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Teaching at The Right Level Approach with the Problem Based Learning Model Effect on Physics Problem Solving Ability

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Abstract. Physics lessons are among the most interesting because they relate to actual events. Physics learning requires an independent learning process that equips students with problem-solving skills. This study examines how the Problem-based Learning (PBL) model and the Teaching at the Right Level (TaRL) strategy affect the resolution of physics issues involving momentum and impulse topics. There are 375 grade XI students participating in a quasi-experiment with a non-equivalent control group design. The TaRL technique and the PBL model had a substantial impact on physics problem-solving; there is a significant influence on students' problem-solving abilities and the magnitude of the influence, according to the results of the independent sample t-test, which had a significance value (Sig. 2-tailed) of 0.001, which is less than 0.05. Cohen's d = 1.08 (high) and the N-gain score was 0.61 (moderate) for the TaRL method and PBL model, respectively.

Keywords: teaching at the right level, problem based learning, problem solving

1. Introduction

Physics lessons are among the most interesting because they relate to actual events. Physics learning requires an independent learning process that equips students with problem-solving skills [1]. The low problem-solving ability is suspected to be due to students not understanding the stages of solving Physics problems and being less active in learning physics [2]. One learning approach teachers can apply to practice problem-solving skills is Teaching at The Right Level (TaRL).

The TaRL approach is a learning approach initiated by Pratham, which was developed specifically to optimize the improvement of students' abilities [3]. Students with the same ability level are grouped in a learning process regardless of their grade level and age but the students' achievement [4]. The progress of the learning outcomes is measured by periodic evaluations [5]. In implementing the TaRL approach, there are four steps: assessment, grouping, basic skills pedagogy, and mentoring & monitoring [6]. In addition to the learning approach, a learning model is also needed to support the formation of problem-solving skills, namely problem-based learning (PBL) [7].

The PBL model is a learning model that involves students in solving problems contextually. The PBL model emphasizes problem-solving activities in learning that can improve students' abilities [8]. Through the PBL model, students learn through problem-solving activities that can enhance their thinking skills. The PBL model is very suitable for physics learning because it is a learning model that presents a hands-on, problem-based experience to students. PBL cannot be separated from the problem-solving method because it is rooted in the problem-solving method [9]. Problem-solving is a complete process for students in learning physics [10]. One of the problem-solving methods proposed by Polya is the following: 1) understand the problem. 2) Develop a plan, 3) Implement the plan. 4) review the answer (look back) [11].

Students are encouraged to collaborate on problem-solving in the PBL model, beginning with the TaRL approach. Students' involvement in learning is increased by the TaRL approach, which gives them chances to participate [12] actively. One teaching strategy that helps students grasp material by their cognitive capacities is the TaRL approach [13]. This suggests that the TaRL and PBL methods help enhance students' problem-solving abilities when studying physics. This is consistent with research by Nugroho et al. [14], which shows that educators may create a stimulating and encouraging learning environment where students actively participate and develop a deeper understanding as they learn. Students develop not only theoretical knowledge but also practical skills in problem-solving. This increases student engagement and strengthens the practical application of what is learned in everyday life [15].

Based on the results of interviews with physics teachers, it is known that the Independent Curriculum has been implemented at SMA Negeri 6 Bengkulu City since the 2023/2024 school year. Physics lesson hours are 5 JP × 40 minutes a week, and learning using the package books available in the library; the teacher uses various learning resources and media, such as package books from the library, LKS, and YouTube materials displayed using projectors. The teaching methods that are often used are PBL and Inquiry. Information was obtained that the minimum competency value in physics (KKM) was 75. Then, from the assessment data and daily exam results conducted by teachers, around 50-60% of students in grade XI still have difficulty in determining what steps they should take to solve physics problems and problems given by teachers. It is concluded that many students are passive and have difficulty understanding the material and solving problems in physics material. Students are highly dependent on gadgets. Students have difficulty focusing and are not motivated to learn because of the habit of using gadgets.

