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The Influence of Student Worksheets Based on PBL-Mathematical Literacy on Problem-solving in Junior High Schools in Bengkulu

Miftahul Izzati[1], Effie Efrida Muchlis[2*], Edi Susanto[3], Sonya Fiskha Dwi Patri[4], Febri Kristiani[5], Pratiwi Disha Stanggo[6]

[1,2,3,4,5,6]Universitas Bengkulu

*Corresponding author: effie_efrida@unib.ac.id

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ABSTRACT

Purpose – Problem-solving is a key component in mathematics education, as emphasized by the NCTM. At SMAN 6 Kota Bengkulu, students' performance in trigonometry remains low due to weak problem-solving skills and limited engagement. This study investigates the effect of the Problem-Based Learning (PBL) model, supported by mathematical literacy worksheets, on students' mathematical problem-solving abilities.

Methodology – A quasi-experimental design was employed using the Nonequivalent Posttest-Only Control Group Design. The population consisted of all 10th-grade students at SMAN 6 Bengkulu. Two classes were selected: Class XJ as the experimental group, taught using the PBL model with literacy-based worksheets, and Class XI as the control group, taught using a Cooperative Learning model. Data were collected through a mathematical problem-solving test and analyzed using an independent t-test.

Findings – Results showed a significant difference in performance, with t_{value} = 3.713 > t_{critical} = 1.673, indicating that the experimental group outperformed the control group in problem-solving ability.

Novelty – This study offers a novel integration of PBL with mathematical literacy worksheets—an underexplored instructional approach in secondary trigonometry education. By combining content-specific literacy materials with a problem-based pedagogy, the study addresses a gap in research focused on enhancing higher-order thinking in mathematics.

Significance – The findings provide empirical support for incorporating literacy-based, student-centered strategies in mathematics instruction. The study has implications for curriculum design aimed at improving problem-solving performance in similar educational contexts.

Keywords: Mathematical literacy; Problem-solving ability; Problem-based learning, Mathematical literacy

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1. Introduction

One of the subjects that must be studied at every level of education, from elementary school to college, is mathematics. This is because mathematics can help someone have logical ideas to apply, systematic thinking skills, and think critically in solving a problem (Pratama & Mardiani, 2022). In addition, mathematics is related to life, so it can help solve problems in everyday life. However, students do not like studying mathematics. One of the main reasons for students' reluctance toward mathematics is their lack of understanding and self-perception of low content knowledge, which leads them to have a negative perception. Students stated that their negative perception was not new but instead something they knew since elementary school (Aguilar, 2021). This has an impact on students' mathematics learning outcomes.

There are five abilities that NCTM suggests students must have in learning mathematics, namely (1) problem-solving ability, (2) representation ability, (3) communication ability, (4) reasoning ability, and (5) mathematical connection ability. One of the basic mathematical abilities that needs to be achieved is problem-solving ability. Mathematical problem-solving is a person's ability to use knowledge, understanding, and skills to solve non-routine mathematical problems. There is no direct procedure to solve it, so gradual steps are needed to achieve the expected goals (Haety & Putra, 2022). Good problem-solving skills also affect mathematics learning outcomes because problem-solving skills can help deal with problems in different subjects and everyday life.

Based on the results of observations during MBKM-AM at senior high school SMA in Bengkulu for 3 months, it was found that the learning outcomes in trigonometry material achieved by students and the results of the mid-semester assessment for the odd semester of the 2023/2024 academic year for participants showed that the achievement of mathematics learning in grade X was still low. Based on the results of interviews with teachers, the low mathematics scores of students were caused by weak problem-solving abilities, and students tended to be passive during learning. Efforts that can be made to overcome the problems that have been conveyed are to apply a learning model that can improve students' problem-solving abilities.

Ahmad & Asmaidah (2018) stated that teaching problem-solving skills to students is an activity carried out by a teacher to encourage students to accept and respond to questions submitted and guide students to arrive at problem-solving. The right learning model can help students solve problems (Oktania & Djami, 2022, p.41). One of the models that can be applied is the Problem-Based Learning model. Problem-based learning is a learning model that can be supplemented with a context, one of which is with real problems so that students can think critically, solve problems, and gain knowledge about concepts (Poon et al., 1997). The problems given in learning are expected to help students so they can solve problems (Yusri, 2018).

