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Effectiveness of Problem-Based Learning Model with Metacognition Strategy in View of Students' Mathematical Literacy and Disposition Ability

Ismul Hadi; Kana Hidayati

Yogyakarta State University, Indonesia

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Abstract

The problem in this study is that the learning model used in schools is still not appropriate, causing less than optimal student learning outcomes. This study aims to describe the effectiveness of the Problem Based Learning model with a metacognition strategy in terms of students' mathematical literacy and disposition. This research is quasi-experimental research using a pretest-posttest nonequivalent multiple-group design. The sample was selected by purposive sampling, and VIII A class using the PBL model with a metacognition strategy and VIII E using the PBL model were selected. Data collection in this study used tests and non-tests. Test to determine the average vector for two independent samples using Hottellings T^2 test followed by a one-sample t-test to test the effectiveness hypothesis. Research results: (1) The PBL model with metacognition strategy and the PBL model are effective in terms of mathematical literacy and disposition; (2) The PBL model with metacognition strategy is more effective than the PBL model in terms of mathematical disposition, but the effectiveness of both classes is the same in mathematical literacy.

Keywords: *Effectiveness; Scientific; Mathematical Connection Ability*

Introduction

The globalization era has a significant impact on several sectors, one of which is the education sector. Some of its impacts can be seen from changes in the learning paradigm, curriculum, and access to knowledge. The impact on learning can be seen from the implementation of distance learning or online learning with applications connected to the internet with learning media used by Zoom meeting applications, Google Meet, and others. The Directorate of High School Development of the Directorate General of Primary and Secondary Education of the Ministry of Education and Culture in 2017 explained that 21st-century learning is learning that includes technological capabilities, literacy, knowledge, skills, and attitudes.

Mathematics is a compulsory subject at the elementary to secondary school level. The mathematics education curriculum is oriented towards the 21st century in accordance with the current era. According to the *World Economic Forum* (2015), in facing 21st-century learning, there are three important parts that must be considered: basic literacy, student competence, and student character. The

Directorate of Primary and Secondary School Development of the Ministry of Education and Culture in 2017 concerning Guidelines for Implementation of 21st Century Skills Curriculum 2013 in High School explains the importance of literacy in an educational process. According to the Organization for Economic Co-operation and Development (OECD) (2019), mathematical literacy is defined as the capacity of students to formulate, use, and interpret mathematics in various contexts.

The Indonesian government has implemented the importance of mathematical literacy skills in the independent curriculum. Based on the decision of the head of the Education Standards, Curriculum, and Assessment Agency (BSKAP) number 033/H/KR/2022 on the revision of learning outcomes related to the cultivation of mathematical literacy, it must be implemented since Early Childhood Education (PAUD) is still an introduction (BSKAP, 2022b). Mathematical literacy also needs to be cultivated in students to be able to follow further education, which has been mentioned in Permendikbudristek RI in 2022 regarding graduate competency standards and Permendikbudristek RI in 2022 Number 7 regarding content standards (Permendikbudristek, 2022).

Mathematics in the independent curriculum is divided into 5 main elements, namely number, algebra, measurement, geometry, and data analysis and probability. Furthermore, the National Council of Teachers of Mathematics (NCTM) (2000) also mentions the first five content standards in mathematics, namely numbers and operations, algebra, geometry, measurement, and data analysis and probability. Algebra is one of the content elements in mathematics lessons, which is an important part of developing an understanding of mathematical concepts as well as abstract and analytical thinking skills. The importance of algebra in mathematics NCTM (2000) explains that teachers can start teaching algebraic concepts from an early age so that it becomes a strong foundation to prepare students for the next level.

The importance of algebra in the math curriculum is not in accordance with the current condition of students. Based on the results of an interview with one of the VIII grade teachers at SMP Negeri 15 Yogyakarta on April 2, 2024, it was explained that one of the materials considered difficult by students, which is the basis for other materials, is algebraic material. In addition, several studies also explain the condition of Indonesian students in algebra material, including Muchoko et al. (2019) and Noto et al. (2020) In their research results, they explain that some junior high school students in Indonesia still have epistemological obstacles, namely learning difficulties caused by the limited knowledge that students have in mathematical concepts related to algebraic form material. These student learning difficulties occur due to several factors, one of which is the lack of optimal teacher learning in teaching algebra material. Teachers play an important role in helping students in learning algebra when students build real problems into algebraic formulas (Agasi et al., 2017). Thus the role of the teacher in the learning process is very important in developing the right strategy in learning.

