initial Observation Question

Based on one of the student answers that is closest to correct, students have been able to solve the problem in the problem and convert it into the form of mathematical symbols. Students have been able to present the form of the relation in an arrow diagram, but students are still mistaken in determining the form of the relation and range, students should only write one of them, namely the relation less than or more than so that students can determine the right range. Students are also not - able to present the relation sequentially such as -listing the sets contained in the problem, then determining the form of relation that can be made from these sets, after that making an arrow diagram and determining the domain, codomain - and range. The student's response indicates that the student still does not understand the meaning of -the problem. Students do not write down what information is in the problem. This is because students do not write down the known, asked and complete information from the problem.

Based on field findings at SMPN 1 Depok, it was found that 283 out of 311 grade 8 students were still below the KKM score on the Midterm Assessment 2 learning outcomes. The teacher taught with an expository learning model with a teacher centre learning approach. When the teacher explains a set and relation material, there are some learners who do not pay attention properly, it seems that some learners are not eager to participate in class learning. Some learners also did not do homework on relation material given by the teacher, with the excuse of forgetting. This indicates that students' lack of learning readiness and lack of attention from teachers to students who do not do homework.

When the teacher gives the question of the set of square numbers less than 6, students can only mention the set members, namely mentioning the set by enumeration. Students are also not able to describe a set and still have difficulty in reasoning such as when the teacher writes the set by enumerating A = $\{4^2, 5^2, 6^2, 7^2, 8^2\}$, students are not able to determine the shape of the set.

According to Mutia et al. (2021) students are accustomed to routine questions presented by educators rather than solving non-routine questions such as PISA is one of the factors causing students' low mathematical literacy. In line with research Masfufah & Afriansyah (2021) it is known that the cause of students' low mathematical literacy is caused by students' lack of understanding of PISA-based questions.

Maths is referred to as an abstract science that only contains formulas and numbers. This paradigm will change if mathematics learning focuses on solving problems in everyday life. In learning activities at school, teachers often prioritise results over the learning process. The learning process is more about directing students to find concepts and apply concepts, so many students have difficulty if the problems in the material are modified according to mathematical problems in everyday life. This is a challenge for mathematics teachers in structuring learning to making problems in accordance with problems in everyday life.

Practice problems given by teachers come from printed books used by students at school. Students are not accustomed to working on contextual problems, so that students have not been able to formulate situations mathematically, have not been able to apply mathematical concepts, facts, procedures and reasoning, and have not been able to interpret, apply, and evaluate mathematical results when given questions about relation and set material related to daily life problems.

As explained earlier, an important part of mathematical literacy is the mathematisation process. The process in question is the process of formulating, using and interpreting and evaluating mathematics in different contexts. In its application, the choice of method or representation is highly dependent on the situation or context of the problem being solved. students are required to be able to apply their knowledge in various contexts. In fact, many students struggle with this. Students who can apply their knowledge to one task may not know how to apply it to a different task. Students must experience the problem- solving process in different situations and in different contexts to know how to use their skills effectively (Ojose, 2011).

These problems can be facilitated by teaching methods that provide experience to students. There are many learning methods or approaches to facilitate this experience. Some of them are the realistic mathematics approach (Budiono et al., n.d.), problem-based learning (De Graaff & Kolmos, n.d.), problem solving and contextualised teaching. In the above learning approaches, students face contextual or real problems that help them improve their knowledge. At this stage, students use their reading skills to formulate real-world problems into mathematical problems, solve them and interpret them in a real- world context.

In this way they use mathematical literacy skills in their development. The problems used in learning should be appropriate to what students experience. Problems that can be used should fulfil the following four characteristics: real, complex, interesting, and powerful (Modelling and Applications in Mathematics Education, n.d.). The point is that the problem describes the general context and the real problem. In addition, it must be difficult for students to identify the correct problem. However, the problems presented should not be just ordinary story problems. The reported problem may be too much information or an unknown problem (Wijaya et al., 2015).

The learning process so that students are mathematically literate must be through learning that has a connection to real situations, which are easily understood and imagined by students so that it can improve students' mathematical understanding structure. This is supported by the opinion of Sumirattana et al., (2017) that "mathematics had to be connected to reality, stay close to children's experiences and be relevant to society". Mathematics learning is applied through real events in life that are close to children's experiences and relevant to society so that students can imagine. Mathematics knowledge is obtained by students from independently constructing concepts based on real events that can be imagined by students. Thus, it is suspected that learning with the PBL model with PMRI approach can improve students' mathematical literacy. The realistic approach is carried out through the mathematisation process. This is in line with the opinion of Gravemeijer (1994) that the realistic mathematics approach is rooted in Frudenthal's interpretation, namely mathematics as an activity in the form of a mathematisation process.

