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Implementation of the Problem Based Learning Model on Critical Thinking and Problem-Solving Skills in Dynamic Electricity Material

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Abstract: This study aims to analyze the effect of problem based learning model on critical thinking ability and physics problem solving of high school students. This study is a quasi-experimental study with a two-group design with two classes, namely the experimental class and the control class. The population of this study consisted of 2 classes and sampling was carried out by saturated sampling. Class XII MIA 1 as the experimental class and class XII MIA 2 as the control class, each consisting of 30 students. The instrument used in this study was a learning outcome test in the form of an essay test of 10 questions. Data analysis was carried out using the MANOVA test. The results of the study showed that the average pretest and posttest scores in the experimental class were 57.00 and 84.00, respectively, while the average pretest and posttest scores in the control class were 53.00 and 73.50, respectively. Data analysis using the MANOVA test concluded that there was an effect of the problem based learning model on critical thinking ability and problem solving of high school students.

Keywords: Critical thinking skills; Problem based learning; Problem solving skills.

Introduction

Education must use learning that can support 21st century skills, namely Communication, Collaboration, Critical Thinking and problem solving, and Creative and innovative (Tohani & Aulia, 2022). Education does not only focus on mastering academic material, but must have critical thinking, creativity, collaboration, and communication. Learning demands require teachers to have a creative and innovative attitude in having and combining learning models and applying learning materials to build student knowledge. One of the skills that students need to achieve is critical thinking and problem solving skills. Critical thinking skills play an important role in solving problems that occur in everyday life (Sundari & Sarkity, 2021). State the objectives of the work and provide an adequate background, avoiding a detailed literature survey or a summary of the results.

Critical thinking and problem solving are closely related. Problem solving skills require critical thinking skills in exploring various alternative ways or solutions (Yadi et al., 2023). Problem solving activities provide problematic situations that trigger the development of students' critical thinking potential. Such relationships need to be explored as a basis for developing critical thinking and problem solving skills.

Indonesia is experiencing development and reform with the demands of the times and the needs of society. The government realizes that education is the key to creating a generation that contributes to the progress of the nation. The education curriculum as an important element has undergone several changes with the aim of improving the quality of education and preparing a competent young generation to face global challenges (Arifin, 2024).

Curriculum changes reflect the development of science and technology. The dynamics of curriculum changes bring a vision of producing graduates who excel

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in academic aspects. Critical thinking and problem solving are carried out with the aim of having 4C skills, but in reality they are still faced with various challenges in their implementation.

Educators have an impact in implementing every knowledge they have to be creative and innovative in choosing, combining learning models, and applying every learning material to be able to build student knowledge. Students' abilities need to be considered to achieve good learning, one of the characteristics is the ability to think critically and solve problems (Akbar et al., 2019).

Critical thinking and problem solving skills in everyday life for all subjects have an important role, one of which is physics. Physics is a Natural Science (IPA) that has an important role in the development of science and technology (Kardoyo, 2022). Physics contributes to various disciplines that give rise to new branches of science. Physics learning is done by seeing, and observing direct events related to the process of a natural phenomenon. Physics is basically an interesting and fun lesson, because the concept of physics is related to everyday life. The fact is that physics learning actually seems monotonous because students are only taught about formulas so that students only memorize formulas, without understanding the concepts and their applications in everyday life (Astuti et al., 2020).

The results of observations at Imelda Medan Private High School showed that the level of student understanding in physics learning was still low. The results of the student's physics exam had not reached the Minimum Completion Criteria (KKM) of 80. The use of less varied learning models affected student responses in the learning process, so that students were less actively involved in learning activities in the classroom. The evaluation process of students in solving problems was dominated by friends who were more capable, so that student independence was still lacking in solving problems with their own abilities. Lack of understanding, activeness and independence had an impact on students' critical thinking and problem-solving abilities, as a result students obtained low learning outcomes (Susanto & Azizah, 2025).

Low learning outcomes are a problem that needs to be addressed to improve the quality of students in accordance with the expected goals (Winaputra, 2019). Creating student involvement in the learning process requires an appropriate learning model so that learning can be more meaningful (Fitria et al., 2022). The learning model is the beginning of the realization of systematic learning to integrate learning experiences so that learning is achieved and changes in learning outcomes occur as expected. One of the appropriate models for integrating learning experiences is the Problem Based Learning (PBL) model (Arends, 2012).