In addition to mathematical literacy skills, which are cognitive abilities, there are also other abilities that are important in maximizing the role of mathematics education, namely affective abilities. One of the affective abilities in mathematics learning is mathematical disposition. Based on BSKAP decree No. 008 of 2022, among the learning objectives in the independent curriculum section on mathematics subject objectives for all primary and secondary school levels is the development of an attitude that values the application of mathematics in everyday life. This includes curiosity, focus, and interest in learning the subject, as well as a resilient and confident approach to problem solving (BSKAP, 2022a). To improve students' problem-solving ability, it is crucial to consider mathematical disposition ability when teaching mathematics (Hutajulu et al., 2019). Thus, the importance of students' mathematical disposition in learning, especially mathematics, can be a positive response in student learning outcomes.

The importance of students' mathematical literacy and disposition skills is not in accordance with the current condition of students. Based on several studies, it is explained that the mathematical literacy of Indonesian students is still in the low category. Aisyah & Juandi (2022) conducted research related to mathematical literacy in Indonesia from 2013 to 2022 at the elementary, junior high, high school, and college levels. The results showed that students at the elementary, junior high, high school, and college levels of mathematical literacy were in the low category. Nurjanah & Saputra (2023) at the junior high school level in Sleman Regency Yogyakarta from 14 selected schools, the results showed that students' mathematical literacy skills were classified into five categories: 5.14% of students who could achieve a very high category, 5.37% high category, 14.02% medium category, 13.32% low category, and 62.15% very low category. The results of some of these studies can illustrate that some students in Indonesia still have low mathematical literacy skills.

Students' mathematical disposition is also known from several studies to be still in the low category. Putri et al. (2023) conducted research on the mathematical disposition of junior high school students in Yogyakarta with a selected number of students, namely 24 students. The results showed that the mathematical disposition of students who took courses and did not take courses outside of school hours had an average percentage value of 69.6% and 62.1%, respectively, in the low category. Research with similar results by Munafiah et al. (2023) of 23 8th-grade junior high school students shows the level of students' mathematical disposition is divided into 3 categories with the number of students in each category, namely 3 students in the high category, 12 students in the medium category, and 13 students in the low category. It is evident from the research findings that some Indonesian students still have low mathematical literacy skills. Thus, it is necessary to improve mathematical literacy skills for students (Junianto & Wijaya, 2019).

Low mathematical literacy skills can be caused by several factors, including personal, environmental, and instructional factors. Instructional factors include intensity, quality, and learning models. The learning model is one of the ways teachers can achieve students' mathematical literacy (Mahdiansyah & Rahmawati, 2014). Thus, the learning model used by teachers at school must be able to support the improvement of students' mathematical literacy skills.

The level of students' mathematical disposition from several studies is also still in the low category. Putri et al. (2023) conducted research on the mathematical disposition of junior high school students in Yogyakarta with a selected number of students, namely 24 students. The results showed that the mathematical disposition of students who took courses and did not take courses outside of school hours had an average percentage value of 69.6% and 62.1%, respectively, in the low category. Research with similar results by Munafiah et al. (2023) of 23 8th grade junior high school students shows that the level of mathematical disposition of students is divided into 3 categories with the number of students in each category, namely 3 students in the high category, 12 students in the medium category, and 13 students in the low category. It is evident from the research findings that there are some students who still have a mathematical disposition in the low category.

According to Putri (2023), there are two main components that influence students' mathematical disposition, namely educators and learning models. The role of educators in choosing appropriate and interesting learning models in learning can affect the learning process of students. Teaching quality is an important factor in students' mathematical disposition (Thomson & Pampaka, 2021). The teacher's failure to inspire or appreciate student learning is one of the reasons why students have a bad attitude towards mathematics or low student mathematics disposition (Putra et al., 2017). Furthermore, Muchoko et al. (2019) explained the condition of students when facing math tasks or problems such as, students easily give up when they do not find the right answer and students stop trying other ways of solving problems. This condition also occurred in some students at the research school when conducting observations for one week, then confirmed by the results of teacher interviews which stated that students easily give up if they face difficult problems or cannot find the answer. Such a situation is one of the factors for the low mathematical disposition of students.

