

Implementation of Problem-Based Learning Based on Mathematical Literacy to Improve Student's Higher-Order Thinking Skills

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Abstract

HOTS are high-level thinking skills that are important to have in the era of globalization to solve complex problems. However, many students still have relatively low HOTS, especially when the issue is relevant to everyday life. This study aims to see how implementing Problem-Based Learning (PBL) based on mathematical literacy improves students' HOTS in class X MP 2 students of SMK Negeri 5 Madiun. This study is classroom action research (CAR) carried out in two cycles, with 29 subjects from class X MP 2 SMK Negeri 5 Madiun. Each research cycle consists of four stages: planning, implementing actions, observation, and reflection. The main objective of this study is to determine whether implementing Problem-Based Learning (PBL) based on mathematical literacy can improve students' HOTS in mathematics learning. The study results showed a significant increase in students' HOTS after the implementation of PBL based on mathematical literacy. In the pre-cycle stage, students' HOTS were at 56.6%. After the actions were carried out in cycle I, students' HOTS increased to 71.8%, although it had not reached the expected completion criteria. In cycle II, another increase in students' HOTS to 79.2% met the success criteria.

Keywords: Higher-order Thinking Skills; Mathematical Literacy; Problem-Based Learning



1. Introduction

HOTS (Higher-order Thinking Skills) are an important component in problem solving because they involve analytical, evaluative, and creative skills that allow someone to understand problems in depth, consider various alternative solutions, and make the right decisions based on logical and critical considerations (Lusiana & Andari, 2020). HOTS involve complex thinking processes, such as explaining, criticizing, and creating solutions. HOTS thinking includes critical and creative thinking (Safitri et al., 2024) in problem solving (Gusteti & Neviyarni, 2022). HOTS, which was developed from Bloom's Taxonomy, is at the top level (Sa'adah et al., 2021), so it is essential in the 21st-century era. HOTS helps students face complex problems through analysis and find various solutions (Yanti et al., 2022). HOTS-based questions encourage students to think critically, creatively, and communicatively, and help them view problems logically and objectively (Dinni, 2018). High-level thinking skills enable students to understand concepts, connect ideas, and apply knowledge effectively in various situations, improving their learning outcomes (Ultra Guesteti & Neviyarni, 2022). One effort to improve these abilities is to use innovative learning models (Lusiana et al., 2021; Launuru et al., 2021).

An effective learning model that allows students to develop creativity in solving problems is Problem-Based Learning (PBL) (Lusiana et al., 2021; Setiawan & Santosa, 2017). The PBL learning model is a learning model that aims to stimulate critical thinking (Husnidar & Hayati, 2021; Nurhayati et al., 2021) and creativity of students by using real problems (Febita et al., 2024) as a learning context. Students are invited to identify, analyze, and solve problems to develop high-level thinking skills and application of knowledge in real-life situations (Marlina et al., 2020). According to PISA (2012), mathematical literacy is a person's ability to formulate, apply, and interpret mathematics in various contexts (Madyaratri et al., 2019). PBL based on mathematical literacy helps students remember information better by connecting it to real contexts, while developing problem-solving, critical thinking, and communication skills through group work (Handayani, 2021).

According to Asriningtyas et al. (2018) PBL study results are suitable for use in the learning process and to improve students' HOTS. Then, research by Kurniawan & Khotimah (2022), mathematical literacy and numeracy influence problem-solving abilities in improving HOTS. Based on observations made by researchers at SMKN 5 Madiun, it was found that students' HOTS were still relatively low in mathematics learning. Many students still have difficulty analyzing and solving complex problems, which shows their low HOTS (Irmawati et al., 2022). The low HOTS of students can be caused by a lack of mathematical literacy skills in problem solving (Hasyim & Andreina, 2019), which does not support the development of critical and creative thinking. Learning that only focuses on memorizing formulas and practicing questions does not allow students to explore problems in depth, question assumptions, or create alternative solutions. In dealing with these problems, innovation and solutions are needed to improve student learning outcomes. One of the factors that influences learning outcomes is implementing the PBL learning model by integrating mathematical literacy in the form of contextual questions. Implementing this PBL learning model based on mathematical literacy can improve student learning outcomes by making the material more relevant and applicable and improving students' ability to reason and create (Tabun et al., 2020; Erria et al., 2023).

Based on the description above, no research still discusses this problem, so the researcher will conduct it with the title "Implementation of the PBL Model Based on Mathematical Literacy to Improve HOTS Abilities of Class X Students at SMKN 5 Madiun". This research is expected to positively impact student learning outcomes and improve students' higher-order thinking skills.

2. Method

This research is classroom action research (CAR) whose main objective is to determine whether the application of PBL based on mathematical literacy can improve students' HOTS in mathematics

learning. The classroom action research was conducted by the researcher on students of class X MP 2 at SMK Negeri 5 Madiun and was carried out in several cycles. The research subjects consisted of 29 students from class X MP 2 at SMK Negeri 5 Madiun in the even semester of the 2024 academic year. The research model used in this study is the model proposed by Kemmis and Mc Taggart (Prihantoro & Hidayat, 2019), where in the CAR research is carried out in several cycles. The results of the research in the first cycle will form the basis for research in the second cycle, where the second cycle is an improvement from the first cycle based on the results of reflection, if it has not met the established success indicators. The data analysis techniques used in this study are quantitative descriptive and qualitative descriptive techniques. According to (Unaradjan, 2019) the method for describing numerical data uses mathematical calculations with hypothesis testing using accurate data. While the qualitative descriptive method is a technique used to study objects in a natural context with the aim of understanding or interpreting phenomena based on the meaning determined by the researcher (Lusiana, 2017). Researchers conducted classroom action research in several cycles following the stages according to Kemmis and McTaggart, namely planning, implementation, observation, and reflection (Muhammad Djajadi, 2019). The stages of the classroom action research cycle that the researcher carried out show at Figure 1.