TaRL approach with PBL model in the context of physics problem-solving. By combining these two pedagogical strategies, this learning method aims to create a more personalized learning experience that meets students' current level of understanding and then progressively challenges them with real-world problems. The TaRL approach ensures that students receive targeted instruction aligned with their specific learning needs, while the PBL model encourages active problem-solving and critical thinking. This method is relatively unexplored in physics education, offering the potential for more effective learning outcomes. This study aimed to determine the effect and extent of the impact of the TaRL approach and PBL model on physics problem-solving skills.

2. Method

The experimental and control groups are the two sample groups used in this study's non-equivalent Control Group Design. The therapy is administered to the experimental group, but not the control group [16]; O1 and O3 are the pretests used to evaluate students' problem-solving skills before treatment, as indicated in Table 1. The last tests and post-tests given following treatment are O2 and O4. X stands for the implementation of the PBL model and the TaRL technique.

Tabel 1. Nonequivalent control group design.

Experimental Classes	O1	×	O2
Control Classes	O3	−	O4

The place of this research is SMA Negeri 6 Bengkulu City in the 2024/2025 school year. The population used in this study is 375 students in grade XI of SMA Negeri 6 Bengkulu City. The survey was conducted using purposive sampling, a sample determination technique based on special considerations [16]. The sample was used in two classes, namely XI C with class XI E, where the XI C experiment totaled 35 students and the XI E control class totaled 34 students. The time for implementing this research was carried out in the odd semester of the 2024/2025 school year.

This study uses both descriptive and differential statistical data analysis. A homogeneity test using the Levene test via SPSS was carried out to confirm that the data was evenly distributed throughout the groups, and a normality test was performed to see if the data had a normal distribution.

The test instrument used to measure student problem-solving is first validated by lecturers and school teachers, after which it is consulted with the supervisor and improved before being given to respondents for testing. This study's pretest and posttest question instruments are made as description questions (essays). The description test questions given to students in this study are assessed based on the stages of problem-solving. The stages of student problem-solving in this study use the problem-solving indicators identified by Polya, namely, understanding the problem. Second, prepare a problem-solving plan (devise a plan). Third, implement the plan. Fourth, review the answer (look back) [11].

The first activity carried out is to orient students to problems. This activity aims to stimulate students' curiosity. Students are expected to ask scientific questions based on natural phenomena around them. The next step is to organize students to learn, where students are directed to explore information related to the topic of the material being taught. The next activity is implementing the TaRL approach, namely assessment, grouping, basic skills pedagogy, and mentoring & monitoring. First, an initial evaluation is conducted to determine the student's ability. This aims to identify the characteristics of the student. After conducting an initial assessment, they were grouped into three groups. The first group of shivas with high abilities is called the very proficient group, the second group of shivas with moderate skills is called the advanced group, and the third group with relatively low abilities is called the group that needs guidance. Students are given LKPD that have different levels of difficulty, whereas, in the group, LKPD needs guidance and guidance.

Furthermore, basic skills pedagogy is carried out by teachers giving basic skills to physics materials to use so that there are no misconceptions and improve students' understanding so that students can solve problems independently. Then, the mentoring & monitoring process is carried out; the teacher provides assistance and monitoring of students. Teachers must periodically monitor the group that needs guidance, using it to help the group that needs guidance so that they can understand the material well and improve their problem-solving skills in this group that needs guidance. The last activity is to present ideas and conduct evaluations. At this stage, students present the results of the design that has been prepared.

Descriptive and inferential statistical techniques are used in this study's data analysis. Using the Levene test in SPSS software, the inferential analysis included a normality test to see if the data had a normal distribution and a homogeneity test to see if the data from each group originated from populations with comparable variability. Parametric statistical analysis assessed hypotheses after the normality and homogeneity tests. The posttest results demonstrated that both the experimental and control groups had significance values (sig. count ≥ sig. reference), indicating that the data was normally distributed, following normality testing using the Kolmogorov-Smirnov method and the homogeneity test. The homogeneity test revealed that the data was homogeneous, which showed that the groups had the same data variance. The t-test for hypothesis testing was then used in parametric statistical analysis.