Relevant research related to the PBL model to improve critical thinking skills in physics material by (Samadun & Dwikoranto, 2022) shows that the problem-based learning model trains students to solve various problems directly so that it can improve students' critical thinking skills. Other studies show that the PBL model has a positive impact on students' critical thinking skills because it helps build new knowledge and hone their critical thinking skills (As-Syauqi et al., 2024). Research conducted by (Rahmadita et al., 2021) shows that the progressiveness of students' critical thinking skills has increased both individually and in groups. The application of the PBL model experienced an increase in the average percentage score of 38.32% and a significance of 0.00. The application of the PBL model has proven effective in improving critical thinking and problem-solving skills (Neswary, 2022).

Problem solving and critical thinking skills are important to analyze problems well. The problem taken in the research on critical thinking and problem solving skills is on dynamic electricity material for grade XII high school. Dynamic electricity material was chosen because it is related to everyday applications and relevant problems. The importance of students in having critical thinking and problem solving skills is a demand of the 21st century, so a study was conducted with the title Implementation of the Problem Based Learning Model on Critical Thinking and Problem Solving Skills in Dynamic Electricity Material.

Method

The study was conducted at SMA Swasta Imelda Medan, Jalan Bilal No.48 Medan, Pulo Brayan Darat I, Medan Timur District, Medan City, North Sumatra Province. This study was conducted from August to October in the 2024/2025 academic year for class XII in the odd semester.

The population in this study were all students of class XII of SMA Swasta Imelda Medan from 2 classes with 30 students in each class. The research sample was taken from two population classes with a sampling method using saturated sampling. One class was used as an experimental class, namely class XII MIA 1 using the problem based learning model and one control class XII MIA 2 using conventional learning.

This study involved two classes that were given different treatments (Sugiyono, 2013). To determine the learning outcomes of students obtained with two treatments on students who were given tests. The tests given were pretests before treatment and posttests after treatment. Thus, the two-group research design (pretest and posttest) can be seen in Table 1.

Table 1. Two Group Research Design (Pretest and Posttest)

Class	Pretest	Treatment	Postest
Experimental	T_1	X	T_2
Control	T_1	Y	T_2

Information:

T_1 = pretest experimental class
T_2 = posttest experimental class
T_1 = pretest control class
T_2 = posttest control class
X = treatment with a problem based learning model.
Y = treatment with conventional learning models.

The researcher gave a pretest to the experimental class and the control class. The instrument used in this study consisted of 10 essay questions on critical thinking and problem solving skills. The test was first standardized using a content validity test by the lecturer and prediction validity. The pretest and posttest data obtained were then tested for normality, homogeneity and a manova hypothesis test was carried out.

Result and Discussion

Result

The results of the study were obtained from the implementation of tests given to students before and after the application of the learning model. The test aims to measure students' critical thinking and problem solving skills in the experimental control class. Based on the data, it shows that students in the experimental class who use the Problem Based Learning (PBL) model get better grades than the control class who use the conventional learning model. This indicates that the application of the PBL model has a positive effect on students' critical thinking and problem solving skills.

At the beginning of the research, both classes were given an initial ability test (pretest) which aimed to determine whether the initial abilities of students in both classes were the same or not. The pretest data obtained from the experimental class and the control class can be seen in Table 2 and Table 3.

Table 2. Experimental Class Pretest Data

Experimental Class							
Critical Thinking Skills				Problem Solving Skills			
Value	f	$\bar{x}$	s	Value	f	$\bar{x}$	s
38-42	1			40-45	2		
43-47	1			46-51	1		
48-52	3			52-57	7		
53-57	6	56	6	58-63	13	58	7
58-62	12			64-69	6		
63-67	7			70-75	1		
$\sum = 30$				$\sum = 30$			

Table 3. Control Class Pretest data

Control Class							
Critical Thinking Skills				Problem Solving Skills			
Value	f	$\bar{x}$	s	Value	f	$\bar{x}$	s
38-42	1			35-40	6		
43-47	1			41-46	2		
48-52	7			47-52	4		
53-57	9	54	6	53-58	11	52	9
58-62	8			59-64	4		
63-67	4			65-70	3		
$\sum = 30$				$\sum = 30$			

Based on the calculation results, it is concluded that the initial abilities of students in the experimental class and the control class are the same. The next step taken by the researcher was to provide a post-test to the experimental and control classes. The treatment given to the experimental class used the problem-based learning model and the control class used the conventional model. The post-test data obtained from the experimental class and control class can be seen in Table 4 and Table 5.