Teaching materials are needed in student worksheets for learning using the Problem-Based Learning learning model. Student worksheets is a teaching material in the form of sheets of paper containing summary material and instructions for implementing learning tasks that must be done by students referring to basic competencies (Prastowo, 2015). Therefore, it is necessary to have appropriate student worksheets to help the learning process so that learning objectives can be achieved, one of which is student worksheets based on mathematical literacy.

Mathematical literacy is a person's ability to formulate, use, and interpret mathematics from various contexts of everyday life (Poernomo et al., 2021). According to the OECD (2019), Mathematical literacy often requires designing strategies to solve problems mathematically. This involves critical control processes that guide individuals to recognize, formulate, and solve problems effectively. This skill is characterized by selecting or developing a plan or strategy for using mathematics to solve problems arising from a task or context and guiding its implementation. This mathematical ability can be demanded at every stage of the problem-solving process.

Meaningful education requires a connection between learning materials and students' real lives. In this case, the implementation of Problem-Based Learning (PBL) based teaching materials that raise contextual problems is crucial, especially for students who live in coastal areas. Local contexts, such as the coastal environment of Bengkulu, reflect students' daily realities and can trigger active engagement and deeper understanding of mathematical concepts.

Research by Susanta et al. (2023) emphasizes that the use of contexts that are close to students' lives increases the relevance and meaningfulness of learning. This is reinforced by the findings of Baidawi et al. (2023), which show that increasing mathematical literacy has a positive impact on mathematics learning outcomes. In addition, learning methods that support contextual learning, such as Problem-Based Learning (PBL), can be applied because PBL can equip graduates with the skills needed to overcome the challenges of today's dynamic and constantly changing world (Knopfel et.al, 2024). Therefore, there is an urgent need to develop PBL-based teaching materials that are contextually adapted to the coastal environment. This adaptation not only enhances students' motivation and literacy, but also supports inclusive and contextual education efforts according to the characteristics of the area where students live. Based on the description of the problem and the results of previous research, researchers will conduct up-to-date research using mathematical literacy-based student worksheets in a coastal context.

2. Methods

2.1 Types of research

The type of research used in this study is a quasi-experiment. Type of this research has a control group but cannot function fully to control external variables that affect the implementation of the experiment (Sugiyono, 2019). This quasi-experimental study was used to determine the effect of the problem-based learning model assisted by the mathematical literacy student worksheet on the mathematical problem-solving ability of grade X on statistics material of senior high school in Kota Bengkulu.

2.2 Population and Sample

This study's population was all grade X senior high school students in Bengkulu (in this research, SMA Number 6 Bengkulu City). The sample in this study was the experimental class for grade XJ and the control class for grade XI. The experimental class was chosen randomly by considering the suitability of the curriculum and the students' ability level, while the control class was chosen based on the availability of classes that did not receive experimental treatment and had similar characteristics to the experimental class.

2.3 Procedure

In the initial stage of the research, at this stage the researcher carries out activities, namely determining the research time adjusted to the material learning time at school, selecting the population and research sample, compiling teaching modules according to the learning model

and student worksheets based on mathematical literacy, compiling a final test (posttest) in the form of descriptive questions, conducting expert validation of the instruments used in the research, conducting trials in the trial class, analyzing the test results data of the final test (posttest). Several carriewere d out to analyze the final test data, namely question validity, question reliability, question difficulty level, and question discrimination test, as well as analyzial data to determine the suitability of the questions for use in the research. Implementation stage: at this stage, the researcher carries out activities, namely carrying out learning activities in the experimental class and control class according to the learning implementation plan, and conducting a final test (posttest) in the experimental class and control class to determine the problem-solving abilities of students. At the Research evaluatio: Inage, the re,searcher carries out activities, namely managing research data, discussing research results, and compiling research results.

2.4 Data, Instruments, and Data Collection

The type of data used to determine students' mathematical problem-solving abilities is quantitative data. Quantitative data is obtained by providing problem-solving ability test questions in essays totaling six items with statistical material. After the test, the answer sheets will be collected and scored according to the mathematical problem-solving indicator rubric.