The alternative hypothesis (Ha) in this study contends that there is an effect. In contrast, the null hypothesis (H0 asserts that the TaRL method with PBL does not influence the physics problem-solving skills at SMA Negeri 6 Bengkulu City. An Independent Sample t-test with the Pooled Variance equation was used to test the hypothesis. According to Sugiyono's instructions, the decision rule was that if the Sig value was less than 0.05, Ha was approved, and H0 was rejected; if the Sig value was more significant than 0.05, Ha was denied, and H0 was accepted.[17]. The Pooled Variant equation for the t-test is like the following equation.

$$\mathbf{t} = \frac{\bar{x}_1 - \bar{x}_2}{\mathbf{s}gab\sqrt{(\frac{1}{n_1}+\frac{1}{n_2})}} \tag{1}$$

$$s_{gab} = \sqrt{\frac{(n_1-1\ S_1{}^2+(n_2-1)S_2{}^2}{n_1+n_2+2}} \tag{2}$$

When the results were found that the approach of TaRL and the PBL model significantly influenced student problem solving, then look for how much influence (Effect Size). The equation used in measuring the effect size in Cohen's [18] is in equation (3).

$$\text{Cohen's d} = \frac{\bar{x}_a - \bar{x}_b}{\text{Pooled SD}} \tag{3}$$

The results of the Effect Size calculation are interpreted in Table 2 according to Becker [18].

Table 2. Effect size calculation.

Effect Size	Interpretation
$0.8 \leq d \leq 2.0$	High
$0.5 \leq d < 0.8$	Medium
$0.2 \leq d < 0.5$	Low

Then, using equation (4), N-gain was calculated according to Retnawati et al. [19] to determine the magnitude of the increase in student problem-solving.

$$\text{Gain} = \frac{\text{score posstest} - \text{skor pretest}}{\text{score maksimal} - \text{skor pretest}} \tag{4}$$

Table 3 shows the interpretation of N-gain, according to Hake et al. [20].

Normalized Gain Value	Interpretation
$g > 0.70$	High
$0.30 \leq g \leq 0.70$	Medium
$g < 0.30$	Low

3. Results and Discussion

3.1. *Result*

This study uses two classes that use different learning processes; the experimental class uses the TaRL approach and the PBL model, while the control class uses conventional methods. Before implementation, the research instrument is validated by expert experts, consisting of two physics education lecturers and one physics teacher, to ensure its suitability with the research. This validation process aims to improve the instrument's reliability before administering it to the sample population—question instruments in the form of explanatory questions (essays). The test results of the instrument were given to the respondents, and then the validity of the question items was tested. The questions tested by the cob consisted of 10 questions and were tested for validity using SPSS. The questions tested for validity were 10, categorized as valid for only five. Then, the reliability test of the questions was carried out with a result of 0.85, a high and credible category. Furthermore, in the test of the difficulty level of the question items, there were five questions with a good level of difficulty. Then, it was only tested on the research sample; the questions used were only five questions.

The Kolmogorov-Smirnov scores from the pretest and posttest for both groups were displayed in the problem-solving ability normalcy test. In the pretest, the experimental group's significance value was 0.09, whereas the control group's was 0.02. In the posttest, the experimental and control groups had a significant value of 0.20. Given that every significance value is more than 0.05, it can be said that the data is distributed normally. The homogeneity test of problem-solving ability showed a Levene's Statistic value of 0.011 with a significance of < 0.05, so the data had non-homogeneous variance. This can happen due to several factors, but the t-test can still be used, according to Zaki Mubarak in his book, stating that in some cases, the data is not homogeneous; the t-test can still be used because it is robust [21]. The descriptive statistical analysis results describe the distribution of problem-solving ability values in pretest and posttest. The data for this study was collected using problem-solving indicators given to the research sample. The findings of descriptive statistical analysis are presented in Table 4.