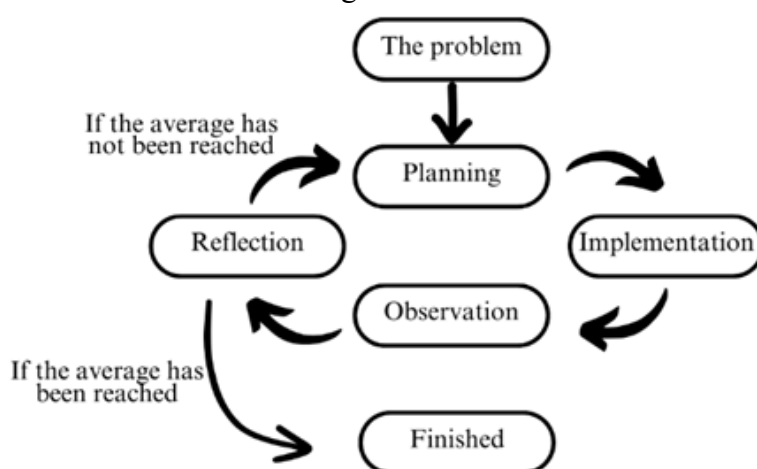


Figure 1. Stages of Classroom Action Research.

The instrument used in this study was a sial test adapted to the HOTS indicators (Sinaga, 2021).

Table 1. HOTS Indicator

HOTS Indicator	Ability
Analyze	Analyze information into its respective parts and determine the relationships between the parts.
Evaluate	Make your own decisions and assess things to achieve a goal based on specific criteria.
Create	Creating ideas/concepts, such as reorganizing existing parts to form a new structure, includes generating, planning, and producing.

The subjects of this study were 29 students of class X of SMKN 5 Madiun in the even semester of the 2023/2024 academic year. The researcher used the indicators in Table 1 to create a scoring guideline, which was compiled based on the indicators listed in Table 1. The scoring guideline can be seen in Table 2.

Table 2. Scoring Guidelines

HOTS Indicator	Score	Student Response
Analyze	1	Students cannot analyze problems based on mathematical literacy in the SPLDV material.
	2	Students can differentiate mathematical literacy-based problems in SPLDV material but cannot organize and connect mathematical literacy-based problems in SPLDV material.
	3	Students can differentiate and organize mathematical literacy-based problems in SPLDV material but cannot connect mathematical literacy-based problems in SPLDV material.
	4	Students can analyze problems based on mathematical literacy in the SPLDV material.
Evaluate	1	Students cannot evaluate mathematical literacy-based problems in the SPLDV material.
	2	Students can check mathematical literacy-based problems in SPLDV material but cannot criticize and interpret mathematical literacy-based problems in SPLDV material.
	3	Students can check and criticize mathematical literacy-based problems in SPLDV material; however, they cannot yet interpret mathematical literacy-based problems in SPLDV material.
	4	Students can evaluate problems based on mathematical literacy in the SPLDV material.
Create	1	Students cannot yet create new solutions to mathematical literacy-based problems in the SPLDV material.
	2	Students can compile mathematical literacy-based problems in SPLDV material but cannot plan and produce mathematical literacy-based problems from mathematical literacy-based problems in SPLDV material.
	3	Students can compile and plan mathematical literacy-based problems in SPLDV material but cannot produce new solutions to mathematical literacy-based problems in SPLDV material.
	4	Students can create new solutions to mathematical literacy-based problems in the SPLDV material.

The results of the students' Posttest test used to measure students' HOTS were analyzed using the following formula.

$$\text{Average} = \frac{\sum \text{Scores obtained in each aspect}}{\sum \text{Maximum Score for each aspect}} \times 100\%$$

Based on these results, they are then converted using HOTS criteria as in the table below.

Table 3. HOTS Categories

Presentation	Criteria
$90 < x \leq 100$	Very good
$80 < x \leq 90$	Good
$70 < x \leq 80$	Enough
$60 < x \leq 70$	Not enough
$0 < x \leq 60$	Very less

This research can be said to be successful if it meets several criteria, namely if the average HOTS percentage of class X MP 2 students reaches 75%.

3. Results and Discussion

The learning was carried out using a PBL learning model based on mathematical literacy for several cycles. However, before applying the PBL learning model based on mathematical literacy, researchers observed the students' initial conditions (precycle). This observation aims to provide an initial picture of the student's condition, so researchers can design appropriate actions to improve students' HOTS. Implementing PBL based on mathematical literacy can encourage students to think critically and develop high-level thinking skills through solving real problems (Asriningtyas et al., 2018; Hastawan et al., 2024).

After implementing the learning actions at the end of the meeting in each cycle, a post-test was conducted by giving one essay question based on mathematical literacy that matches the HOTS indicators to students. This test was given to measure students' HOTS abilities. The results of each cycle are as follows.

