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THE EFFECT OF PROBLEM BASED LEARNING (PBL) MODEL ON PROBLEM SOLVING ABILITY OF STUDENTS AT SMA NEGERI 14 MEDAN

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ABSTRACT

This study aims to determine the effect of applying the problem based learning (PBL) learning model on problem solving abilities of students at SMA Negeri 14 Medan. The research method used is quantitative research with quasi-experiment non-equivalent control group design. The sample was selected using purposive sampling. The experimental class consisted of 25 students from class X IPA 4, while the control class consisted of 25 students from class X IPA 2. Data collection for this study was conducted using a pretest and posttest. The results showed that the average pretest score of students in the experimental class was 46 and the average posttest score was 80, while in the control class, the average student pretest score was 45 and the average score was posttest average of 52. The results of hypothesis testing using a one-sample t-test indicated that the problem based learning (PBL) model has a positive effect to increase the problem solving abilities of students.

Keywords: Problem based learning model, problem solving abilities of students

INTRODUCTION

Physics is a branch of natural science that encompasses a compilation of facts, concepts, principles, laws, postulates, and theories related to natural occurrences. Physics is a scientific discipline that investigates phenomena using a systematic approach based on a scientific mindset, resulting in a scientific outcome consisting of three fundamental constituents, namely universally applicable concepts, principles, and theories (Trianto, 2010). Nevertheless, in the process of studying physics, students are not solely expected to acquire a deep understanding of the concepts, but also to apply the concepts they have already comprehended in resolving physics problems (Sujarwanto *et al.*, 2014).

In the process of acquiring knowledge in physics, students need to be actively engaged, frequently practice problem-solving, engage in discussions and ask questions. The teacher's role is to act as a facilitator in group work, class discussions, and experimental activities, and to connect real-world problems with the subject matter being taught, following the established learning steps. Furthermore, teachers are expected to possess the skills to design effective teaching strategies and methods, ensuring that the learning process is optimized (Hastuti *et al.*, 2016).

Based on the results of student questionnaires and teacher interviews at SMA Negeri 14 Medan, it was found that the learning process was still primarily teacher-centered, the learning model used in the physics learning process had not made students able to understand physics concepts, learning activities had not been able to improve abilities and results, students were unable to tackle different variations of physics questions presented to them.

Moving on from the problems that have been outlined, we require a solution that can address these challenges so that students can actively and scientifically engage in resolving physics problems that arise during the learning process. Moreover, this problem-solving ability is one of the important skills that students must have in 21st-century learning.

According to Vitasari & Trisniawati (2017), problem solving ability refers to an individual's capacity to employ their knowledge in order to solve a problem. Individuals who can solve problems well can find the right solution to overcome the problems they face. There are several stages of problem solving ability. The stages of problem solving ability (Heller & Heller Patricia, 2010) encompass visualize the problem, describe the problem in physics term, plan a solution, execute the plan, and check and evaluate.

Therefore, the problem based learning (PBL) model can be utilized to facilitate the learning of physics. Trianto (2010) suggests that problem based learning involves introducing challenging situations to learners, with the problems presented being tailored to real and meaningful situations, making it easy for learners to conduct investigations and inquiries. According to Ariyana *et al.*, (2018), in the problem based learning model there are five syntax, namely students orientation to problems, organizing students to study, guiding individual as well as group investigation, develop and present the word, and analyze and evaluate the problem solving.

This study builds on prior research that utilized the problem based learning (PBL) model to enhance problem solving abilities. Firmansyah's (2022) findings indicate that the use of the PBL model has a significant positive impact on students' ability to solve physics problems. Similarly, Radika's (2022) research revealed that the PBL model influenced students' problem solving proficiency in the sound wave domain. This aligns with Ammalia Nurjannah's (2017) study, which demonstrated that the PBL model is effective in boosting students' problem solving skills in physics.

Given the above description, the author intends to determine the effect of applying the problem based learning (PBL) learning model on problem solving abilities of students at SMA Negeri 14 Medan.

RESEARCH METHOD

This study was conducted at SMA 14 Medan in the Even Semester Academic Year 2022/2023. The population for this study included all students in class X IPA at SMA Negeri 14 Medan totaling 250 students. The sample for this study was selected using purposive sampling. The experimental class consisted of 25 students from class X IPA 4, while the control class consisted of 25 students from class X IPA 2. The research design used in this study was a quasi-experimental non-equivalent control group design. The test included a pretest and posttest, which consisted of 7 descriptive questions. In this research, the prerequisite tests consisted of normality test homogeneity and one-sample t-test and two-sample t-test.

RESEARCH RESULTS AND DISCUSSION

Research Result

The pretest results of students' problem solving abilities can be found in Table 1.

Table 1. Pretest Data on Problem Solving Ability

Control Class		Experiment Class	
Interval	**Frequency**	**Interval**	**Frequency**
34-37	4	34-38	4
38-41	5	39-43	5
42-45	2	44-48	2
46-49	9	49-53	9
50-53	1	54-58	1
54-57	4	59-63	4
Average	45	Average	46

The results of the pretest data normality test in the experimental class and control class obtained can be seen in Table 2.