Mathematical literacy can be improved by creating quality learning so teachers need to use the right learning model. Research Ayunis & Dorisno (2022) stated that the PMRI approach is effective in improving mathematical literacy skills. In addition, there needs to be various technology based leaming innovations that can relate to the context of everyday life to face the challenges of the 21st century, one of which is Math Trail-based learning using the MathCityMap application. Based on the description of the problems above, researchers are encouraged to conduct research on the PBL model with PMRI approach based on Math Trail to improve students' mathematical literacy.

This research is different from previous research because it develops a PBL model with PMRI approach based on Math Trail with MathCityMap application on flat-sided space building material. This research needs to be done at this time with the aim of getting maximum results on students' mathematical literacy which is carried out every year on the National Assessment. Thus this research is expected to be an in-depth study related to students' mathematical literacy in the PBL model with PMRI approach based on Math Trail.

METHOD

The research method used is mixed method. This research design uses sequential explanatory design. The sequential explanatory method is a mixed research method applied by collecting and analysing quantitative data in the first stage followed by collecting and analysing qualitative data in the second stage that builds on the initial quantitative results (Creswell, 2014).

Quantitative data collection is followed by qualitative data collection. Quantitative research to obtain data on the average mathematical literacy of students after applying the PBL model with PMRI approach based on Math Trail. While the analysis of the mathematical literacy of students who are categorised as high, medium and low after the application of the PBL model with PMRI approach based on Math Trail is used in qualitative research.

PBL model with PMRI approach based on Math Trail was implemented with the help of MathCityMap for six meetings, one meeting contained pretest and the last meeting contained posttest of mathematical literacy. Learning with the PBL model with a PMRI approach based on Math Trail took place four times.

RESULTS AND DISCUSSIONS

Learning quality consists of three stages, namely the planning stage, the implementation stage, and the evaluation stage. The mathematics learning that has been carried out in this study has fulfilled the 3 stages of learning quality in question, namely: (1) at the planning stage, the learning tools that have been prepared are valid, (2) at the implementation stage, the implementation of learning has been categorised as good and has received positive responses from students, and (3) at the evaluation stage, has met the effectiveness test. The first learning quality criteria is the preparation stage. The research data of this process stage includes learning tools. These learning tools include Teaching Modules, ATP, Math Trail teaching materials on Mathcitymap, interview guideline sheets, and questionnaires for learning implementation and student responses. Based on the validity criteria, it is concluded that the preparation stage with PBL learning tools with PMRI approach based on Math Trail is categorised as good.

The next learning quality criterion is the process stage. Data on learning outcomes of PBL with PMRI approach based on Math Trail is seen from the implementation of learning. From 4 meetings, observations were made by the mathematics teacher of SMPN 1 Depok. The results of observations of the implementation of PBL learning with a Math Trail-based PMRI approach based on learning implementation criteria concluded that PBL learning with a Math Trail-based PMRI approach was a good category.

The next learning quality criterion is the evaluation stage. The results of the mathematics literacy test in the experimental class showed that 29 students completed out of 30 students. From the calculation with the help of SPSS software, it is obtained that PBL with PMRI approach based on Math Trail is used to determine the success of students in the experimental class can reach more than 80%. The average mathematical literacy test results in the experimental and control classes were 85.87 and 81.23 respectively with the standard deviation values of the two classes being 7.385 and 8.760 respectively. The number of students from both classes is 60 students. Based on calculations with the help of SPSS software, the sig value on Equal Variances Assumed is 0.031, meaning sig < $\boldsymbol{\alpha}$ = 0,05 so that He is rejected and it is concluded that there is a difference between the results of the posttest of mathematical literacy of the experimental class and the control class. Then seen from the average mathematical literacy test results between the experimental and control classes, it was found that the average mathematical literacy test results between the experimental class were better than the control class.

From the results of the research and calculations, information can be obtained, namely (1) PBL learning with PMRI approach based on Math Trail is classically complete, (2) the average mathematical literacy test results of the experimental class are better than the control class, (3) there is an increase in students' mathematical literacy, and (4) there is a positive influence between PBL learning with PMRI approach based on Math Trail and mathematical literacy test results. So, it can be concluded that PBL learning with PMRI approach based on Math Trad is effective.

Analysis of students' mathematical literacy in Problem-based learning (PBL) learning with Indonesian Realistic Mathematics Learning (PMRI) based on Math Trail is measured through posttest questions with the highest score of 100 and the lowest score of 0. The mathematical literacy posttest question consists of 4 questions with 30 respondents in the experimental class at SMPN 1 Depok, Cirebon Regency. From the posttest question in the experimental class, the highest score was 96 and the lowest score was 60. After calculating using SPSS software version 17.0, the mean was 85.87 and the standard deviation (SD) was 7.385. The greater the standard deviation number, the greater the distribution of the data (the more heterogeneous). Conversely, the smaller the standard deviation, the smaller the data distribution (the more homogeneous) (Benefits, 2018).