3.1 Results

3.1.1 Pre Cycle

The precycle stage is the initial stage before the Action (cycle I) begins, and it has an important purpose as a foundation for proper and data-based action planning. Learning activities at this stage are carried out according to plan, starting with triggering questions from the teacher to recall previous material. At the end, students take a post-test to measure their HOTS. The implementation of the Precycle activities consists of the following stages:

(1) Planning

The initial stage of Classroom Action Research (CAR) is careful planning, namely: determining learning objectives, Preparation of Teaching Modules, Designing Learning Scenarios, Determining Teaching Materials, compiling group/individual assignments, Providing Observation Sheets or Observations. The following is a post-test on pre-cycle activities.

<p>Di sebuah kafe, terdapat dua jenis paket makan siang:</p> <ul style="list-style-type: none"> • Paket A: berisi 1 sandwich dan 2 jus dengan harga Rp 40.000. • Paket B: berisi 2 sandwich dan 1 jus dengan harga Rp 50.000. <ol style="list-style-type: none"> 1. Buatlah model matematika dalam bentuk sistem persamaan linear dua variabel berdasarkan informasi di atas. 2. Tentukan jumlah masing-masing paket yang harus disiapkan kafe agar kebutuhan sarapan siswa tercukupi. 3. Setelah mengetahui harga sebuah sandwich dan sebuah jus, seorang pelanggan ingin membeli 3 sandwich dan 3 jus. Berapa total biaya yang harus dikeluarkan? Jelaskan proses perhitunganmu.
<p>At a café, there are two types of lunch packages:</p> <ul style="list-style-type: none"> • Package A: contains 1 sandwich and 2 juices, priced at Rp 40,000. • Package B: contains 2 sandwiches and 1 juice, priced at Rp 50,000. <ol style="list-style-type: none"> 1. Create a mathematical model in the form of a system of linear equations with two variables based on the information above. 2. Determine how many of each package the café should prepare to meet the students' breakfast needs. 3. After finding the price of one sandwich and one juice, a customer wants to buy 3 sandwiches and 3 juices. How much will it cost in total? Explain your calculation process.

Figure 2. Post-test Questions in the Pre-cycle.

(2) Implementation

The implementation stage involves implementing the plan that has been designed in detail. The planned actions are implemented in the classroom according to the strategies and methods that have been prepared. This activity aims to test the effectiveness of the learning plan in achieving the

objectives. Implementation begins with a trigger question, continues with learning according to the learning plan, and ends with the provision of post-test questions that are worked on individually.

<ol style="list-style-type: none"> 1. Apa yang terlintas di benak kalian saat mendengar kata "persamaan"? 2. Berdasarkan persamaan $2x + y = 10$, ada berapa variable dari persamaan tersebut? 3. Apa bedanya antara persamaan dengan satu variabel dan dua variabel? 4. Ada berapa metode yang bisa kita gunakan untuk menyelesaikan SPLDV?
<ol style="list-style-type: none"> 1. What comes to your mind when you hear the word "equation"? 2. Based on the equation $2x + y = 10$, how many variables are in the equation? 3. What is the difference between an equation with one variable and an equation with two variables? 4. How many methods can we use to solve a system of linear equations with two variables (SPLDV)?

Figure 3. Post-Test Question.

(3) Observation

Observation aims to assess how the actions implemented achieve the stated objectives. At this stage, the researcher must explain each element used in detail; clarity in this observation is important so that the data collection process takes place systematically and the results can be analyzed accurately and comprehensively.

Based on the post-test results of 29 students, the average of their ability to analyze information into their respective parts and determine the relationship between the parts was 60.3%. Meanwhile, their average ability to make their own decisions was 57.7%, and their average ability to create their ideas/concepts only reached 51.7%. These figures indicate that students still have difficulty understanding and solving problems, which may be caused by the lack of relevance of the material to their daily lives. The percentage of students' HOTS in each indicator in the Precycle activities is as follows.

Table 4. Student's HOTS in Pre-cycle

Indikator HOTS	Average (%)	Caregories
Analyze information into its respective parts and determine the relationships between the parts.	60,3	Not enough
Make decisions and assess things to achieve a goal based on specific criteria	57,7	Very less
Creating ideas/concepts, such as reorganizing existing parts to form a new structure, includes generating, planning, and producing.	51,7	Very less

(4) Reflection

After the Action, reflection aims to identify weaknesses and deficiencies. Researchers analyze the implementation, record the results of observations, and evaluate learning, the results obtained before implementing the PBL learning model based on problem literacy. The results obtained were that students only achieved one HOTS indicator. The following are the results of the post-test to see HOTS from one of the students regarding problem solving.

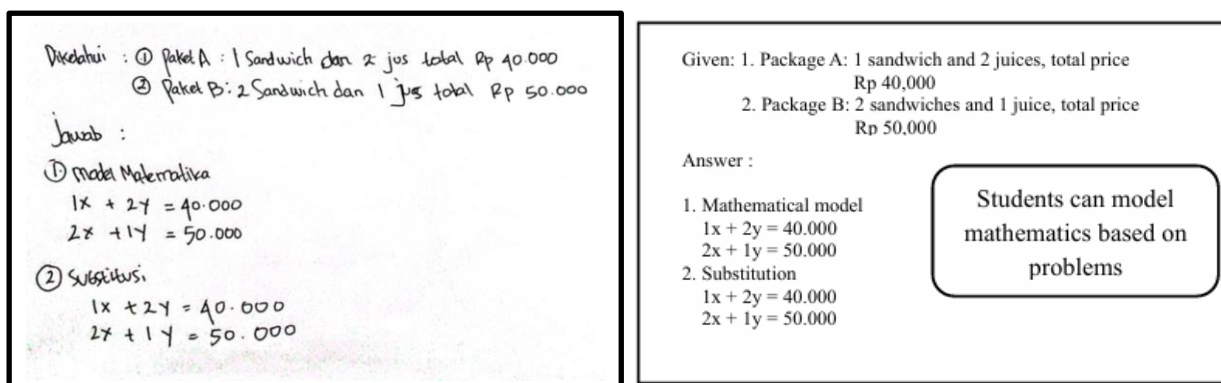


Figure 4. Example of Student Answer Results in the pre-cycle.

