

IMPLEMENTATION OF PBL-HOTS MODEL TO STUDENTS MATHEMATICAL LITERACY SKILL

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Received 18 December 2021; Received in revised form 07 March 2022; Accepted 22 March 2022

Abstrak

Tujuan dilakukannya penelitian ini adalah untuk mengetahui kemampuan literasi matematika siswa dalam menyelesaikan soal HOTS sebelum dan setelah penerapan model PBL-HOTS pada materi gradien garis singgung yang saling tegak lurus. Selain itu, tujuan dari artikel ini untuk mengetahui tanggapan siswa terhadap pembelajaran model PBL-HOTS yang dilaksanakan. Penelitian ini merupakan penelitian deskriptif dengan pendekatan kualitatif. Teknik pengumpulan data yang digunakan berupa tes, angket, dan dokumentasi. Subjek penelitian ini adalah 25 siswa kelas VIII SMP Labschool UPI yang memiliki kemampuan matematika tinggi, sedang dan rendah. Penelitian ini menggunakan 15 soal tes dan 19 pernyataan pada angket yang terdiri dari 7 pernyataan negatif dan 12 pernyataan positif. Teknik analisis dalam penelitian ini terdiri dari tiga tahapan, yaitu 1) reduksi data (*data reduction*); 2) paparan data (*data display*); 3) penarikan kesimpulan dan verifikasi (*conclusion drawing/verifying*). Hasil penelitian menunjukkan kemampuan literasi matematika siswa dalam menyelesaikan soal HOTS sebelum diterapkannya PBL-HOTS adalah 18 siswa teridentifikasi gagal, 1 siswa teridentifikasi kurang, 4 siswa teridentifikasi cukup, dan 2 siswa teridentifikasi baik sekali. Sedangkan kemampuan literasi matematika siswa setelah diterapkannya model PBL-HOTS adalah 9 siswa teridentifikasi gagal, 1 kurang, 8 cukup, 3 baik, dan 4 baik sekali. Selain itu, dari hasil persentase angket sikap siswa terhadap pembelajaran yang dilaksanakan menunjukkan rata-rata dari 25 siswa kelas VIII SMP Labschool UPI memiliki sikap baik terhadap pembelajaran yang dilaksanakan atau rata-rata siswa menyukai atau cocok dengan pembelajaran menggunakan model PBL-HOTS dalam meningkatkan kemampuan literasi matematika. Hasil penelitian ini diharapkan dapat dijadikan informasi mengenai kemampuan literasi matematika siswa SMP dan dapat bermanfaat dalam bidang pendidikan khususnya pengajaran matematika, dimana dapat menggunakan model PBL-HOTS dalam meningkatkan kemampuan literasi matematika siswa SMP.

Kata kunci: HOTS; Literasi Matematika; PBL

Abstract (12pt)

The purpose of this study was to determine the mathematical literacy ability of students in solving HOTS questions before and after applying the PBL-HOTS model on gradient of perpendicular line. In addition, the purpose of this article is to find out student responses to the PBL-HOTS model learning implemented. This research is descriptive research with a qualitative approach. Data collection techniques were used tests, questionnaires, and documentation. The subjects of this study were 25 students of class VIII SMP Lab school UPI who had high, medium, and low mathematical abilities. This study uses 15 test questions and 19 statements in the questionnaire consisting of 7 negative statements and 12 positive statements. The analysis technique in this study consists of three stages, namely 1) data reduction; 2) data display; 3) drawing conclusions and verification. The results showed that students' mathematical literacy skills in solving HOTS questions before the implementation of PBL-HOTS were 18 students identified as failing, 1 student identified as lacking, 4 students identified as adequate, and 2 students identified as very good. Meanwhile, the students' mathematical literacy skills after implementing the PBL-HOTS model were 9 students identified as failing, 1 less, 8 enough, 3 good, and 4 very good. In addition, from the results of the percentage of students' attitude questionnaires towards the learning carried out, it shows that on average 25 students of class VIII SMP Lab school UPI have a good attitude towards the teaching carried

DOI: <https://doi.org/10.24127/ajpm.v11i1.4588>

out or on intermediate students like or match learning using the PBL-HOTS model in improving their mathematical literacy ability. The results of this study are expected to be used as information about the mathematical literacy skills of junior high school students. They can be helpful in education, especially mathematics teaching, which can use the PBL-HOTS model in improving the mathematical literacy skills of junior high school students.