From the explanation above, it can be seen the importance of mathematical literacy and disposition skills in supporting student learning success. However, the current condition of some students in Indonesia still requires special attention to improve these abilities. Muchoko et al. (2019) emphasized the important role of schools in creating a conducive learning environment to encourage the improvement of students' mathematical abilities. Teachers can develop learning innovations such as approaches, methodologies, and learning models to improve students' abilities (Nasrulloh & Nurlia, 2021). Faqiroh (2020) learning model has a considerable influence on the success of a student in an educational environment. Thus, the learning model applied by the teacher in the classroom can be a good solution in improving student learning outcomes.

The PBL model is a model that can encourage student competence and skills in dealing with 21st century learning through problem solving and application of knowledge in everyday life situations (Ali, 2019; Merrit et al., 2017; Pecore, 2012). The application of the right learning model in schools can help improve students' mathematical literacy and disposition. In addition to the right learning model, another aspect that plays an active role in learning is the learning strategy. One strategy that is considered appropriate to be combined with the Problem-Based Learning model is the metacognition strategy. Siagian et al. (2019) in their research explained that when students solve problems, metacognition questions from teachers can help students solve problems by directing their thought process to generate relevant and effective mathematical ideas in each stage of solving problems. Furthermore, it was also explained by Sutarto et al. (2022) in their research that each stage in PBL is able to encourage students' metacognition activities, especially when students are involved in group discussions. Thus, metacognition strategies can be applied in the PBL model so that each stage of student problem solving can be well controlled through metacognition questions posed by the teacher.

Son et al. (2020) explained that there are still some junior high school teachers who tend to use learning models that do not support active student participation. Furthermore, Wiyono et al. (2021), in their research results, emphasized that the application of performance-based learning, one of which is the PBL model in the learning process, is still very minimal, even though the application of performance-based learning can improve student learning outcomes. In accordance with the results of interviews with one of the teachers also during observation, namely the application of PBL in learning mathematics, it is still rarely used. The application of PBL in the classroom is only limited to group learning and discussion, not fully using PBL steps. In addition, the application of strategies in learning, especially metacognitive strategies, is also still rarely used. Therefore, it is important to explore the application of PBL with metacognition strategies as a new innovation in learning that can be used by teachers. Based on explanations from various existing studies and theories, the application of PBL models with metacognition strategies can be one solution in improving students' mathematical literacy and disposition skills.

Based on the description above, the Problem-Based Learning model can be an effective solution for teachers in improving students' mathematical literacy and disposition. However, it still needs to be studied further whether the application of metacognition strategies in the PBL model can have a more significant impact than PBL without these strategies. Therefore, this study aims to explore the effectiveness of the Problem-Based Learning model with metacognition strategies in improving students' mathematical literacy and disposition. This research is expected to provide new insights into the development of learning methods that are more innovative and oriented towards improving the quality of students' understanding and positive attitudes towards mathematics.

Method

This research uses a quantitative approach with pseudo-experimental research. Experimental research is a scientific method in which one or two more independent variables are actively manipulated to measure their impact on the dependent variable under controlled conditions. The design used in this research is a pretest-posttest non-equivalent control group design. This research uses pretest and posttest as a test to measure the ability before and after treatment. In this design there are two research groups consisting of two experimental class groups, the first experimental class group using the Problem-Based Learning model with metacognition strategies and the second experimental class group using the Problem-Based Learning model.

This research was conducted at SMP Negeri 15 Yogyakarta. The research was conducted in the odd semester of the 2024/2025 academic year. Starting from August to September 2024, there will be 6 meetings: 2 meetings for giving pretests and posttests and 4 meetings for learning. The time allocation for learning material to simplify algebraic forms in each week is 5 × 40 minutes (5 lesson hours). The population in this study were all VIII grade students of SMP Negeri 15 Yogyakarta. From the school data at SMP Negeri 15 Yogyakarta, 5 classes were obtained, which could be used as the population in this study. The sample used in this study was taken using a purposive sampling procedure.

The data collection techniques used in this study were tests and non-tests. Tests were given to measure student learning outcomes, while non-tests (questionnaires) were used to measure students' mathematical disposition. A literacy ability test and a mathematical disposition questionnaire were given before treatment (pretest) to see the initial condition of students and given after treatment, namely the application of the PBL model with a metacognition strategy (posttest). The data in this study were analyzed using test statistics. The effectiveness of the treatment was analyzed by a one-sample t-test, which compared the average before and after treatment. In addition, the comparison of effectiveness between groups was analyzed using an independent sample t-test.

Results and Discussion

Results

1. Learning Implementation Outcomes

The learning implementation activities of each meeting are known through the observation sheet filled in by the observer. The observer in this study was the math teacher in the class. The teacher in the classroom acts as an observer of learning; the tasks that teachers and students do during learning are recorded in the observation sheet. The results of the achievement of the implementation of learning activities between teachers and students are described in the following table.