From the results of the students' work in Figure 3, it appears that the students have analyzed the given problem, as seen from the way the students form a mathematical model that matches the information in the question, indicating that the students have met the skill indicators in identifying important aspects for problem solving. However, in the second question, when students are asked to solve the problem, it is seen that they have difficulty following the proper steps and choosing the appropriate method. This difficulty indicates that students have not achieved the skill indicator in making independent decisions needed in the problem-solving process. Because students have not been able to solve the second question, similar difficulties are also seen in the next question, so students have not met the skill indicator in developing independent ideas or concepts needed to solve the problem.

3.1.2 Cycle 1

Learning activities are carried out according to the design that has been made. The activity begins with a trigger question, to remind students of the previous material. Then we continued with learning according to the stages of the Problem-Based Learning (PBL) learning model. Then at the end of the learning process, students are given post-test questions to measure students' HOTS. The implementation of Cycle I activities involves the following stages:

(1) Planning

Based on the results of reflection in the Pre-Cycle, it was found that students' HOTS were still relatively low, so in Cycle I, the researcher made a plan, namely determining learning objectives, compiling teaching modules, designing PBL learning scenarios (teachers design problem-based learning scenarios that involve students in problem solving, analysis, or evaluation related to the selected topic), determining teaching materials, compiling group/ individual assignments, providing observation or observation sheets. The following is the post-test in cycle I activities.

Untuk memperingati ulang tahun SMKN 5 Madiun sekolah mengadakan perlombaan membaca puisi dan bernyanyi. Osis yang kebetulan ditunjuk sebagai panitia kegiatan ingin menyiapkan paket hadiah yang akan diberikan kepada siswa yang memenangkan lomba. Terdapat dua jenis paket hadiah, yaitu Paket Hadian 1 dan Paket Hadian 2. Paket Hadian 1 terdiri dari 2 buah buku tulis dan 1 buah pensil, sedangkan Paket Hadian 2 terdiri dari 1 buah buku tulis dan 3 buah pensil. Panitia hanya menyediakan hadiah total 10 buku tulis dan 10 pensil. Harga Paket Hadian 1 adalah Rp30.000 dan harga Paket Hadian 2 adalah Rp40.000.

Selesaikan :

1. Tentukan model matematika dari masalah ini dalam bentuk sistem persamaan linear dua variabel.
2. Tentukan jumlah masing-masing paket Hadiah yang harus disiapkan oleh panitia agar sesuai dengan persediaan yang disediakan.
3. Setelah mengetahui jumlah masing-masing paket hadiah yang harus disiapkan, selanjutnya buktikan apakah jumlah paket Hadiah 1 dan paket Hadiah 3 sesuai dengan persediaan yang disediakan panitia, serta berapa total biaya yang dikeluarkan panitia untuk membuat paket Hadia tersebut.

To celebrate the anniversary of SMKN 5 Madiun, the school is holding a poetry reading and singing competition. The student council (OSIS), which has been appointed as the organizing committee, wants to prepare gift packages for the students who win the competition. There are two types of gift packages: Gift Package 1 and Gift Package 2. Gift Package 1 consists of 2 notebooks and 1 pencil, while Gift Package 2 of 1 notebook and 3 pencils. The committee only has a total of 10 notebooks and 10 pencils available. The price of Gift Package 1 is Rp 30,000, and the price of Gift Package 2 is Rp 40,000.

Solve the following:

1. Create a mathematical model for this problem in the form of a system of linear equations with two variables.
2. Determine how many of each type of gift package the committee should prepare to match the available supplies.
3. After determining the number of each gift package to prepare, verify whether the total number of Gift Package 1 and Gift Package 2 fits the available supplies, and calculate the total cost incurred by the committee to create the gift packages.

Figure 5. Post-test Questions in the Cycle 1.

(2) Implementation

The implementation stage involves implementing the designed plan, with actions in class according to the strategies and methods prepared. This stage aims to test the plan's effectiveness in achieving the objectives. Implementation begins with a trigger question, providing student worksheets (LKPD) for group work, followed by a presentation, and ending with individual post-test questions.

1. Jika kalian pergi ke supermarket dan membeli 2 jeruk dan 1 mangga dengan total harga tertentu, lalu kembali membeli 3 jeruk dan 4 mangga dengan harga yang berbeda, apakah mungkin menghitung harga satu apel dan satu pisang? Bagaimana cara kalian menentukan jawabannya?
2. Di kantin sekolah, 2 nasi dan 3 lauk seharga Rp45.000, sedangkan 4 nasi dan 2 lauk seharga Rp70.000. Berapa harga 1 nasi dan 1 lauk?