Keywords: HOTS; Mathematical Literacy; PBL.



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INTRODUCTION

Mathematical literacy is a person's ability to efficiently formulate, use, and interpret mathematics in various contexts and problems in everyday life. The intended mathematics includes all concepts, procedures, facts, and mathematical tools in calculations, numbers, and spaces. In terms of process, this ability is not only limited to the ability to calculate but also how to communicate, reason, and other mathematical thinking processes. Mathematical literacy skills are an essential part of mathematics. This is in line with Sari (2015) statement, which states that mathematical literacy is still foreign to some people but crucial to have in this 21st century. The facts found indicate that the literacy ability of junior high school students in Indonesia is still relatively low. The 2018 PISA results show that students' mathematical literacy in Indonesia is lacking, where Indonesia scores 379 and ranks 73rd out of 78 participating countries (OECD, 2019).

Program for International Student Assessment (PISA) is an international study to test students' mathematical literacy skills. The mathematical literacy domain in PISA relates to students' capacity to analyze, reason, and communicate opinions effectively when formulating, solving, and interpreting mathematics in various situations. In PISA, mathematical literacy is defined as an individual's

capacity to develop, employ, and interpret mathematics in multiple contexts. It includes reasoning mathematically and using mathematical concepts, procedures, facts, and tools to describe, explain and predict phenomena. It assists individuals to recognize the role that mathematics plays in the world and make the well-founded judgments and decisions needed by constructive, engaged, and reflective citizens. Mathematical literacy is an individual's ability to formulate, use and explain mathematics in various contexts. This includes mathematical reasoning and operating concepts, procedures, facts, and mathematical tools to describe, explain and predict events. This guides individuals to recognize the role of mathematics in life and make sound judgments and constructive and reflective decision-making.

The characteristics of PISA questions that require reasoning and problem-solving skills can be used to see the extent of mathematical literacy skills. Then it can be known whether students are classified as High Order Thinking or Low Order Thinking. According to Setiawan (2014), math literacy questions for levels 1 and 2 are included in the lower-scale group. The math literacy questions for levels 3 and 4 are in the middle-scale category, and levels 5 and 6 for math literacy in the high-scale group with contexts that are completely unexpected by students.

DOI: <https://doi.org/10.24127/ajpm.v11i1.4588>

According to Santoso & Setyaningsih (2020), mathematical literacy skills can be improved by training students to solve Higher Order Thinking Skills (HOTS). HOTS questions will help students develop their ability to think critically, logically, metacognitively, reflectively, and creatively because they must consider the analysis, evaluation, and creative stages in HOTS questions.

According to Sari (2017), one of the eighth-grade math materials in the 2013 curriculum closely related to other math materials is straight-line equations. Students need good mastery of the straight line equation material before studying other mathematical material at the next level. Students can be given straight-line equation questions with the HOTS type to hone their skills in higher-order thinking and improve students mathematical literacy skills. HOTS is the ability to connect, manipulate, and change knowledge and experience that already exists critically and creatively in making decisions to solve problems in new situations. According to Saputra (2016), HOTS is a thinking process of students at a higher cognitive level developed from various mental concepts and methods and taxonomies of learning such as problem-solving methods, Bloom's taxonomy, and taxonomies learning, teaching, and assessment.

This HOTS includes problem-solving skills, creative thinking skills, critical thinking, argumentation skills, and decision-making abilities. According to Widodo & Kadarwati (2013), with HOTS, students will be able to clearly distinguish ideas or ideas, argue well, solve problems, construct explanations, and hypothesize understand complex things more clearly. According to Dinni (2018), HOTS will occur when a person

associates new information with information already stored in his memory, relates it, and rearranges and develops the knowledge to achieve a goal or find a solution to a problematic situation. The primary purpose of HOTS is to improve students' thinking skills at a higher level, especially those related to the ability to think critically in receiving various information, think creatively in solving a problem using the knowledge they have, and make decisions in complex situations (Saputra, 2016). In Bloom's Taxonomy, the level of higher-order thinking skills lies at the level of analyzing (C4), evaluating (C5), and creating (C6).