The mathematical literacy of students in the experimental class at SMPN 1 Depok, Cirebon Regency was mapped into three categories, namely high ($\mu+\sigma$), medium (μ), and low ($\mu-\sigma$), The symbol u in this case is used to denote the average, while the symbol (σ) is used to denote the standard deviation. The categories of mathematical literacy of experimental class students are as in the following table.

Table 2. Frequency of Maths Literacy Score

Score	Freq	Freq (%)	Category
X ≥ 93	6	20%	High
79 < X < 92	20	66,67%	Medium
X ≤ 78	4	13,33%	Low
Total	30	100%	

In general, mathematical literacy after applying the PBL model with PMRI approach based on Math Trail is normally distributed, most (66.67%) are classified as medium, while some are classified as high (20%) and low (13.33%).

To facilitate the process of analysing data obtained from the field, researchers provide coding for each subject, question number, and indicator of mathematical literacy on space and shape content. The coding form determined by the author is as follows.

Table 3. Informant Code Category of Mathematical Literacy

Aspects Measured	*Indicators*
Formulate Able Formulate Situations Mathematically.	A1 Identify the Mathematical aspect of the problem. A2 Translate a problem into mathematical language or mathematical representation using appropriate symbols, figures or modelling. B1 Devise a strategy to find a mathematical solution.

Employ Able to Apply Mathematical Concepts, Facts, Procedures and Reasoning.	B2 Apply the mathematical concepts required during the process of finding solutions by means of geometric representations as well as analysing the data.
Interpret Able to Interpret, Apply and Evaluate Maths Results.	C1 Reinterpret the solution obtained into the context of real-world problems. C2 Explain the reasons why the result or conclusion is appropriate in the context of the given problem.

The coding information to facilitate data analysis is the use of subject informant codes, question numbers and indicator codes. For example LMT-1A1: Subject with high mathematical literacy on question number 1 indicator A1. LMT indicates the subject code, 1 indicates the question number code, and A1 indicates the indicator code, and so on.

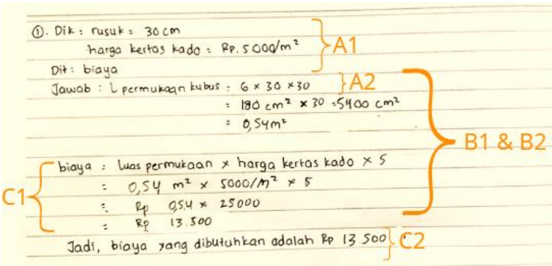

Figure 3. LMT Subject's Answer to Problem Number 1

Based on the results of the analysis of the written answers and interview transcripts of LMT students in question number 1, it can be concluded that subject 1 has shown mastery of the six indicators of mathematical literacy in the question. This is evidenced by subject 1's ability to: (1) Identifying mathematical aspects in the problem (LMT-IA1): Learners are able to recognise mathematical concepts and elements relevant to the problem. (2) Translate the problem into mathematical language (LMT-1A2): Learners are able to represent the problem in the form of an appropriate mathematical model, symbol, picture, or diagram. (3) Designing a solution strategy (LMT-1B1): Learners are able to devise systematic steps to solve the problem. (4) Applying mathematical concepts (LMT- 1B2): Learners are able to use mathematical concepts and theories relevant to the problem in the solution process. (5) Interpreting the solution (LMT-1C1): Learners are able to relate the results of the mathematical solution to the context of the actual problem. (6) Explaining the reasoning behind the result (LMT-1C2): Learners are able to logically explain why their solution is appropriate to the context of the problem.

The ability of students to solve problem number 1 well shows that subject 1 has reached a high level of mathematical literacy. This is evidenced by subject 1's ability to write and explain the answers to each question completely and accurately.