1. If you go to the supermarket and buy 2 oranges and 1 mango for a certain total price, then later buy 3 oranges and 4 mangoes for a different price, is it possible to calculate the price of one apple and one banana? How would you determine the answer?
2. At the school canteen, 2 portions of rice and 3 side dishes cost Rp 45,000, while 4 portions of rice and 2 side dishes cost Rp 70,000. What is the price of 1 portion of rice and 1 side dish?

Figure 6. Trigger Question in Cycle 1.

(3) Observation

Observation aims to assess how the actions implemented achieve the stated objectives. At this stage, the researcher must explain each element used in detail; clarity in this observation is important so that the data collection process takes place systematically and the results obtained can be analyzed accurately and comprehensively.

Based on the analysis of the post-test results of 29 students, the average of their ability to analyze information into their respective parts and determine the relationship between the parts was 74.1%. Meanwhile, the average of their ability to make their own decisions and assess something to achieve a goal based on specific criteria was 68.9%. The average of their ability to create their ideas/concepts, such as reorganizing existing parts to form a new structure, the process includes producing, planning, and producing, only reached 67.2%. This percentage shows that students have slightly improved in understanding and solving problems. The percentage of students' HOTS in each indicator in cycle one activities is as follows.

Table 5. Students HOTS in Cycle 1

Indikator HOTS	Average (%)	Caregories
Analyze information into its respective parts and determine the relationships between the parts.	74,1	Enough
Make decisions and assess things to achieve a goal based on specific criteria	68,9	Not enough
Creating ideas/concepts, such as reorganizing existing parts to form a new structure, includes generating, planning, and producing.	67,2	Not enough

(4) Reflection

Reflection is conducted after the Action, which aims to identify weaknesses and deficiencies. Researchers analyze implementation, record observation results, and evaluate learning to improve weaknesses in cycle one so that they can be applied in cycle two if the indicators have not been achieved. The research results conducted by researchers and students are given story problems related to everyday life to see how far students have HOTS. The following are the results of the post-test to see HOTS from one of the students in solving story problems.

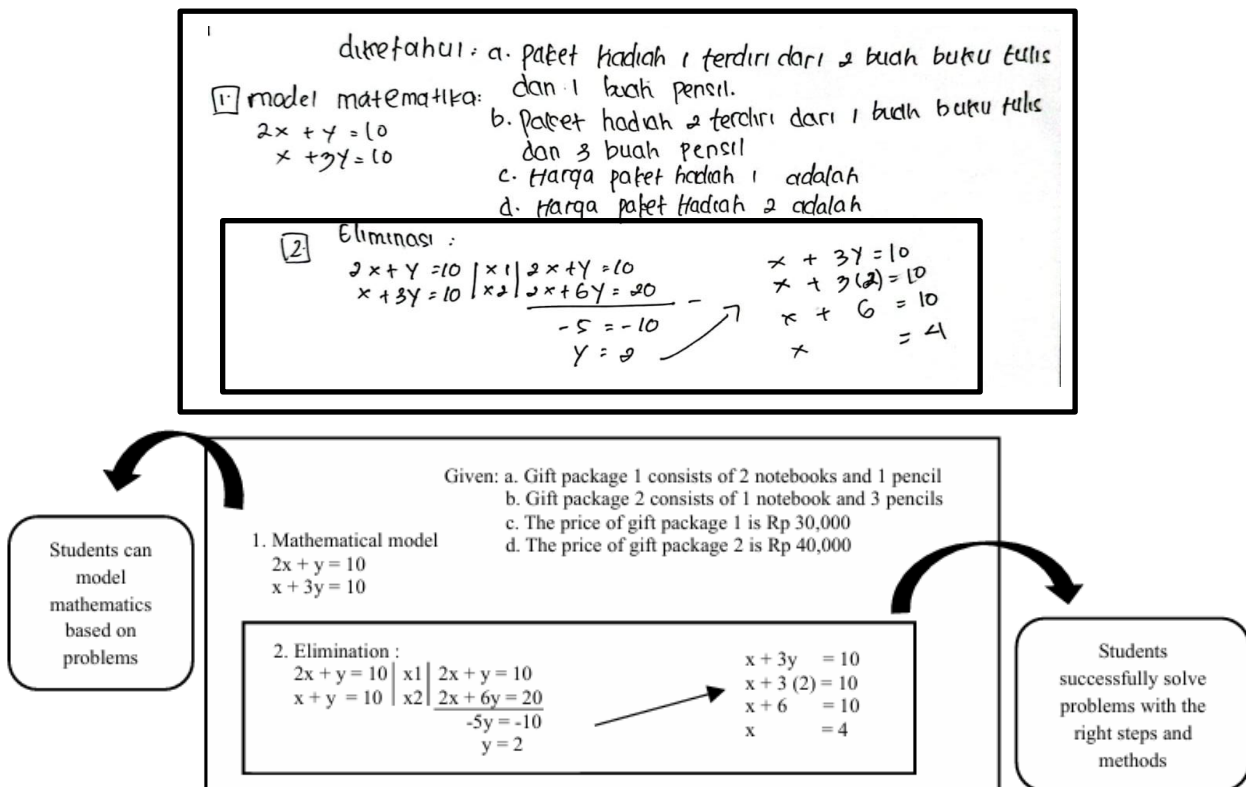


Figure 7. Example of Student Answer Results in Cycle 1.