Pranoto (2011) shows that 76.6% of Indonesian students at the junior high school level (SMP) are 'blind' in mathematics. Ironically, this condition is found amid various achievements of Indonesian children in international science olympiads. The phenomenon of 'blindness' of mathematics experienced by junior high school students directly results in the low learning outcomes of students' mathematics. Therefore, the learning process carried out must facilitate students to have good mathematical literacy skills. Learning mathematics in the classroom should provide sufficient opportunities for students to practice and develop mathematical literacy skills as an essential part of improving student learning outcomes. The 2013 curriculum recommends several learning approaches that lead to students' habit of solving independent problems. One of them is the Problem Based Learning (PBL) learning model (Kebudayaan, 2013). PBL is a learning model in which students are faced with authentic (real) problems. They are expected to be able to construct their knowledge, develop higher-order

DOI: <https://doi.org/10.24127/ajpm.v11i1.4588>

thinking skills and problem-solving skills, make students independent and increase their confidence.

Some of these understandings of PBL explain that learning using the PBL model will significantly contribute to students' mathematical literacy abilities. According to Hidayat et al. (2019), a learning model that can stimulate students to improve their mathematical literacy skills is a problem-based learning model. This is because this model is an innovation in learning. With this PBL model, students are genuinely optimized through a systematic group or teamwork process so that students can empower, hone, test, and develop their thinking skills on an ongoing basis (Tan, 2009). The results of research from Pamungkas & Franita (2019) showed that learning mathematics using problem-based learning was able to improve students' mathematical literacy skills.

Based on the background described, information is obtained that the mathematical literacy ability of junior high school students is low, and mathematical literacy ability can be improved by training students to solve HOTS-type questions. In addition, PBL has a very high contribution to students' mathematical literacy skills; this is reinforced by the research results of Hidayat et al. (2018) and Pamungkas & Franita (2019). However, their research is limited to the use of PBL in improving mathematical literacy skills. Thus, researchers are interested in conducting research by integrating HOTS content into the HOTS model or, in other words using the PBL-HOTS model to improve the mathematical literacy skills of junior high school students. This research aims to determine students' mathematical literacy skills in solving HOTS

questions before and after the implementation of the PBL-HOTS model. In addition, the purpose of this article is to find out student responses to the PBL-HOTS learning model implemented. The results of this study are expected to be used as information regarding the description of the mathematical literacy abilities of junior high school students. They can be helpful in education, especially mathematics teaching, which can use the PBL model in improving the mathematical literacy skills of junior high school students.

METHOD

This research is descriptive research with a qualitative approach. Data collection techniques used tests, questionnaires, and documentation. The subjects of this study were 25 students of class VIII SMP Lab school UPI. They were selected based on their mathematical abilities, namely several students representing low, medium, and high skills. This is done so that mathematical literacy skills can be identified as a whole from various levels of student abilities. This study uses 15 test questions with tangent gradients perpendicular to each other and 19 statements in the questionnaire consisting of 7 negative statements and 12 positive statements. Before the test and questionnaire were given to students, both were tested. The test used the Rasch model with the help of Winstep software. The analysis results show the reliability of 0.9 questions in the excellent category (Sumintono & Widhiarso, 2014). However, the criteria for examining questions according to Boone et al. (2014) in terms of the MNSQ outfit, ZSTD outfit, and PT Measure Corr, it is known that two

DOI: <https://doi.org/10.24127/ajpm.v11i1.4588>

questions are invalid so we discarded the question.

The data analysis stage in this study includes the process of data reduction, data presentation, and concluding. Reducing data means summarizing, choosing the main things, focusing on the essential things, looking for themes and patterns, and removing unnecessary ones. So that the reduced data will provide a clearer picture and make it easier for researchers to carry out further data collection and look for it when needed. After the data is reduced, the next step is to display the data, which is to show the information

simply in the form of words, sentences, narratives, tables, matrices, and graphs with the aim that the researcher masters the data that has been collected as a basis for drawing the correct conclusions.

RESULT AND DISCUSSION **Students' Mathematical Literacy Ability in solving HOTS questions before and after the implementation of the PBL-HOTS model**

The following (table 1) are the results of students' mathematical literacy skills before and after implementing the PBL-HOTS model.