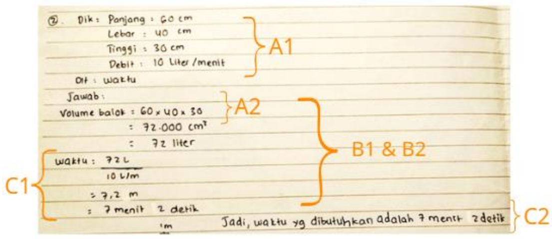

Figure 4. LMT Subject's Answer to Problem Number 2

Based on the results of the analysis of the written answers and interview transcripts of LMT students on question number 2, it can be concluded that the subjects have shown mastery of the six indicators of mathematical literacy in the question. This is evidenced by their ability to: (1) Identifying mathematical aspects in the problem (LMT-2A1): Learners are able to recognise mathematical concepts and elements relevant to the problem. (2) Translate the problem into mathematical language (LMT-2A2): Learners are able to represent the problem in the form of appropriate mathematical models, symbols, pictures, or diagrams. (3) Designing a solution strategy (LMT-2B1): Learners are able to devise systematic steps to solve the problem. (4) Applying mathematical concepts (LMT- 2B2): Learners are able to use mathematical concepts and theories relevant to the problem in the solution process. (5) Interpreting the solution

(LMT-2C1): Learners are able to relate the results of the mathematical solution to the context of the actual problem. (6) Explaining the reasoning behind the result (LMT-2C2): Learners are able to logically explain why their solution is appropriate to the context of the problem.

The ability of students to solve problem number 2 well shows that subject 1 has reached a high level of mathematical literacy. This is evidenced by subject 1's ability to write and explain the answers to each question completely and accurately.

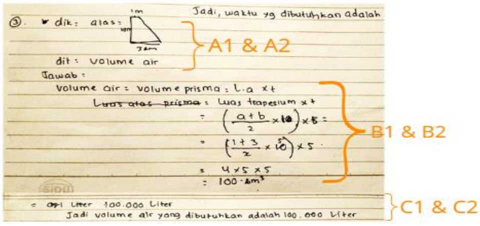

Figure 5. LMT Subject's Answer to Problem Number 3

Based on the results of the analysis of the written answers and interview transcripts of LMT students in question number 3, it can be concluded that subject 1 has shown mastery of several indicators of mathematical literacy in the question. This is evidenced by their ability to: (1) Identifying mathematical aspects in the problem (LMT-3A1): Learners are able to recognise mathematical concepts and elements relevant to the problem. However, students have not mentioned what is known and asked in the problem thoroughly. (2) Translate the problem into mathematical language (LMT-3A2): Learners are able to represent the problem in the form of appropriate mathematical models, symbols, pictures, or diagrams. Learners are able to convert the known information in the problem into a picture of the base of the prism, and are able to write down the information and concepts used to solve the problem. (3) Designing a solution strategy (LMT-3B1): Learners are able to devise systematic steps to solve the problem. (4) Applying mathematical concepts (LMT- 3B2): Learners are able to use mathematical concepts and theories relevant to the problem in the solution process. (5) Interpreting the solution (LMT-3C1): Learners are able to relate the results of the mathematical solution to the context of the actual problem. (6) Explaining the reasoning behind the result (LMT-3C2): Learners are able to logically explain why their solution fits the context of the problem.

The learners' ability to solve problem number 3 well shows that they have reached a high level of mathematical literacy. This is evidenced by their ability to write and explain the answers to each question completely and accurately.

However, although subject 1 had shown a good understanding of mathematical concepts and was able to solve the problem correctly, subject 1 had not written down the important information contained in the problem completely and clearly in indicator Al, and still had difficulty in connecting the problem with the real world context as a whole. This can be seen from the inability of subject 1 to explain the relationship between the problem and real life in indicator Cl.

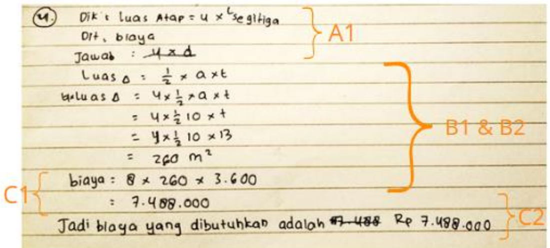

Figure 6. LMT Subject's Answer to Problem Number 4

Based on the results of the analysis of the written answers and interview transcripts of LMT students in question number 4, it can be concluded that subject1 has shown mastery of several indicators of mathematical literacy in the question. This is evidenced by their ability to: (1) Identifying mathematical aspects in the problem (LMT-4A1): Learners are able to recognise mathematical concepts and elements relevant to the problem. Learners have written the known and questionable information, but learners have not been able to identify and write down the important information known from the problem in indicator A1. Learners write the roof area formula that should be written in the answer section not in the known section, namely in indicator A2. (2) Translate the problem into mathematical language (LMT-4A2): Learners are able to represent the problem in the form of appropriate mathematical models, symbols, pictures, or diagrams. Learners are able to determine the concepts and formulas used to solve the problem, although they do not write clearly in the answer section.3) Designing a solution strategy (LMT-4B1): Learners are able to devise systematic steps to solve the problem. (3) Applying mathematical concepts (LMT- 4B2): Learners are able to use mathematical concepts and theories relevant to the problem in the solution process. (4) Interpreting the solution (LMT-4C1): Learners are able to relate the results of the mathematical solution to the context of the actual problem. (5) Explaining the reasoning behind the result (LMT-4C2): Learners are able to logically explain why their solution is appropriate to the context of the problem.