Table 2. Normality Test of Pretest Data in the Experiment Class and Control Class

	Class	L_{count}	L_{table}	Description
Pre test	Experiment Class	0.1658	0.1732	Normal
	Control Class	0.1505	0.1732	

The results of the pretest data homogeneity test in the experimental class and control class obtained can be seen in Table 3.

Table 3. Homogeneity Test for Pretest Data

Data	F_{count}	F_{table}	Description
Pretest	1.1891	1.9838	Homogeneous

From the table above, it was found that the data is normal and homogeneous, because $L_{count} < L_{table}$ and $F_{count} < F_{table}$.

2.Description of Posttest of Problem Solving Ability

Meanwhile for posttest results of students' problem solving abilities can be found in Table 4.

Table 4. Posttest Data on Problem Solving Ability

Control Class		Experiment Class	
Interval	Frequency	Interval	Frequency
40-43	2	71-74	7
44-47	4	75-78	5
48-51	12	79-82	4
52-55	3	83-86	6
56-59	3	87-90	2
60-63	2	91-94	1
Average	52	Average	80

The results of the posttest data normality test in the experimental class and control class obtained can be seen in Table 5.

Table 5. Normality Test of Posttest Data in the Experiment Class and Control Class

	Class	L_{count}	L_{table}	Description
Pos test	Experiment Class	0.1676	0.1732	Normal
	Control Class	0.0892	0.1732	

The results of the pretest data homogeneity test in the experimental class and control class obtained can be seen in Table 6

Table 6. Homogeneity Test for Posttest Data

Data	F_{count}	F_{table}	Description
Postest	1.1687	1.9838	Homogeneous

From the table above, it was found that the data is normal and homogeneous, because $L_{count} < L_{table}$ and $F_{count} < F_{table}$.

To find out students' problem-solving abilities for each indicator, an analysis of problem-solving ability indicators was carried out based on the scores obtained by students. The average score of student answers for each indicator of problem solving abilities can be seen in Table 7.

Table 7. Analysis of Problem Solving Ability Indicators

No	Indicator	Control Class		Experiment Class	
		Pretest	Postest	Pretest	Postest
1	Visualize the Problem	2.6	1.7	5.7	10.6
2	Describe the Problem in Physics Term	13.8	15.2	15.8	18.6
3	Plan a Solution	16.5	17.3	15.4	19.8
4	Execute the plan	11.4	14.4	8.6	17.3
5	Check and Evaluate	0.5	3.2	0.7	13.5
	Total	45	52	46	80

From the analysis of the problem solving ability indicators, it can be explained that in the first indicator, namely visualize the problem, the experimental class score was 10.6 and the control class was 1.7. In the second indicator, namely describing the problems in physics term, the experimental class score was 18.6 and the control class was 15.2. In the third indicator, namely plan solutions, the experimental class score was 19.8 and the control class was 17.3. On the fourth indicator, namely execute a plan, the score for the experimental class was 17.3 and for the control class was 14.4. While for the last indicator, namely check and evaluate solutions, the score for the experimental class was 13.5, and the control class was 3.2. The average score on each indicator of students' problem solving abilities in the experimental class was higher than that of the control class.

To test the hypothesis is done with 2 tests, namely two-sample t-test for pretest data and one sample t-test for posttest data. Table 8 presents the result of the hypothesis test calculation for the pretest ability in experiment class and control class.

Table 8. Hypothesis Test for Pretest Data

Pretes Data	T_{count}	T_{table}	Description
Experiment Class Control Class	0,5643	2,0086	Students' initial problem-solving ability is same

It is obtained that $T_{count} < T_{table}$ or 0.5643<2.0086. This means that H_0 is accepted and H_a is rejected, so the initial problem solving abilities of the experimental class students are the same with the control class.

Table 9 presents the result of the one sample t-test for posttest ability in experiment class and control class.

Table 9. Hypothesis Test for Postest Data

Postest Data	T_{count}	T_{table}	Description
Experiment Class Control Class	17.8016	1,6759	There is a significant difference in the final problem-solving abilities of students

It was found that $T_{count} > T_{table}$ or 19.7595 > 1.6759. This means that H_0 is rejected and H_a is accepted, so there are significant differences in students' problem solving abilities between the experimental class and the control class.

In addition, an analysis of student learning activities was carried out by taking into results of observations that had been made in the learning process which can be seen in Table 10 below.

Table 10. Analysis of Student Learning Activities

No	Indicator	(%)
1	Orient students to the problem	76,75
2	Organizing student learning	84,75
3	Assist independent and group investigations	85,5
4	Develop and present the work	90,5
5	Analyze and evaluate the problem solving process	83,23
	Average	84,15

Based on Table 10, it was found that in the first indicator, namely the phase of orienting students to problems, the percentage score obtained was 76.75% in the active student category. In the second indicator, namely the phase of organizing student learning, a score percentage of 84.75% was obtained in the active student category. In the third indicator, namely the phase of assisting independent and group investigations, a score percentage of 85.5% was obtained in the very active student category. In the fourth indicator, namely the phase of developing and presenting the results of the work, a percentage score of 90.5% was obtained in the very active student category and the last indicator, namely the phase of analyzing and evaluating the problem-solving process, obtained a score percentage of 83.25% in the active student category.