Based on the results of the students' work in Figure 5, it can be seen that the students have analyzed the problems presented, this can be seen from the way the students for example the variables x and y , where the variable x is the number of Gift packages one purchased and the variable y is the number of Gift packages two purchased according to the information obtained from the question. Furthermore, students are asked to model the problem in mathematical form, and the answers given are based on expectations. Thus, students have achieved the indicators of the specifications of the aspects or elements needed in solving the problem. In the second question, students successfully solved the problem with the proper steps, understood the problem-solving process well, and met the indicators of skills in making independent decisions. However, in the third question, students had difficulty in proving the adequacy of supplies and calculating the total cost, which requires the ability

to develop ideas independently. As a result, students have not achieved the indicators of skills in developing independent problem-solving ideas.

3.1.3 Cycle 2

Learning activities are carried out according to the design that has been made. The activity begins with a trigger question to remind students of the previous material. Then, they continued with learning according to the stages of the Problem-Based Learning (PBL) learning model. Then, at the end of the learning, students are given post-test questions to measure their HOTS. The implementation of Cycle 2 activities involves the following stages:

(1) Planning

Based on the results of reflection in cycle I, students still have not achieved the HOTS thinking ability indicators, so in Cycle 2 the researcher made a plan, namely determining learning objectives, compiling teaching modules, designing PBL learning scenarios (teachers design problem-based learning scenarios that involve students in problem solving, analysis, or evaluation related to the selected topic), determining teaching materials, compiling group/individual assignments, providing observation or observation sheets. The following is the post-test for cycle two activities.

Kantin Bu Ros yang ada di SMKN 5 Madiun, menyediakan dua jenis paket makan yang ditawarkan untuk siswa, yaitu Paket A dan Paket B. Paket A berisi 1 Nasi bungkus dan 2 Gorengan, sedangkan Paket B berisi 2 Nasi bungkus dan 1 Gorengan. Setiap hari, Bu Ros harus menyediakan 10 Nasi bungkus dan 8 Gorengan untuk memenuhi kebutuhan sarapan siswa. Harga satuan dari masing-masing paket adalah sebagai berikut :

- Harga Paket A adalah Rp6.000
- Harga Paket B adalah Rp8.000

Selesaikan :

1. Buatlah model matematika dalam bentuk sistem persamaan linear dua variabel berdasarkan informasi di atas.
2. Tentukan jumlah masing-masing paket yang harus disiapkan oleh kantin agar kebutuhan sarapan siswa tercukupi.
3. Setelah mengetahui jumlah masing-masing paket yang harus disiapkan, selanjutnya buktikan apakah jumlah paket A dan paket B dapat memenuhi kebutuhan siswa, serta berapa penghasilan Bu Ros jika menjual paket-paket makan tersebut.

Bu Ros's canteen at SMKN 5 Madiun offers two types of meal packages for students: Package A and Package B. Package A contains 1 wrapped rice and 2 fried snacks, while Package B contains 2 wrapped rice and 1 fried snack. Every day, Bu Ros must prepare a total of 10 wrapped rice and fried snacks to meet the students' breakfast needs.

The prices for each package are as follows:

- The price of Package A is Rp 6,000
- The price of Package B is Rp 8,000

Solve the following:

1. Create a mathematical model in the form of a system of linear equations with two variables based on the information above.
2. Determine the number of each package that the canteen must prepare to fulfill the students' breakfast needs.
3. After finding out how many of each package should be prepared, verify whether the quantities of Package A and Package B meet the students' needs, and calculate Bu Ros's total income from selling the meal packages.

Figure 8. Post-test Questions in Cycle 2.

(2) Implementation

The implementation stage involves implementing the designed plan, with actions in class according to the strategies and methods prepared. This stage aims to test the plan's effectiveness in achieving the objectives. Implementation begins with a trigger question, providing student worksheets (LKPD) for group work, followed by a presentation, and ending with individual post-test questions.

<ol style="list-style-type: none"> 1. Jika Ridho memiliki uang Rp50.000 dan ingin membeli Buku dan Bolpoint. Ridho tahu harga Buku adalah Rp2.000 per batang, dan harga Bolpoint adalah Rp3.000 per buah. Berapa jumlah maksimal pensil dan penghapus yang bisa Ridho beli dengan uang Rp50.000? 2. Di koperasi sekolah harga 3 pensil dan 2 penghapus adalah Rp20.000, sementara harga 5 pensil dan 4 penghapus adalah Rp34.000. Berapa harga satu pensil dan satu penghapus?
<ol style="list-style-type: none"> 1. Ridho has Rp 50,000 and wants to buy erasers and pens. He knows that the price of an eraser is Rp 2,000 each, and the price of a pen is Rp 3,000 each. What is the maximum number of erasers and pens that Ridho can buy with Rp 50,000? 2. At the school cooperative, the price of 3 pencils and 2 erasers is Rp 20,000, while the price of 5 pencils and 4 erasers is Rp 34,000. What is the price of one pencil and one eraser?

Figure 9. Trigger Question in Cycle 2.

(3) Observation

Observation aims to assess how the actions implemented achieve the stated objectives. At this stage, the researcher must explain each element used in detail; clarity in this observation is important so that the data collection process takes place systematically and the results can be analyzed accurately and comprehensively.

Based on the analysis of the post-test results of 29 students, the average ability of them to analyze information into their respective parts and determine the relationship between them was 81.8%. Meanwhile, their average ability to make their own decisions and assess something to achieve a goal based on specific criteria was 80.1%. Their average ability to create ideas/concepts, such as reorganizing existing parts to form a new structure, includes producing, planning, and reaching 75.8%. This percentage shows that students have experienced a significant increase in understanding and solving problems. This is because the material and questions are relevant to their daily lives. The percentage of students' HOTS in each indicator in cycle 2 is as follows.