2.5 Data Analysis Techniques

The data analysis technique used is hypothesis testing. First, a prerequisite test is carried out, namely the normality test and the homogeneity test of variance on the sample. After it is known that the sample class data is usually distributed and homogeneous, the next step is to conduct a hypothesis test using the t-test for independent samples. The hypothesis test aims to determine whether the mathematical problem-solving ability of students in the experimental class is better than that of the control class.

3. Results and Discussion

3.1 Results

The Problem-Based Learning model was applied to mathematical literacy students' worksheets in the experimental class. Students were given a posttest after learning using the Problem-Based Learning model assisted by mathematical literacy students' worksheets on statistics material. The posttest was in the form of essay questions and was followed by 28 students. The recapitulation of the results of the mathematical problem-solving abilities of students in the experimental in Table 1.

Table 1 - Mathematical Problem-Solving Ability of Experimental Treatment

Description	Value
Number of students	28
Average value	57.34
The highest score	90.28
Lowest value	16.67
Standard deviation	22.75

Based on Table 1, it is found that the class using the Problem-Based Learning model has an average that shows that the posttest results of problem-solving ability are still below the Learning Objective Achievement Criteria, namely 70, the range of the highest and lowest values in the experimental class is very far at 73.61, and the standard deviation of 22.75 indicates that the data has a varied distribution or students have diverse abilities.

The Cooperative Learning model was applied in the control class. Students were given a posttest after the learning process using the Cooperative Learning model on statistics material. The posttest given was in the form of essay questions that were the same as the experimental class. It was attended by 30 students and was carried out on May 15, 2024. The recapitulation of the results of the mathematical problem-solving abilities of students in the control class is as Table 2.

Table 2 - Mathematical Problem-Solving Ability of Control Treatment

Description	Value
Number of students	30
Average value	29.35
The highest score	66.67
Lowest value	6.94
Standard deviation	16.89

Based on Table 2, it is found that the class using the cooperative learning model has an average that shows that the posttest results of problem-solving ability are still below the learning objective achievement criteria, which is 70, the range of the highest and lowest values in the experimental class is very far at 59.73 and the standard deviation of 16.89 indicates that the data has a varied distribution or the abilities of students vary.

Students' mathematical problem-solving abilities are achieved from the posttest scores in the experimental and control classes. Based on the test results, it was found that there was a significant influence of the problem-based learning seen from the posttest scores of the experimental class, which were higher than the posttest scores of the control class. The following is the percentage of achievement of students' problem-solving abilities:

Table 3 - Problem-Solving Ability of Experimental and Control Treatment

No	Value	Category	Experimental		Control	
			Number of Students	Percentage	Number of Students	Percentage
1	$90 < N \leq 100$	Very high	1	3,57%	0	0%
2	$70 < N \leq 90$	Tall	10	35,7%	0	0%
3	$50 < N \leq 70$	Currently	7	25%	4	13%
4	$40 < N \leq 50$	Low	3	10,7%	6	20%
5	$0 < N \leq 40$	Very Low	7	25%	20	67%

Based on Table 3, the posttest score obtained shows that the level of problem-solving ability of students in the control class is four students in the medium criteria, six students in the low criteria, and 20 students in the very low criteria. So, the percentage level of mathematical problem-solving ability for the control class is in the interval p <20 with a very low category.

In the post-test score obtained, the level of problem-solving ability of students in the experimental class is one student in the very high criteria, 10 students in the high criteria, seven students in the medium criteria, three students in the low criteria, and seven students in the very low criteria. So, the percentage level of mathematical problem-solving ability for the experimental class is in the interval 20 <p ≤ 40 with a low category.

Based on the hypothesis test conducted on the posttest value of the problem-solving ability of students in the experimental and control classes, which shows that the t count value = 3.713> t(table) = 1.673, then H0 is rejected. A comparison of the average posttest values of students in the experimental class showed an average value of 57.34 and a variance of 517.17. In contrast, students in the control class got an average value of 29.35 and a variance of 284.50. This shows that learning with the Problem-Based Learning model is better for statistical material on problem-solving ability than learning the cooperative learning method.