Discussion

This research shows that the use of a problem based learning model (PBL) has a significant effect on students' problem solving abilities at SMA Negeri 14 Medan. This is supported by the average pretest score of the students in the experimental class, which falls within the medium range at 45, and the average posttest score in the high range at 80. Conversely, in the control class, the average pretest score of the students was 46 in the medium range, and the average posttest score was 52, also in the medium category.

Through the analysis of the hypothesis using a two-sample t-test for pretest data and one-sample t-test for posttest data, it was discovered that the two-sample t-test was $T_{count} < T_{table}$ or 0.5481<2.0086, so it can be concluded that the initial problem solving abilities of experimental class students the same as the control class on Momentum and Impulse material. Based on the one-sample t-test, it was discovered that $T_{count}>T_{table}$ or 19.6137>1.6759 so it can be concluded that there are differences in the results of students' problem solving abilities in the experimental class with the results of students' problem solving abilities in the control class. Thus, it can be concluded that the sample is normal and homogenous because $L_{count}<L_{table}$ and $F_{count}<F_{table}$. The average student activity score reached 84.15% in the active category.

The reason why students' problem solving ability is better with the problem based learning model (PBL) than the conventional learning model is that students in the experimental group were presented with real-life problems right from the beginning of their learning process. Throughout their learning journey, students in the experimental class are more engaged in finding solutions to problems given by the teacher compared to students in the control class who follow conventional learning models. This aligns with Radika's viewpoint (2022) that problem solving abilities of students improve with problem based learning as they are trained to solve problems and find solutions. Students are more involved and motivated in their learning as they develop their knowledge and retain the information they have learned. The difference between this study and Radika's research lies in the utilization of Polya's theory as a foundation for developing students' problem solving abilities. The steps of problem solving according to Polya's theory include understanding the problem, making a problem solving plan, implementing the plan, and checking again.

Moreover, another factor that contributes to the superior problem solving abilities of students in the experimental class compared to the control class is their capability to independently or collaboratively solve problems in groups. This helps students deepen their understanding of problems and the approaches to solving them through cooperation and collaboration. During discussions, students feel more confident in expressing their opinions and engaging in debates with their classmates or teachers. This supports Surif's (2013) perspective that interaction with peers aids students in sharing information and enhancing their communication skills.

Another factor that leads to an increase in problem solving abilities is that students in the experimental class, who are taught using the PBL model, are more proactive in tackling problems. This aligns with the findings of Suardani *et al.* (2014), which state that the problem solving process engages students' sensory-motor skills, making them active and proficient problem solvers. This is also supported by the research outcomes of Aristawati *et al.* (2018), which demonstrate that the problem based learning model encourages students to be more active in problem solving and exploring their knowledge, motivating them to compete with their peers. Based on the aforementioned explanation, it can be concluded that the problem based learning model is more effective in improving students' physics problem solving abilities compared to conventional learning.

In this study, researchers applied a problem-based learning model (PBL) which this model had an impact on students' problem-solving abilities. Even though the researcher has followed the procedures that have been made in the planning stage, obstacles are still found during the use of this model in each phase. Obstacles encountered included confusion and inactivity of students in the first stage, indiscipline of some students when forming groups in the second stage, lack of discipline and confidence in a small number of students in conducting discussions and experiments in the third and fourth stages, as well as some students having difficulties in concluding learning in the second stage. The final stage is by connecting the experimental results and the concept.

However, this can be minimized to achieve better results with the same learning model. Researchers can work closely with subject teachers at the school so that teachers can directly observe the atmosphere and teaching and learning activities during the research. It is also beneficial for researchers to exchange ideas and share information with subject teachers. Researchers can collaborate with subject teachers in the school to enable them to witness firsthand the environment and learning practices during their research. Additionally, it is advantageous for researchers to interchange concepts and disseminate knowledge with teachers who specialize in the subject matter.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

It can be concluded that there is the effect of applying the Problem Based Learning (PBL) learning model on problem solving abilities of students at SMA Negeri 14 Medan. The average value of the problem-solving ability of students who studied using the PBL model reached 80, while students who studied with the conventional model only reached 52. The average score of each indicator of problem-solving ability using the PBL model was also higher than that of the conventional model. In addition, the average student activity score reached 84.15% in the active category.

Recommendations

Based on the findings of this study, there are several suggestions to enhance the teaching and learning of physics in the classroom, including:

1. The problem based learning PBL model should be implemented in schools that have sufficient resources and where students are accustomed to using problem-based learning during instruction.
2. Future researchers to allocate more time so that the research can be conducted more effectively and yield more satisfactory outcomes.
3. Further research is suggested to incorporate diverse forms of media in the PBL model to engage students' interest throughout the learning process. Further research on the PBL model can also be developed in other physics learning topics.

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