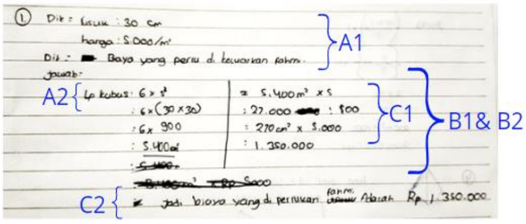

Figure 7. LMS Subject's Answer to Problem Number 1

Based on the results of the analysis of the written answers and interview transcripts of LMS students in question number 1, it can be concluded that subject 2 has shown mastery of several indicators of mathematical literacy in the question. This is evidenced by subject 2's ability to: (1) Identifying mathematical aspects in the problem (LMS-IA1): Learners are able to recognise mathematical concepts and elements relevant to the problem, by writing down the known and questionable information in the problem. (2) Translate the problem into mathematical language (LMS-LA2): Learners are able to represent the problem in the form of appropriate mathematical models, symbols, pictures, or diagrams. Learners are able to represent the problem by writing the surface area of the cube. (3) Designing a solution strategy (LMS-1B1): Learners are able to devise systematic steps to solve the problem. (4) Applying mathematical concepts (LMS- 1B2): Learners are able to use mathematical concepts and theories relevant to the problem in the solution process. (5) Interpreting the solution (LMS-1C1): Learners are able to relate the results of the mathematical solution to the context of the actual problem. However, learners are not yet able to convert cm2 to m2 units. (6) Explaining the reasoning behind the result (LMT-1C2): Learners are able to logically explain why their solution is appropriate to the context of the problem. However, learners' answers are not precise enough.

The ability of students to solve problem number 1 well shows that subject 2 has reached a moderate level of mathematical literacy. This is evidenced by subject 2's ability to write and explain the answers to each question clearly.

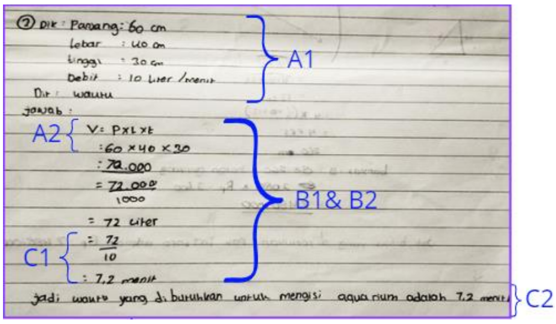

Figure 8. LMS Subject's Answer to Problem Number 2

Based on the results of the analysis of the written answers and interview transcripts of LMS students in question number 2, it can be concluded that subject 2 has shown mastery of several indicators of mathematical literacy in the question. This is evidenced by subject 2's ability to: (1) Identifying mathematical aspects in the problem (LMS-2A1): Learners are able to recognise mathematical concepts and elements relevant to the problem, by writing down the known and questionable information in the problem. (2) Translate the problem into mathematical language (LMS-2A2): Learners are able to represent the problem in the form of appropriate mathematical models, symbols, pictures, or diagrams. Learners are able to represent the problem by writing the formula for the volume of a beam. (3) Devising a solution strategy (LMS-2B1): Learners are able to devise systematic steps to solve the problem. (4) Applying mathematical concepts (LMS- 2B2): Learners are able to use mathematical concepts and theories relevant to the problem in the solution process. (5) Interpreting the solution (LMS-2C1): Learners are able to relate the results of the mathematical solution to the context of the actual problem. (6) Explaining the reasoning behind the result (LMT-2C2): Learners are able to logically explain why their solution is appropriate to the context of the problem.

The ability of students to solve problem number 2 well shows that subject 2 has reached a moderate level of mathematical literacy. This is evidenced by subject 2's ability to write and explain the answers to each question clearly.