Table 4. Results of Descriptive Statistical Analysis

	N	Minimum	Maximum	Mean
Experimental Class Pretest	29	4	90	46.55
Experimental Class Posttest	29	68	100	87.17
Control Class Pretest	29	10	60	30.69
Posttest Control Classes	29	30	90	67.24
Valid N (listwise)	29			

The experimental class had a minimum score of 4 and a maximum score of 90, with an average score of 46.55, a standard deviation of 21.705, and a variance of 471.113, according to Table 4's descriptive statistical analysis using SPSS for the pretest. The experimental class's post-test scores ranged from a minimum of 68 to a maximum of 100, with an average of 87.17, a variance of 68.148, and a standard deviation of 8.255. The pretest scores for the control class ranged from 10 to 60, with an average of 30.69, a standard deviation of 16.460, and a variance of 270.936. With an average score of 67.24, a standard deviation of 17.507, and a variance of 306.404, the control group's post-test scores ranged from 30 to 90. The findings were examined following a pre-test for normalcy using the Kolmogorov-Smirnov test, which is advised when the sample size surpasses 50. According to Tyastirin et al. [22], when the sample size exceeds fifty, the Kolmogorov-Smirnov test is employed. The posttest average scores of two independent groups were then compared using a parametric test with SPSS software, especially the Independent Sample T-test. The results of the Independent Sample T-test for students' problem-solving abilities are shown in Table 5.

Table 5. Independent sample t-test test results.

t-test for Equality of Means				
		t	Df	Mr. (2-tailed)
Troubleshooting	Equal variances assumed		56	0.000
	Equal variances not assumed	5.144	47.26	0.000

Therefore, if the result of sig< is 0.05, it may be stated that Ha is accepted and H0 is rejected based on the t-test decision-making. Consequently, it can be concluded that the PBL model and the TaRL technique impact SMA Negeri 6 Bengkulu City students' capacity to solve physics issues. The effect's magnitude is then sought. Table 6 displays the impact of the effect size test.

Table 6. Effect size test results data.

	N	$\overline{x}_a$	$\overline{x}_b$	Effect size	Interpretation
Cohen's d	29	82.28	64.31	1.08	High

According to Table 6, the average and standard deviation for every class produced a substantial Cohen's d value of 1.08. With an effect size of 1.08, it can be inferred that the TaRL technique and the PBL model significantly impact students' ability to solve physics problems at SMA Negeri 6 Bengkulu City since H0 is rejected and Ha is approved. The experimental class's pupils' improved problem-solving skills were evaluated using the N-gain test, and the findings are displayed in Table 7.

Table 7. N-gain test results.

	N	Minimum	Maximum	Mean	Std. Deviation
N-gain_Score	58	0	1	0.61	0.13
N-gain_Persen	58	30	91	61.38	13.40
Valid N (listwise)	58				

The average N-gain score for the experimental class was 0.61, as shown in Table 7. The average N-gain percentage was determined to be 61.38. Concerning Table 2, the experimental class's N-gain result falls between 0.30 to 0.70 g, indicating a modest effect of 0.61.

Table 8. N-gain test results per indicator of the experimental class.

Critical Thinking Skills Indicators	Pre-Test	Post-Test	N-Gain	Category
Understanding the problem	67.93	98.62	0.95	High
Planning solutions	42.99	90.11	0.82	High
Implement solutions	37.93	83.10	0.72	High
Revisit	33.10	76.55	0.64	Medium
Total score obtained			0.79	High

According to Table 8's statistics, the experimental class's overall N-gain score is 0.79, classified as high, and its indicator score is 0.64, classified as moderate. This implies that the PBL model and the TaRL technique have improved problem-solving abilities.

Table 9. N-gain test results per indicator of the control class.

Critical Thinking Skills Indicators	Pre-Test	Post-Test	N-Gain	Category
Understanding the problem	93.10	99.31	0.9	High
Planning solutions	43.91	73.79	0.53	Medium
Implement solutions	39.48	69.31	0.49	Medium
Revisit	22.76	63.45	0.52	Medium
Total score obtained			0.61	Medium

According to Table 9's statistics, the control class's overall N-gain score is 0.61 (medium category), with the review indication showing the most significant improvement at 0.9 (high category). However, compared to the experimental class, the control group's improvement in problem-solving skills was less pronounced.