Table 1. Comparison of mathematical literacy skills results before and after implementing the PBL-HOTS model

Mastery Level	Identification	Before applying PBL-HOTS	After applying PBL-HOTS
91% - 100 %	Very well	2	4
81% - 90 %	well	0	3
71% - 80 %	Enough	4	8
61% - 70%	Not enough	1	1
≤ 60%	Fail	18	9
Total		25	

Based on table 1, information was obtained that before implementing the PBL-HOTS learning model, students' mathematical literacy skills were still relatively low. This is because students are only used to solving routine questions, so they are not trained in solving non-routine questions, in this case, HOTS questions. The observations on the learning process in class VIII of SMP Lab school UPI showed that the questions given to students as exercises or math assignments were routine and unrelated to the students' real lives. Questions like this do not develop aspects of students' mathematical literacy. This is in line with the statement made by Efriani et al. (2018);

Masjaya & Wardono (2018); Pereira et al. (2022). They found that mathematical literacy skills were low because students were used to routine questions so that when students were given non-routine questions, they had difficulties. Therefore, the solution to overcome this problem is to apply PBL because it has been proven that PBL can improve students' mathematical literacy skills. The results of the theoretical study proposed by Hidayat et al. (2019); Pamungkas & Franita (2019); Widiaswara & Pertiwi (2018) showed that using PBL can train students' mathematical literacy skills; this is because the PBL model can facilitate students to carry out authentic

DOI: <https://doi.org/10.24127/ajpm.v11i1.4588>

investigations in solving real problems. In addition to this, with PBL, students' thinking abilities can be optimized through a systematic group or teamwork process.

When compared with mathematical literacy skills before implementing the PBL-HOTS model, it can be seen that students' mathematical literacy skills are better when compared to learning before the performance of PBL-HOTS. This is because learning the PBL model presents contextual problems so that it stimulates students to learn to solve problems in real life. Students are allowed to understand and solve various real-life issues such as determining which locations are possible to visit if they have a certain amount of money, the speed of charging cellphone batteries if the percentage of battery charging is known for every 1-minute addition, the slope of a path that wheelchair users will traverse, and determine the product of the gradient of two perpendicular lines from the illustration of several positions of windmill vanes. These problems use the HOTS indicator with the basic competence of analyzing linear functions (as straight-line equations) and interpreting their graphs related to contextual issues.

These problems are close to students' daily lives so that students do not feel foreign and are motivated to solve these problems based on the mathematical concepts that have been studied. The results of Istiandaru et al (2014) research reveal that students' mathematical literacy skills can increase if the material being taught is directly related to everyday life so that it can foster student interest in learning. One of the cognitive learning theories proposed by Robert M. Gagne, called Gagne's learning theory, states that

learning mathematics needs to be linked to real-life so that it trains students to investigate and solve problems, learn independently, have a positive attitude towards mathematics, and know-how to learn (Gagne, 1985).

De Graaff & Kolmos (2003) stated that problem-based learning is a method or learning approach that can facilitate students to solve problems in various situations and contexts to use their skills effectively. In PBL learning, students will face contextual problems or real problems that will help them construct their knowledge. At this stage, students will use their literacy skills and interpret them in authentic contexts. In this way, they use their mathematical literacy skills and develop them.

The PBL model is a learning model that applies contextual problems to stimulate students to learn to solve real-world problems (Kemendikbud, 2013). This PBL learning model has six steps, namely: 1) Student orientation to the problem; at this stage, the teacher's role is to explain the learning objectives, explain everything needed, motivate students to be involved in the problem-solving activities they choose. 2) organize students to learn; at this stage, the teacher helps students define and organize learning tasks related to the problem. 3) guiding individual and group investigations; at this stage, the teacher encourages students to collect appropriate information and carry out experiments or observations to get explanations and solve problems. 4) develop and present the work; at this stage, the teacher helps students plan and prepare appropriate works carry out experiments or observations to get explanations, and solve problems. 5) analyze and evaluate the problem-solving process; at this stage, the teacher helps students reflect or

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evaluate their investigations and the processes they use.

This study uses HOTS questions because HOTS questions are questions that can train and improve students' literacy skills. In addition, the HOTS questions given are non-routine questions. Steen et al. (2007) explain that the problems used in learning should not be used just any problem. The problem used should meet the four characteristics: natural, complex, engaging, and substantial. The problem that describes the general context and the real problem is the real thing. Complicated problems are problems that require students to identify the right questions. Not only that, the problems presented should not just be a matter of ordinary stories. According to Wijaya et al. (2015), the problems presented should not just be about familiar stories, but problems that have excess information or are unknown.

Student responses to the PBL-HOTS learning carried out.