Table 6. Student's HOTS in cycle 2

Indikator HOTS	Average (%)	Caregories
Analyze information into its respective parts and determine the relationships between the parts.	81,8	Good
Make decisions and assess things to achieve a goal based on specific criteria	80,1	Enough
Creating ideas/concepts, such as reorganizing existing parts to form a new structure, includes generating, planning, and producing.	75,8	Enough

(4) Reflection

Reflection is conducted after the Action, which aims to identify weaknesses and deficiencies. Researchers analyze the implementation, record the results of observations, and evaluate learning to improve weaknesses in the second cycle so that they can be applied in the third cycle if the indicators have not been achieved.

The research results conducted by researchers and students are given story problems related to everyday life to see how far students have HOTS. The following are the results of the post-test to see HOTS from one of the students in solving story problems.

Seselaikan :

1. Buatlah model matematika dalam bentuk sistem persamaan linear dua variabel berdasarkan informasi di atas.
2. Tentukan jumlah masing-masing paket yang harus disiapkan oleh kantin agar kebutuhan sarapan siswa tercukupi.
3. Setelah mengetahui jumlah masing-masing paket yang harus disiapkan, selanjutnya buktikan apakah jumlah paket A dan paket B dapat memenuhi kebutuhan siswa, serta berapa penghasilan Bu Ros jika menjual paket-paket makan tersebut.

Jawab

Misal : x : Jumlah paket A yang dibeli
 y : Jumlah paket B yang dibeli

Diketahui :
 - Paket A berisi 1 Nasi bungkus dan 2 gorengan
 - Paket B berisi 2 nasi bungkus dan 1 gorengan
 - Harga paket A adalah Rp. 6.000
 - Harga paket B adalah Rp. 8.000

Ditanya :

② Jawab : $x + 2y = 10$
 $2x + y = 8$ $\times 2$ $2x + 4y = 20$
 $2x + y = 8$ $\times 1$ $2x + y = 8$
 \hline
 $3y = 12$
 $y = 4$
 $x + 2(4) = 10$
 $x + 8 = 10$
 $x = 2$

Modal Matematika
 $x + 2y = 10$
 $2x + y = 8$

Solve the following:

1. Create a mathematical model in the form of a system of linear equations with two variables based on the information above.
2. Determine the number of each package that the canteen must prepare to fulfill the students' breakfast needs.
3. After finding out how many of each package should be prepared, verify whether the quantities of Package A and Package B meet the students' needs, and calculate Bu Ros's total income from selling the meal packages.

Answer:
 Let: x = number of Package A purchased
 y = number of Package B purchased
 Given: -Package A contains 1 wrapped rice and 2 fried snacks
 -Package B contains 2 wrapped rice and 1 fried snack
 -The price of Package A is Rp 6,000
 -The price of Package B is Rp 8,000

1. Mathematical model
 $x + 2y = 10$
 $2x + y = 8$

Answer
 $x + 2y = 10$
 $2x + y = 8$ $\times 2$ $2x + 4y = 20$
 $2x + y = 8$ $\times 1$ $2x + y = 8$
 \hline
 $3y = 12$
 $y = 4$
 $x + 2(4) = 10$
 $x + 8 = 10$
 $x = 2$

Students successfully solve problems with the right steps and methods

Students can model mathematics based on problems

Figure 10. Example of Student Answer Results in Cycle 2.

Based on the students' work results in Figure 7, the students have analyzed the problems presented. This can be seen from how the students assume the variables x and y , where the variable x is the number of packages A purchased, and the variable y is the number of packages B purchased, according to the information obtained from the question. Furthermore, students are asked to model the problem in mathematical form, and the answers given are based on expectations. Thus, students have achieved the indicators of the specifications of the aspects or elements needed in solving the problem. Furthermore, in the second question, students are asked to solve the problem given. It can be seen that students have been able to solve the problem by using the appropriate solution steps and following the correct sequence. In this way, students show they have understood the problem-solving process correctly. Therefore, students have succeeded in making their own decisions and assessing something to achieve a goal based on specific criteria needed in the problem-solving process.

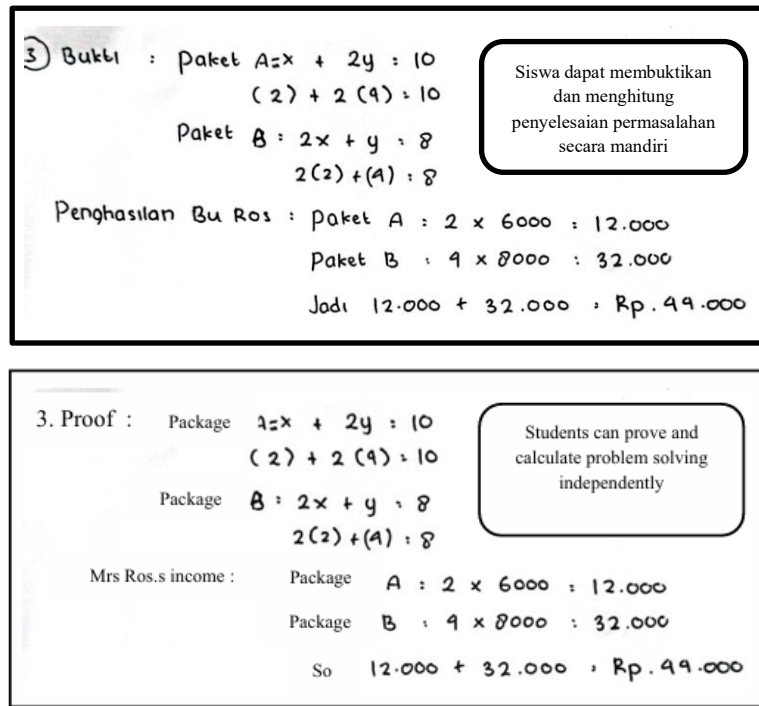


Figure 11. Example of Student Answer Results in cycle 2 (question 3).