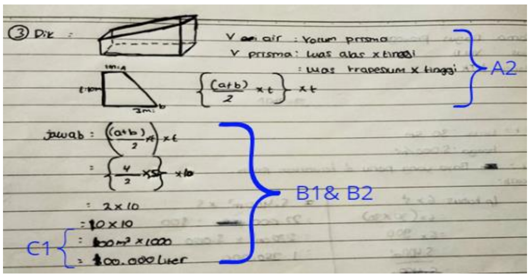

Figure 9. LMS Subject's Answer to Problem Number 3

Based on the results of the analysis of the written answers and interview transcripts of LMS students in question number 3, it can be concluded that subject 2 has shown mastery of several indicators of mathematical literacy in the question. This is evidenced by subject 2's ability to: (1) Identifying mathematical aspects in the problem (LMS-3A1): Learners are less able to recognise mathematical concepts and elements relevant to the problem, learners are less able to write the known and questionable information in the problem. (2) Translate the problem into mathematical language (LMS-3A2): Learners are able to represent the problem in the form of an appropriate mathematical model, symbol, picture, or diagram. Learners have been able to represent the problem with a picture illustration of a prism-shaped swimming pool. (3) Devising a solution strategy (LMS-3B1): Learners are able to devise systematic steps to solve the problem by writing the formula for the volume of a prism to find the volume of swimming pool water. (4) Applying mathematical concepts (LMS- 3B2): Learners are able to use mathematical concepts and theories relevant to the problem in the solution process. (5) Interpreting the solution (LMS-3C1): Learners are able to relate the results of the mathematical solution to the context of the actual problem. (6) Explaining the reasoning behind the result (LMT-3C2): Learners are not yet able to logically explain why their solution is appropriate to the context of the problem.

Learners do not write the conclusion of the answer. The ability of students to solve problem number 3 well shows that subject 2 has reached a moderate level of mathematical literacy. This is evidenced by subject 2's ability to write and explain the answers to each question clearly.

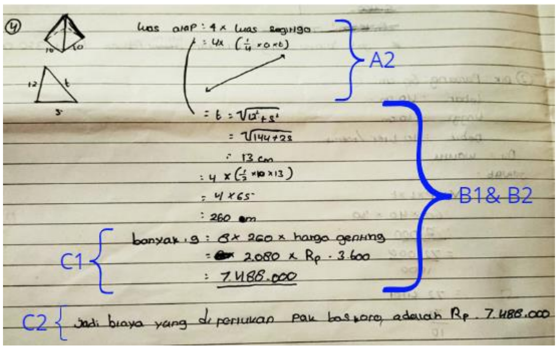

Figure 10. LMS Subject's Answer to Problem Number 4

Based on the results of the analysis of the written answers and interview transcripts of LMS students in question number 4, it can be concluded that subject 2 has shown mastery of several indicators of mathematical literacy in the question. This is evidenced by subject 2's ability to: (1) Identifying mathematical aspects in the problem (LMS-4A1): Learners are less able to recognise mathematical concepts and elements relevant to the problem, learners have not written the known and questionable information in the problem. (2) Translate the problem into mathematical language (LMS-4A2): Learners are able to represent the problem in the form of an appropriate mathematical model, symbol, picture, or diagram. Learners are able to represent the problem with a picture illustration of a pyramid-shaped tile roof. (3) Designing a solution strategy (LMS-4B1): Learners are less able to develop systematic steps to solve the problem. Learners do not write the formula and solution clearly. (4) Applying mathematical concepts (LMS- 4B2): Learners are able to use mathematical concepts and theories relevant to the problem in the solution process. (5) Interpreting the solution (LMS-4C1): Learners are able to relate the results of the mathematical solution to the context of the actual problem. (6) Explaining the reasoning behind the result (LMT-4C2): Learners are able to logically explain why their solution fits the context of the problem.

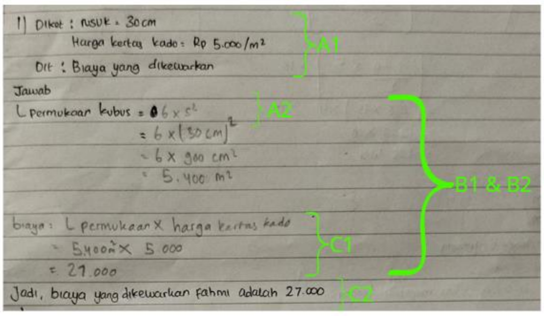

Figure 11. LMR Subject's Answer to Problem Number 1

Based on the analysis of LMR's written answers and interviews on question number 1, subject 3 showed a fairly good mastery of mathematical literacy in several problem indicators. This is evidenced by LMR's ability to: (1) Identifying mathematical aspects in the problem (indicator A1): LMR was able to recognise mathematical concepts and elements relevant to the problem. Subject 3 was able to write down the known and questionable information in the problem. (2) Translating the problem into mathematical language (A2 indicator): LMR has not been able to represent the problem in the form of appropriate mathematical models, symbols, pictures, or diagrams. Subject 3 wrote the formula for the surface area of the cube incorrectly. (3) Designing a solution strategy (indicator B1): LMR has not been able to compile systematic steps to solve the problem. However, because the formula used by subject 3 from the beginning was not appropriate, the solution results were not correct.