3.2 Discussion

The study results indicate that using the Problem-Based Learning model assisted by mathematical literacy student worksheet influences students' mathematical problem-solving abilities. This can be seen from the hypothesis test results with the t-test for independent samples, which shows that the significance value <significance level. These results align with research conducted by Ulva et al. (2020), which indicates that there is an influence of implementing the Problem-Based Learning learning model on students' mathematical problem-solving abilities.

The Problem-Based Learning learning model is more effective because this model is a learning approach focusing on students using real-world problems. The goal is to build student knowledge, train independence and self-confidence, and develop students' problem-solving thinking skills (Arends, 2012). The Problem-Based Learning model is very effective in helping students with mathematical problem-solving skills. This is because, according to Nisak & Istiana (2017), the Problem-Based Learning learning model provides opportunities for students to develop their skills in solving mathematical problems.

Problem-Based Learning has proven effective in strengthening students' problem-solving abilities and increasing their interest in mathematics. Through this approach, students are invited to actively explore contextual problems so that they can develop critical and creative thinking skills in a more meaningful way. The implementation of PBL also encourages students' emotional and cognitive involvement, which leads to increased learning motivation and curiosity about mathematical concepts. The implication is that the application of PBL in mathematics learning is critical to producing students who are not only competent in solving problems, but also enthusiastic about exploring the world of mathematics in more depth (Nisa et al., 2023). In addition, Susanto and Retnawati (2016) stated that problem-based learning can improve students' high-level thinking skills, which are very much needed in facing the challenges of the 21st century. Thus, the integration of problem-based learning in the learning process is not only relevant for improving learning outcomes but is also a key strategy in forming student profiles that are adaptive, independent, and ready to face complex problems in the real world.

During the learning process, the researcher observed that the implementation of the Problem-Based Learning (PBL) model, supported by mathematical literacy worksheets, helped students improve their mathematical problem-solving skills. This model also contributed to enhancing students' confidence in thinking and fostering collaborative attitudes within groups. Similar findings were reported by Rahmawati et al. (2023), who stated that the application of the Problem-Based Learning model in mathematics learning helps students find meaning in their learning process. In line with these findings, Jumaidin et al. (2024) also concluded that the implementation of Problem-Based Learning is effective in improving students' mathematical literacy.

Based on the research conducted by following the stages of the Problem-Based Learning model, supported by mathematical literacy worksheets and problem-solving indicators, it was

concluded that the implementation of Problem-Based Learning has a positive influence on students' mathematical problem-solving abilities. This finding is consistent with the study by Susino et al. (2024), which demonstrated a significant impact of Problem-Based Learning in enhancing students' mathematical problem-solving skills. Furthermore, research by Pratiwi et al. (2023) also revealed that the Problem-Based Learning model positively influences the improvement of students' problem-solving abilities and collaboration skills during the learning process.

4. Conclusion

Based on the results of the research that has been conducted in Grade X of senior high school on statistics material, it can be concluded that there is an influence of the Problem-Based Learning model assisted by students' worksheet mathematical literacy on the mathematical problem-solving ability of in Grade X of senior high school in Bengkulu. This can be seen from the results of the hypothesis testing of the t-test for independent samples, namely t count = 3.713> t (table) = 1.673, then H0 is rejected. These findings imply the need to integrate the PBL model in mathematics curriculum design, especially in material that requires critical thinking skills such as statistics. Apart from that, teachers need to receive special training in compiling and implementing student worksheets that supports mathematical literacy so that learning is more effective. Future research can be focused on testing the effectiveness of similar models on other materials, developing interactive digital student worksheets, and longitudinal studies to see the long-term impact on improving problem-solving abilities.

This research is expected to be a choice of learning models teachers will use. Teachers can accustom students to each stage or process of working on questions wholly and correctly. Other researchers are expected to be able to conduct further research as a development of this research on different materials and schools. Problem-based learning models and student worksheets can be developed for other mathematical-solving abilities.

Conflict of Interest

The authors declare no conflicts of interest.

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