After passing through the pretest, implementing the PBL-HOTS model and the posttest, the researchers distributed questionnaires to 25 students of class VIII. The questionnaire contains students' attitudes towards learning the PBL-HOTS model. The results obtained are as follows.

Table 2. Results of student attitudes towards PBL-HOTS learning carried out.

Statement	Index	Scale
1	62,4%	Good
2	79,2%	Good
3	66,4%	Good
4	86,7%	Very well
5	63,2%	Good
6	78,4%	Good
7	81%	Very well

Statement	Index	Scale
8	73,6%	Good
9	76,8%	Good
10	83%	Very well
11	93,3%	Very well
12	73,6%	Good
13	72%	Good
14	67,2%	Good
15	81%	Very well
16	72,8%	Good
17	73,6%	Good
18	76%	Good
19	72,8%	Good
Average	75,42%	Good

From the results of the percentage of students' attitude questionnaires in table 2, it can be seen that students' attitudes are good towards learning carried out with an average rate of 75.42%. This is obtained from student questionnaires as many as 5 statements achieving a very good scale and 14 statements reaching a good scale. From the results of this questionnaire, it can be concluded that 25 students of class VIII SMP Lab school UPI have a good attitude towards the learning carried out. On average, students like or match learning using PBL-HOTS to improve mathematical literacy skills. This good attitude is caused by a new atmosphere when learning. Learning with PBL-HOTS provides opportunities for students to play an active role in solving problems and the teacher only as a facilitator. The process shows the involvement of students in every learning process. The results of this study are in line with research conducted by Muharomah & Setiawan (2020); students have a positive attitude towards learning mathematics using the PBL model.

HOTS is students' thinking process at a higher cognitive level developed from various mental concepts

DOI: <https://doi.org/10.24127/ajpm.v11i1.4588>

and methods and learning taxonomies such as problem-solving methods, Bloom's taxonomy, and taxonomies of learning, teaching, and assessment. According to Saputra (2016), the primary purpose of HOTS is how to improve students' thinking skills at a higher level, especially those related to the ability to think critically in receiving various types of information, think creatively in solving problems using the knowledge they have and make decisions in solving problems. Complex situations. Higher-order thinking skills are cognitive operations that are much needed in thinking processes that consist of short-term memory. If it is associated with problem-solving, Krulik & Jesse (1999) mentions high-order thinking skills, including Critical and Creative.

Krulik & Jesse (1999) explain problem-solving is a process in which each individual uses the acquired knowledge, skills, understanding, which is then used in new situations. The process begins by comparing and concluding; then, students must integrate what they have learned and apply it to new situations. The pattern of problem-solving is (1) reading a problem, (2) developing information, (3) choosing a strategy, (4) solving the problem, and (5) checking again. Meanwhile, based on Bloom's Taxonomy (1956), HOTS is in the Analysis, Synthesis, and Evaluation stages. Analysis means identifying and understanding parts of the material or the whole material. Synthesis means combining elements to form a new whole, and evaluation means examining or assessing carefully based on several criteria. Bloom's taxonomy was revised by Anderson & Krathwohl (2010); the revision stated that HOTS is at the levels of Analyze, Evaluate, and Create.

Analyze is the ability to separate concepts into several components and relate to each other to understand the image as a whole. Evaluation is the ability to determine the degree of something based on specific norms, criteria, or benchmarks. Create is the ability to combine elements into a new whole and broad form or create something original. The revision of Bloom's taxonomy conducted by Anderson & Krathwohl (2010) focuses more on how the cognitive domain is more lively and applicable for educators and learning practices expected to assist educators in processing and formulating learning objectives and efficient assessment strategies.

High Order Thinking Skill occurs when students can change or create the knowledge they know and produce something new. Through HOTS, students will be able to distinguish ideas or ideas clearly, argue well, solve problems, construct explanations, hypothesize, and understand complex things more clearly, where this ability clearly shows how students reason. Similar to literacy, mathematical literacy skills and High Order Thinking Skills are limited to memorizing skills and how to apply mathematics in everyday life to solve a problem and communicate it.