Although LMR showed indicator achievement in indicators A1, B1, B2, and C1 both in writing and orally, the weakness in indicators B2 & C2 in both test forms showed that LMR still needed to improve her understanding in translating questions into mathematical language, mathematical concepts and her ability to solve problems by connecting mathematics with real-world contexts, as well as explaining logically why the solution results were in accordance with the context of the problem.

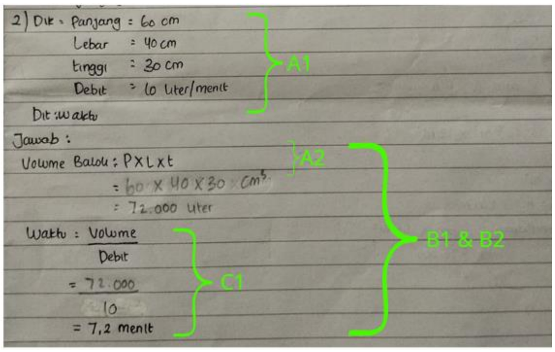

Image 12. LMR Subject's Answer to Problem Number 2

Based on the analysis of LMR's written answers and interviews on question number 2, subject 3 showed a fairly good mastery of mathematical literacy in several problem indicators. This is evidenced by MR's ability to: (1) Identifying mathematical aspects in the problem (indicator A1): LMR was able to recognise mathematical concepts and elements relevant to the problem. Subject 3 was able to write down the known and questionable information in the problem. (2) Translating the problem into mathematical language (A2 indicator): LMR was able to represent the problem in the form of appropriate mathematical models, symbols, pictures, or diagrams. Subject 3 wrote the formula for beam volume correctly. (3) Designing a solution strategy (indicator B1): LMR was able to develop systematic steps to solve the problem. (4) Applying mathematical concepts (indicator B2): Learners are able to use mathematical concepts and theories relevant to the problem in the solution process.

Although LMR showed the achievement of indicators A1, A2, B1, B2, and C1 in writing, subject 3 was not able to interpret the solution results and was not able to logically explain why the solution results were in accordance with the context of the problem.

Overall, although LMR showed good mastery of mathematical literacy in some indicators, there are still some abilities that need to be improved, especially in communication skills and connecting mathematics with real-world contexts.

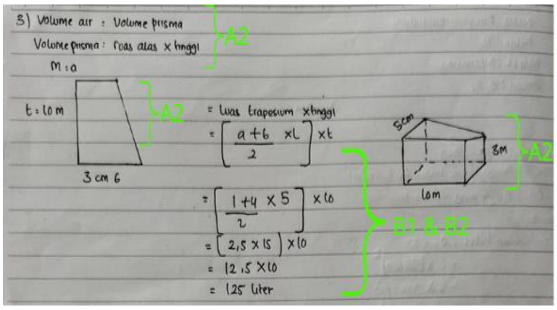

Figure 13. LMR Subject's Answer to Problem Number 3

Based on the analysis of LMR's written answers and interviews on question number 3, LMR has not shown adequate mastery of mathematical literacy in several question indicators. This can be seen from LMR's inability to: (1) Identifying mathematical aspects in the problem (indicator A1): LMR was not able to recognise mathematical concepts and elements relevant to the problem. Subject 3 did not write down the known and questionable information in the problem. (2) Interpreting the results of the solution (indicator C1): LMR has not been able to connect the results of mathematical solutions with the context of the actual problem. (3) Explaining the reason behind the result (C2 indicator): LMR has not been able to logically explain why his solution is in accordance with the context of the problem.

LMR has not been able to identify mathematical aspects in the problem, and has not been able to use mathematical concepts and theories relevant to the problem in the solution process.

Subject 3 still had difficulty in verbally demonstrating his abilities in indicators B2 and C2. This means that LMR has not been able to verbally explain the solution process and the reasons behind the results obtained. In addition, LMR has also not shown mastery of indicators A1, B1, B2, C1, C2 in writing. This means that LMR has not been able to connect the results of mathematical solutions with the actual context of the problem in writing.