Table 1. Achievement Results of Implementation of Learning Activities

Meeting	**Persentase**			
	Experimental Class 1		**Experimental Class 2**	
	Teacher activities	Student activities	Teacher activities	Student activities
2nd meeting	82%	73%	75%	70%
3rd meeting	91%	82%	80%	75%
4th meeting	95%	91%	95%	90%
5th meeting	100%	100%	100%	100%
Average	92%	86%	88%	84%

Based on Table 1, it can be seen that the implementation of learning at each meeting in experimental class 1 and experiment 2 with the average of each success in learning has been successful with 92% teacher activities and 86% students in experimental class 1 and 88% teacher activities and 84% student activities. These criteria are based on the criteria for effective learning implementation when the average $K \geq 80\%$ result is obtained. Thus the achievement of learning implementation meets the effective criteria used, namely $K \geq 80\%$.

The increase in the achievement of learning implementation in Table 1 shows that the activities of teachers and students at each meeting are quite good, although in the second and third meetings there is a modest increase. The increase in each meeting occurred due to several things, one of which was the implementation of learning evaluations at the end of each lesson, each meeting focused on one sub-chapter which was equipped with individual and group assignments, study groups that were made so that it was easy to discuss and WA groups were also provided to be able to ask questions related to material that had not been understood, and various types of questions at each meeting added to students' enthusiasm in learning.

2. Data on Mathematical Literacy Skills

Students' mathematical literacy skills in this study were measured using pretest and posttest instruments in the form of description questions consisting of 5 questions. The following Table 2 presents descriptive statistical data for students' mathematical literacy skills in experimental class groups 1 and 2.

Table 2. Descriptive statistics of mathematical literacy of experiment class 1 and 2

Description	**Experimental Classes 1**		**Experimental Classes 2**	
	Pretest	*Post-test*	*Pretest*	*Post-test*
Number of Students	34	34	34	34
Ideal Maximum Value	100	100	100	100
Maximum Value	53	90	53	88
Ideal Minimum Score	0	0	0	0
Minimum Values	15	68	8	60
Average	30,368	79,559	27,132	77,500
Variance	84,520	42,981	150,429	48,485
Standard Deviation	9,193	6,556	12,265	6,963

Based on Table 2, it can be seen that the average value of mathematical literacy skills of experimental class 1 and experiment 2 has increased. The increase can be seen from the value in the PBL class with metacognition strategies from 30.368 to 79.559, while the PBL class also increased from 27.132 to 77.500. As a result, the average posttest score for mathematical literacy skills of the PBL class using metacognition techniques is greater than the average score of the class. Both classes have exceeded the score of 75, which is the minimum limit of effectiveness of mathematical literacy in this study. Thus, the learning model used in each class was effective in improving students' mathematical literacy skills.

The increase in mathematical literacy skills seen from the pretest and posttest scores shows a positive effect of the application of the learning model provided. Students' active participation in learning is enhanced by the application of the learning model in each class. For example, students ask questions of the teacher or other groups and respond to their questions, participate in group discussions, and reflect in groups and independently. From the posttest results, it can also be seen that most students have reached the optimal level of understanding compared to the initial ability of students before being given learning. Optimal understanding refers to the level of student understanding of the material or concept being very good, as can be seen from the increase in student posttest results.

3. Mathematics Disposition Ability Questionnaire Data

In this study, pretest and posttest data in the form of a questionnaire with 16 statements were used to measure students' disposition in mathematics. The following Table 3 presents descriptive statistical data for students' mathematics disposition in experimental class 1 and experimental class 2.

Table 3. Descriptive statistics of mathematics disposition of experimental class 1 and 2

Description	Experimental Classes 1		Experimental Classes 2	
	Pretest	*Post-test*	*Pretest*	*Pretest*
Number of Students	34	34	34	34
Ideal Maximum Value	80	80	80	80
Maximum Value	59	74	60	68
Ideal Minimum Score	16	16	16	16
Minimum Values	43	51	37	42
Average	50,353	61,559	49,515	54,588
Variance	19,084	40,315	36,201	49,704
Standard Deviation	4,368	6,349	6,017	7,050

Based on Table 3, it can be seen that the average value of mathematical disposition ability of experimental class 1 and experiment 2 has increased. The increase was seen from 50.353 to 61.559 in the PBL class with metacognition strategies, while the PBL model class also experienced an increase from 49.515 to 54.588. Both classes have exceeded the value of 50, which is the minimum limit of effectiveness of mathematical disposition in this study. Thus, the learning model used in each class was effective in improving students' mathematical disposition.