Polya's problem-solving indicators, which comprise 1) comprehending the problem, 2) formulating a strategy, 3) carrying out the plan, and 4) evaluating the solution, are used in this study. One of these problem-solving markers was covered in each of the five essay questions that were used. Figure 1 shows the mean scores on each Polya indicator for the experimental and control groups' problem-solving abilities.

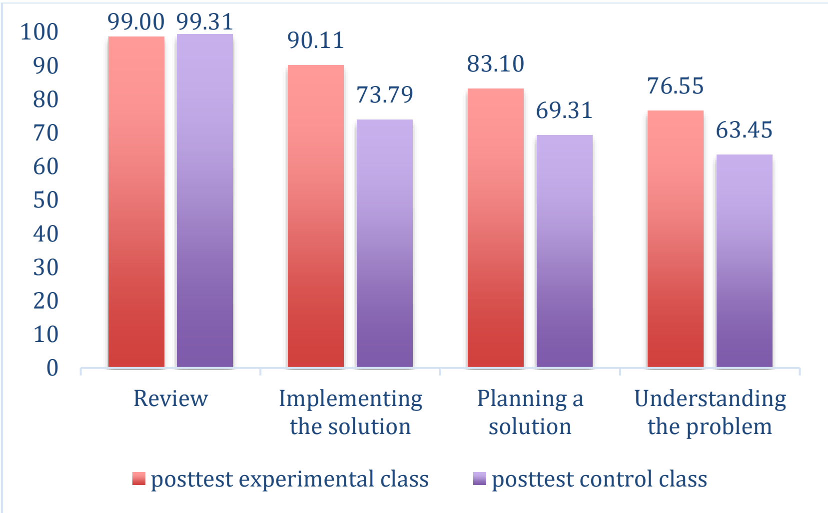

Figure 1. Troubleshooting improvement graph

The results of the problem-solving graph in Figure 1 show that the control class obtained an average posttest score of 63.45 in the problem understanding indicator. In the solution planning indicator, the average post-test score was obtained 69.31. The average score and posttest were obtained in the solution implementation indicator of 73.39. The last indicator's average post-test score was obtained at 93.10 and 93.31. Meanwhile, in the examination class, the average score on the pretest and post-test on the problem comprehension indicator was 76.55. In the solution planning indicator, the average post-test score was 83.10. In implementing the solution, the average post-test score was obtained at 98.62. In the last indicator, the average posttest score was obtained of 99.31. It was concluded that using the TaRL and PBL approaches significantly influenced the ability to solve physics problems for SMA Negeri 6 Bengkulu City students.

3.2. *Discussion*

In this study, applying the TaRL approach with the PBL model is crucial in improving students' problem-solving skills at SMAN 6 Bengkulu City. The TaRL approach can help students understand physics concepts and enhance their problem-solving skills in daily life. The first activity carried out is to orient students to problems. This activity aims to stimulate students' curiosity. Students are expected to ask scientific questions based on natural phenomena around them. This directly hones students' thinking skills to try to solve problems that occur in daily life. In addition, teachers also guide students in providing predictions or temporary answers. The next step is to organize students to learn, where students are directed to explore information related to the topic of the material being taught.

The next activity is implementing the TaRL approach, namely assessment, grouping, basic skills pedagogy, and mentoring & monitoring. First, an initial evaluation is conducted to determine the student's ability. This aims to identify the characteristics of the student. After conducting an initial assessment, they were grouped into three groups. The first group of shivas with high abilities is called the very proficient group, the second group of shivas with moderate skills is called the advanced group, and the third group with relatively low abilities is called the group that needs guidance. Students are given LKPD that have different levels of difficulty, whereas, in the group, LKPD needs guidance and guidance. Furthermore, basic skills pedagogy is carried out by teachers giving basic skills to physics materials to use so that there are no misconceptions and improve students' understanding so that students can solve problems independently. Then, the mentoring & monitoring process is carried out; the teacher provides assistance and monitoring of students. Teachers must periodically monitor the group that needs guidance, using it to help the group that needs guidance so that they can understand the material well and improve their problem-solving skills in this group that needs guidance. The last activity is to present ideas and conduct evaluations. At this stage, students present the results of the design that has been prepared.