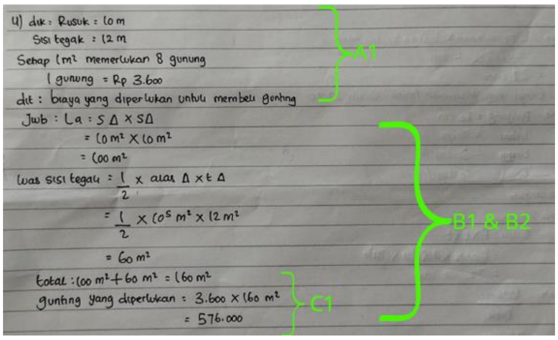

Figure 14. LMT Subject's Answer to Problem Number 4

Based on the analysis of LMR's written answers and interview results on question number 4, LMR has not shown a thorough mastery of mathematical literacy on the question. This can be seen from LMR's inability to fulfil all six indicators of the problem, namely: (1) Identifying mathematical aspects in the problem (indicator A1): LMR was not able to recognise mathematical concepts and elements relevant to the problem. Subject 3 did not write down the known and questionable information in the problem. (2) Translating the problem into mathematical language (A2 indicator): LMR was able to represent the problem in the form of appropriate mathematical models, symbols, pictures, or diagrams. However, subject 3 was not able to explain verbally during the interview. (3) Designing a solution strategy (indicator B1): LMR has not been able to develop systematic steps to solve the problem. (4) Applying mathematical concepts (indicator B2): LMR has not been able to use mathematical concepts and theories relevant to the problem in the solution process. (5) Interpreting the results of the solution (indicator C1): LMR has not been able to connect the results of mathematical solutions with the context of the actual problem. (6) Explaining the reason behind the result (C2 indicator): LMR has not been able to logically explain why his solution is in accordance with the context of the problem.

CONCLUSION

Problem-based learning (PBL) model with Indonesian Realistic Mathematics Learning (PMRI) based on Math Trail on the mathematical literacy of students in class VIII SMP Negeri 1 Depok is qualified. Based on the analysis of answers and interviews conducted, learners with High Mathematical Literacy (LMT) are able to fulfil six indicators of mathematical literacy. Learners with Moderate Mathematical Literacy (LMS) are able to fulfil three indicators of mathematical literacy, namely identifying mathematical aspects in problems, translating problems into mathematical language, designing solution strategies. Learners with Low Mathematical Literacy (LMR) were only able to fulfil one mathematical literacy indicator correctly, namely the indicator of identifying mathematical aspects in problems.

REFERENCES

Agusdianita, N., & Karjiyati, V. (2021). Training on the Use of Manipulative Learning Media to Embed the Concept of Building Space for Teachers at SDN 67 Bengkulu City. Darmabakti: Journal of Service Innovation in Aviation, 1(2).

Ayunis, A., & Dorisno, D. (2022). Effectiveness of RME Approach on Mathematical Literacy of Elementary School Students. Tarbiyah Al-Awlad, XII(1).

Budiono, C. S., Maths, W. J., Maths, F., Science, D., Nature, P., & Articles, I. (n.d.). Unnes Journal of Mathematics Education PISA-Oriented PBM with PMRI Approach and LKPD Improves Mathematical Literacy of Junior High School Students.

Creswell, J. W. (2014). Research-Design-Creswell-Chapter-I.Pdf. In Research Design.

De Graaff, E., & Kolmos, A. (n.d.). Characteristics of Problem-B ased Learning*.

Genc, M., & Erbas, A. K. (2019). Secondary mathematics teachers' conceptions of mathematical literacy. International Journal of Education in Mathematics, Science and Technology, 7(3).

Gravemeijer, K. (1994). Developing realistic mathematics education. In Faculty of Sciences, Freudenthal Institute.

Masfufah, R., & Afriansyah, E. A. (2021). Analysis of Students' Mathematical Literacy Skills through PISA Questions. Mosharafa: Journal of Mathematics Education, 10(2).

Modelling and Applications in Mathematics Education. (n.d.).

Mutia, Effendi, K. N. S., & Sutirna. (2021). PISA-LIKE: Uncertainty and data content in Statistics subject with futsal context. Journal of Physics: Conference Series, 1778(1).

Nurlaili, N., Fauzan, A., Yerizon, Y., Musdi, E., & Syarifuddin, H. (2022). Analysis of Student Mathematical Literacy in Integral Calculus Course. Journal of Scholarship: Journal of Mathematics Education, 6(3).

OECD. (2021). Pisa 2021 Mathematics Framework (Draft). Angewandte Chemie International Edition, 6(11), 951-952.

Ojose, B. (2011). Mathematics Literacy: Are We Able To Put The Mathematics We Learn Into Everyday Use? In Journal of Mathematics Education © Education for All, 4(1).

Education Assessment Research Agency, P., Education, D., Education, K., & Culture, D. (n.d.). EDUCATION IN INDONESIA.

Permendikbudristek Number 17 of 2021. (n.d.).

Sumirattana, S., Makanong, A., & Thipkong, S. (2017). Using realistic mathematics education and the DAPIC problem-solving process to enhance secondary school students' mathematical literacy. Kasetsart Journal of Social Sciences, 38(3), 307-315.

Wijaya, A., Van Den Heuvel-Panhuizen, M., & Doorman, M. (2015). Faculty of Education; ERME.