Increasing mathematical dispositions can occur in strengthening dispositions in learning. Strengthening dispositions in learning refers to efforts to form positive attitudes or habits that support learning success. Some strengthening of mathematics disposition in learning is to form independent and responsible student characters from several tasks given individually and in groups, increase student motivation in every learning activity and enthusiasm in learning, develop students' collaborative attitudes by working in groups, and accustom students to reflect in learning, integrating ethical values in learning such as honesty in completing the assigned tasks.

Discussion

a. Effectiveness Test

Effectiveness tests aim to see whether learning data is effective in improving an ability or not. In this study, the data of the PBL class with the metacognition strategy and the PBL class were analyzed to see whether it was effective to improve students' mathematical literacy skills and mathematical disposition. The effectiveness test in this study used the one-sample t-test with a significance level of alpha = 0.05. The following results of the learning effectiveness test with the one-sample t-test are presented in Table 4.

Table 4. One Sample T test results

Learning model	**Variable**	***One sample t test***
PBL with metacognition strategy	Mathematical literacy	$t = 4{,}054$ $p - value = 0{,}000$
	Mathematical disposition	$t = 10{,}615$ $p - value = 0{,}000$
PBL	Mathematical literacy	$t = 2{,}093$ $p - value = 0{,}044$
	Mathematical disposition	$t = 3{,}794$ $p - value = 0{,}000$

Based on Table 4, it can be seen that in the posttest data of mathematical literacy of PBL classes with metacognition strategies, the $t = 4.054 > 2.034$ and $p - value = 0.000 < 0.05$, so H_0 is rejected. Therefore, it can be said that the PBL program that includes metacognition techniques succeeds in improving students' mathematical literacy at the 0.05 significance level. If $t = 10.615 > 2.034$ and $p - value = 0.000 < 0.05$ on the posttest data of mathematical disposition of PBL class that uses metacognition techniques, then H_0 is rejected. So, at a significance level of 0.05, it can be concluded that PBL class with metacognition strategy is effective in terms of students' mathematical disposition.

The effectiveness of PBL models with metacognition strategies in improving mathematical literacy and disposition is influenced by the learning models and strategies applied by teachers. Chrissanti & Widjajanti (2015) stated that the metacognition approach is effective in improving student learning achievement, which can be seen from the improvement of students' mathematical literacy and disposition skills in their research. Siagian *et al.* (2019) explained that when students solve problems, metacognition questions from teachers can help students by directing their thinking process, thus producing mathematically relevant and effective ideas at each stage of problem solving. Sutarto *et al.* (2022) also revealed that the involvement of metacognition activities, such as metacognition questions, in learning can motivate students to solve problems and be more involved in classroom learning. Moore (2015) explains that learning that uses metacognition strategies can provide a real improvement in student learning achievement. Furthermore, Hartman (2002) also explained that applying metacognition strategies in learning can maximize the effectiveness of learning because it is equipped with an evaluation process at each stage of learning. Thus, it can be concluded that the PBL model with metacognition strategies is effective in improving students' mathematical literacy and disposition.

In the posttest data of mathematical literacy of the PBL class, the value of $t = 2.093 > 2.034$, and $p - value = 0.044 < 0.05$, then H_0 is rejected. So, at a significance level of 0.05, it can be concluded that the PBL class is effective in terms of students' mathematical literacy skills. In the posttest data of the PBL class mathematical disposition, the $t = 3.794 > 2.034$, and the $p - value = 0.000 < 0.05$, then H_0 is rejected. So, at a significance level of 0.05, it can be concluded that the PBL class is effective in terms of students' mathematical disposition.

The effectiveness of the PBL model in improving mathematical literacy and disposition skills is influenced by the learning model used by the teacher. Pamungkas & Franita (2019) showed that the PBL model was effective in improving mathematical literacy skills, as seen from the percentage increase in students' abilities after learning. Research by Faisal et al. (2024) also explained that the application of the PBL model was able to improve students' mathematical literacy skills, as evidenced by the increase in students' posttest results. The same thing was found by Rahmalia et al. (2020), who reported an increase in the mathematical disposition of students taught using the PBL model. One of the factors that support this improvement is the focus of the PBL model on problems that are relevant to students' daily lives. Thus, it can be concluded that the PBL model is effective in improving students' mathematical literacy and disposition.

b. Comparison Test of Learning Models

Based on the results of the research that has been done, it is known that the average increase in students' mathematical literacy skills in PBL classes with metacognition strategies is higher than the PBL model. This shows the contribution of metacognition strategies in learning at each stage. In accordance with Ferdianto et al. (2018), in their research, results show that the PBL model class with metacognition strategies in learning problem-solving skills is higher than the PBL model. Furthermore, research by Rizka et al. (2018) showed that the improvement of problem-solving skills in the PBL model with metacognitive strategies was better than the class that only applied the PBL model.