According to Polya, the first is understanding the problem in the problem-solving indicators. In the TaRL approach, teachers group students based on their abilities so that they can provide guidance according to their needs. This allows students to understand the problem more quickly because the material provided is based on their ability level. In the PBL model, students face problems that require them to understand the context and issues in depth. This approach hones students' ability to read, understand, and identify problems more effectively.

The second indicator is planning solutions. With the TaRL approach, this planning is more straightforward because students have been given instruction that matches their level of understanding, allowing them to be more confident in planning problem-solving. The third indicator is to implement solutions. The TaRL approach can reinforce this process by ensuring students have mastered the basic concepts needed to implement the solution. In PBL, students implement solutions independently or in groups. The last indicator is to review. The TaRL approach can reinforce this reflection by providing relevant feedback and tailoring learning for students to understand their mistakes better and learn from those experiences. In PBL, students can reflect on their work results and re-examine the solutions found.

Assisting groups also improves problem-solving skills. In applying the PBL model with the TaRL approach, students are encouraged to solve problems. Next, students discuss to solve problems in groups. Students are grouped based on their abilities. Then, the group was assisted according to their needs. For the low-ability group, more aid is given than the medium or high-ability group. Then, for the high-ability group, they are given a challenge question if they have finished working on the LKPD or become a tutor for their friends in one group or another. A study [23] shows that using the TaRL technique with the problem-based learning paradigm can improve student learning outcomes. According to Listyaningsih [24], the TaRL technique may inspire pupils to participate in their education.

Several variables, including the employment of distinct instructional approaches, may impact the variations in problem-solving skills between the experimental and control groups. Students' engagement and cognitive learning results were significantly affected by the TaRL approach in the experimental class, which used both the TaRL approach and the PBL model. Because students are directed to real-world problems as a learning context, they understand issues and develop problem-solving skills. This research is in line with the study conducted by Oktaviana, which states that the PBL mode can increase learning activities, build student self-control, develop students' problem-solving skills, and stimulate students to learn continuously [25]. The application of this PBL model is that students must become independent learners who can solve problems independently based on the experiments. Therefore, students participate directly in solving problems and discovering concepts on their own to understand the concepts better and be active in solving them. Students exploit the benefits of learning because the problems solved are related to daily life [26].

There are several limitations in this study. First, this study was conducted in a specific context. The sample used in this study was relatively limited, which may affect the statistical power and representativeness of the data. In addition, the limited duration of the study only covered a certain period, so the long-term impact of implementing the TaRL approach and the PBL model on physics problem-solving may not be fully reflected. Variations in how teachers implement these two learning models may also affect the consistency and quality of the learning experience received by students. External factors, such as students' prior knowledge, motivation, or socio-economic background, may influence the study results but cannot always be fully controlled or measured in this study design. Finally, bias in data collection, such as using self-reports or observations, may affect the results' objectivity. However, these limitations do not diminish the importance of the study findings, which still provide valuable contributions to developing more effective physics learning strategies

4. Conclusion

Based on the research that has been done, it is concluded that the first is an influence of the TaRL approach and the PBL model on the ability to solve physics problems in SMA Negeri 6 Bengkulu City. A significant impact is shown at 0.001, where this value is smaller than the significance (α) = 0.05. The magnitude of the influence of the TaRL approach and the PBL model on the ability to solve physics problems in SMA Negeri 6 Bengkulu City. Cohen's d was obtained at 1.085, categorized as significant with $\alpha = 5\%$. So H0 was rejected, and Ha was accepted. The increase in physics problem solving using the TaRL approach and the PBL model in SMA Negeri 6 Bengkulu City based on the results of the N-gain test, the N-gain score was 0.61, a moderate interpretation, meaning that there was a mild increase in physics problem-solving. These results show that physics problem-solving in the experimental class using the TaRL approach and the PBL model has a higher increase compared to the control class using conventional learning.

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