Program for International Student Assessment (PISA) is an international study to test students' mathematical literacy skills. The mathematical literacy domain in PISA relates to students' capacity to analyze, reason, and communicate opinions effectively when formulating, solving, and interpreting mathematics in various situations. In PISA, mathematical literacy is defined as "an individual's capacity to develop, employ, and interpret mathematics in multiple

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contexts. It includes reasoning mathematically and using mathematical concepts, procedures, facts, and tools to describe, explain and predict phenomena. It assists individuals to recognize the role that mathematics plays in the world and make the well-founded judgments and decisions needed by constructive, engaged, and reflective citizens. Mathematical literacy is an individual's ability to formulate, use and explain mathematics in various contexts. This includes mathematical reasoning and operating concepts, procedures, facts, and mathematical tools to describe, explain and predict events. This guides individuals to recognize the role of mathematics in life and make sound judgments and constructive and reflective decision-making.

The characteristics of PISA questions that require reasoning and problem-solving skills can be used to see the extent of mathematical literacy skills. Then it can be known whether students are classified as High Order Thinking or Low Order Thinking. PISA also assigns a basic level of knowledge on a scale of 6 as the highest level and 1 as the low level. According to Johar (2012), at level 1, students can use their knowledge to solve routine problems and solve problems with general contexts. Level 2, students can interpret issues and solve them with formulas. Level 3, students can carry out procedures to solve the problems and choose solving strategies. Level 4, students can work effectively with models, select and integrate different representations, and then relate them to the real world. Level 5, students can work with models for complex situations and can solve complex problems. Level 6, students use their reasoning to solve mathematical

problems, make generalizations, and formulate and communicate their findings. Literacy questions for levels 5 and 6 belong to a group of questions with a large scale with contexts that are completely unexpected by students. Because levels 5 and 6 are included in questions that require High Order Thinking. This is in line with Setiawan, (2014) opinion, which explains that math literacy questions level 1 and 2 include groups of questions with a lower scale or low order thinking. Then the level 3 and 4 math literacy questions have a group of questions with a medium scale or middle-order thinking. Math literacy questions at levels 5 and 6 include a group of questions with a large scale or high order thinking.

Pranoto (2011) research shows that 76.6% of Indonesian students at the junior high school level (SMP) are 'blind' in mathematics. Ironically, this condition is found amid various achievements of Indonesian children in international science olympiads. The phenomenon of 'blindness' of mathematics experienced by junior high school students directly results in the low learning outcomes of students' mathematics. Therefore, the learning process carried out must facilitate students to have good mathematical literacy skills. Learning mathematics in the classroom should provide sufficient opportunities for students to practice and develop mathematical literacy skills as an essential part of improving student learning outcomes. The 2013 curriculum recommends several learning approaches that lead to students' habit of solving independent problems. One of them is the Problem Based Learning (PBL) learning model. Several studies have found that PBL can improve students' mathematical literacy skills.

DOI: <https://doi.org/10.24127/ajpm.v11i1.4588>

Indah et al. (2016); Pamungkas & Franita (2019; Pratiwi & Ramdhani (2017) found an increase in students' mathematical literacy skills after the implementation of the PBL learning model. In addition, Paloloang et al. (2020) found the overall effect size of the application of PBL on students' mathematical literacy skills was 0.830, with a standard error of 0.142. This finding indicates that the implementation of PBL in Indonesia is quite effective because it has a high positive effect in improving students' mathematical literacy skills. From this explanation, it can be concluded that PBL and HOTS can contribute to enhancing students' mathematical literacy skills.

CONCLUSION AND SUGGESTION

Based on the description above, it can be concluded that students' mathematical literacy skills can be improved by using the PBL-HOTS model. This can be seen from the results of comparing mathematical literacy skills before and after the implementation of the PBL-HOTS model. The comparison results show that students' mathematical literacy skills using PBL-HOTS are better when compared to learning before the performance of PBL-HOTS. This is because learning the PBL-HOTS model presents contextual problems so that it stimulates students to learn to solve problems in real life. In addition, from the results of the percentage of student attitude questionnaires towards the learning carried out, it shows that on average, 25 students of class VIII SMP Lab school UPI have a good attitude towards the teaching carried out or on intermediate students like or match learning using PBL-HOTS in improving literacy skills. This good attitude is

caused by a new atmosphere when learning. Learning with PBL-HOTS provides opportunities for students to play an active role in solving problems and the teacher only as a facilitator. This process shows the activeness of students in each learning process. For further research on the PBL-HOTS model, it is recommended to specifically focus on testing the effectiveness of the PBL-HOTS model in improving mathematical literacy skills. Therefore, it can be added with statistical tests and then described based on the answers or can be added with interviews so that the information or research results become complete and robust.

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