The univariate mean difference test was conducted to determine which learning model was more effective on math literacy and disposition. The data used in this test is the posttest value of mathematical literacy and disposition skills in both experimental class groups. The following independent sample t-test results are presented in Table 5.

Table 5. Independent Sample T-Test Results

Uji tes	Variabel	*t-test*	*p-value*
independent sample t test	Literasi matematika	$t = 1{,}255$	$p - value = 0{,}106$
	Disposisi matematika	$t = 4{,}283$	$p - value = 0{,}000$

Based on Table 5, it can be seen that the P-value is more than $\alpha = 0.05$ for the math literacy variable. This means that the PBL model with metacognition strategies is not more effective or the same as the PBL model to improve students' mathematical literacy. Then the P-value is smaller than $\alpha = 0.05$ for the math disposition variable. It means that the PBL model with a metacognition strategy is more effective than the PBL model in improving students' mathematical disposition.

Based on the results of the independent sample t-test on each variable, mathematical literacy ability shows that the PBL model with metacognition strategies is not more effective than the regular PBL model in improving students' mathematical literacy. This result indicates that both learning models have equal effectiveness in improving students' mathematical literacy skills. In accordance with the results of research by Syarifudin et al. (2020), there was no significant difference in influence between the PBL model with metacognition strategies and the ordinary PBL model. This is due to the learning stages applied to the two classes not being much different, because experimental class 1 and experimental class 2 both use the PBL model.

There are several factors suspected to be the cause that can be found in the research, including the learning model applied in the classroom is still new, so it needs adjustment to the classroom environment, especially students and mathematical literacy problems that are rarely given by teachers in learning, making students difficult when solving the mathematical problems given, which results in several stages in the learning model not yet being optimal. Time management in learning is also a major obstacle as a result of the learning model used still needs adjustment and the cognitive condition of students who are not used to solving mathematical literacy problems.

Based on the results of the independent sample t-test on each variable, mathematical disposition shows that the PBL model with metacognition strategies is more effective than the PBL model in terms of students' mathematical disposition. This shows that the average scores of mathematical literacy skills of both classes are statistically significantly different. This result shows that the PBL model with a metacognition strategy is more effective than the PBL model in improving students' mathematical disposition.

One of the main factors that cause the PBL model with metacognition strategies to be more effective than the PBL model is the different learning steps used. The learning steps in the PBL model with metacognition strategies are thought to be closer to mathematical disposition, as evidenced by the increase in pretest and posttest data previously described. Some supporting theories explain that mathematical disposition is closer to metacognition strategies. Quigley et al. (2018) explained that metacognition is also called a strategy in organizing and directing the learning process in the classroom with metacognition questions. According to Moore (2015), metacognition skills that can be shown in learning after being given metacognition questions from the teacher are that students can monitor learning progress from each completion of learning reflection, correct calculation errors and solution strategies used at the review stage, and change learning conditions as desired. Overall, metacognition skills help students become more independent, effective, and aware of their own learning process.

Conclusion

The results of data analysis of this study indicate that the use of the problem-based learning (PBL) model with a metacognition strategy is effective in terms of the average value of mathematics literacy skills and mathematics disposition. The PBL model is effective in terms of the average value of mathematics literacy skills and mathematics disposition, and the PBL model with a metacognition strategy is more effective than the PBL model in terms of students' mathematics disposition. The PBL model with a metacognition strategy is not more effective or equal to the PBL model in terms of students' mathematical literacy skills.

Based on the results of this study, several recommendations are given, including to educators to be able to carry out learning by applying PBL models with metacognition strategies. This is because this learning is proven to be effective in terms of students' mathematical literacy and disposition. Suggestions for future researchers are to expand studies related to the application of problem-based learning with metacognitive strategies with more diverse aspects, such as reviewing different aspects of mathematical skills, aspects in terms of learning materials, and aspects of the student population.

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