In the third question, students can solve the problem, this is proven by the students being able to prove and calculate the expenses needed to make Gift Package 1 and Gift Package 2. Therefore, students have achieved the indicators in developing independent ideas or concepts needed in the problem-solving process.

Table 7. Recapitulation of Research Results

HOTs Indicator	Precycle (%)	Cycle 1 (%)	Cycle 2 (%)
Analyze information into its respective parts and determine the relationships between the parts.	60,3	76,7	81,8
Make decisions and assess things to achieve a goal based on specific criteria	57,7	71,5	80,1
Creating ideas/concepts, such as reorganizing existing parts to form a new structure, includes generating, planning, and producing.	51,7	67,2	75,8
Average	56,6	71,8	79,2
Category average	Very less	Enough	Enough

Based on the recapitulation table, the following is a recapitulation diagram of the research results to improve students' HOTS in each indicator and the average for each category.

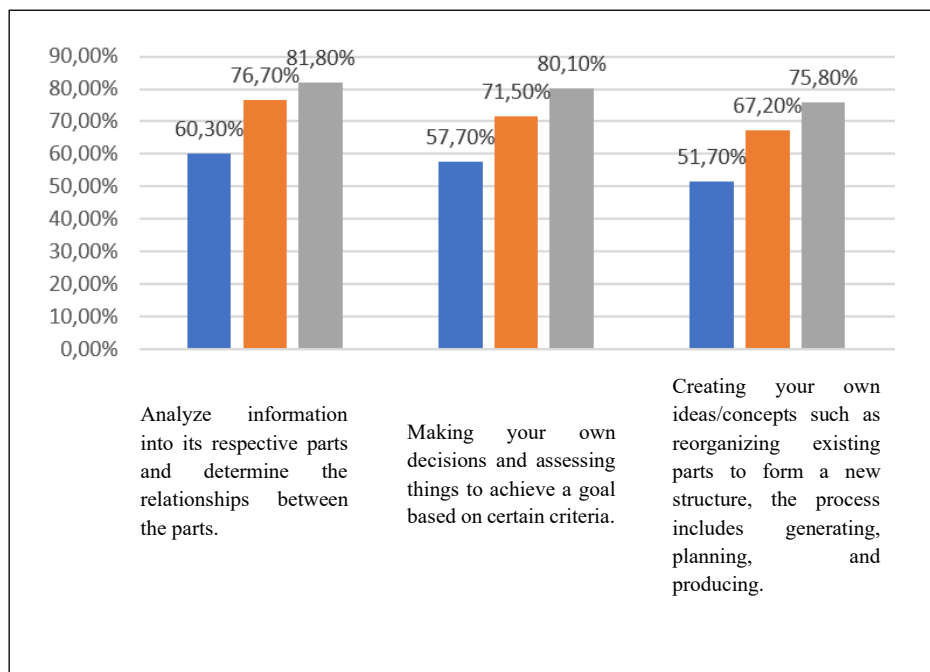


Figure 12. Recapitulation diagram of research results.

3.2 Discussion

This classroom action research (CAR) aims to improve students' HOTS in mathematics learning through learning with the Problem-Based Learning learning model based on mathematical literacy in class X MP 2 SMK Negeri 5 Madiun. By integrating the Problem-Based Learning learning model based on mathematical literacy into mathematics learning, it can create an environment that allows students to develop a deeper understanding of mathematical concepts and at the same time improve their HOTS in dealing with mathematical problems in real life (Utami, 2023; Wulandari & Badjeber, 2023).

The research showed students' HOTS in solving mathematical problems was still relatively low. In the precycle stage, students' abilities were far below the expected level of success, with an average completion of only 56.6%. After the Action was taken in the first cycle, there was a significant increase, but the results still did not reach the set completion criteria, with an average of 71.8%. Then learning was continued in the second cycle, where a significant increase occurred again, and this time students managed to achieve the completion criteria, with an average of 79.2%. These data show positive developments in students' HOTS after going through two learning cycles. This is in line with research (Husnidar & Hayati, 2021) that the Problem-Based Learning (PBL) learning model can stimulate students' critical and creative thinking by using real problems (Hirda Yanti, 2017). Research by Antonio & Prudente (2023) also states that with HOTS abilities, students are invited to identify, analyze, and solve problems, so that they can develop high-level thinking skills and application of knowledge in real-life situations.

4. Conclusion

Based on the research results, it can be concluded that the application of the Problem-Based Learning learning model based on mathematical literacy in solving mathematical problems in class X MP 2 SMK Negeri 5 Madiun has proven effective in improving students' HOTS. The implementation of PBL based on mathematical literacy helps students relate relevant mathematical concepts to real life, making it easier to understand and apply in the context of problem solving. This research was only conducted in one class and in two cycles. Therefore, it is suggested that further research be conducted in more than one class or across levels to see the consistency of the results more broadly.

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