Table 4. Experimental Class Posttest Data

Experimental Class							
Critical Thinking Skills				Problem Solving Skills			
Value	f	$\bar{x}$	s	Value	f	$\bar{x}$	s
73-76	5			75-78	6		
77-80	8			79-82	4		
81-84	4			83-86	7		
85-88	6	83	7	87-90	8	85	6
89-92	2			91-94	3		
93-96	5			95-98	2		
$\sum = 30$				$\sum = 30$			

Table 5. Control Class Posttest Data

Control Class							
Critical Thinking Skills				Problem Solving Skills			
Value	f	$\bar{x}$	s	Value	f	$\bar{x}$	s
65-68	7	75	7	65-68	9	72	7
69-72	4			69-72	4		
73-76	5			73-76	6		
77-80	6			77-80	5		
81-84	5			81-84	4		
85-88	3			85-88	2		
$\sum = 30$				$\sum = 30$			

Based on the posttest data of students from the experimental class and the control class, a normality test and homogeneity test of the posttest data were first carried out to determine the effect after being given different treatments to the two classes. The calculation results showed that the posttest data was normally distributed and homogeneous, so a hypothesis test of the posttest data was carried out using the MANOVA test.

In summary, the hypothesis test of the posttest data for the two classes can be seen in Table 6.

Table 6. Calculation of Post-test Manova Test of Critical Thinking and Problem Solving Ability

Data	$\bar{x}$	Sig	Conclusion
Experimental Class Posttest	84	0,001	Critical thinking and problem solving skills are influenced by the problem-based learning model.
Control Class Posttest	75		

The MANOVA test of the post-test data on critical thinking and problem-solving skills is shown in Table 4.6. The results of the post-test H_o score were rejected because the test criteria for the sig value $\text{sig} > 0.05$ $(0{,}001 > 0{,}05)$. H_o was rejected and $H_a$was accepted, which means that there is an influence of the problem-based learning model on critical thinking and problem-solving skills in dynamic electricity material.

Discussion

Problem Based Learning (PBL) is a learning model that is considered effective in improving the quality of learning, especially developing students' critical thinking and problem-solving skills. The application of the PBL model in grade XII is very relevant because students are at a stage of cognitive development that requires them to think complexly and independently. Learning that begins with a problem makes students try to deepen their knowledge of what is known and what needs to be known to solve the problem (Fitria et al., 2022).

The syntax or stages in the PBL model such as identifying basic questions, designing projects, preparing work schedules, monitoring the process, and evaluating results, are in line with critical thinking indicators. The stages of critical thinking as explained by Ennis include providing simple explanations, building basic skills, providing conclusions, making further explanations and organizing strategies optimally through direct student involvement in learning activities (Cahyono & Dwikoranto, 2021).

Previous studies have shown that students who learn with the PBL model show significant improvements in critical thinking skills, compared to conventional learning (Hidayati et al., 2024). The collaborative process required in PBL also provides additional stimulus for students to convey ideas critically but openly to the opinions of others. The collaborative aspect in PBL also strengthens student learning outcomes because they are invited to work in teams, discuss ideas, and build problem-solving strategies together (Kholifah & Dwikoranto, 2022).

Data analysis shows that the experimental class and the control class experienced significant differences. The experimental class obtained an average pretest score of 56 and an average posttest score of 83. The control class obtained an average pretest score of 54 and an average posttest score of 75. Pretest and posttest testing were carried out with the same number of instruments. The instruments used were 10 questions on the Dynamic Electricity material.

The Problem Based Learning (PBL) model encourages the development of critical thinking, but also contributes directly to improving problem-solving skills. The problem-solving steps proposed by Polya are, understanding the problem, planning a solution, calculating and re-evaluating. PBL provides space for students to analyze contextual problems, evaluate various available information, and draw conclusions based on evidence and logical reasoning (Hidayati et al., 2024).

Problem solving in PBL creates a process where students do group work, feedback, discussion and investigation. PBL-based learning allows students to experience the stages of learning systematically. Learn to identify relevant information, formulate solution strategies, try solutions, and reflect on whether the solution is effective (Arzak & Prahani, 2023). Therefore, the role of the teacher in the PBL learning model is as a guide and facilitator for students to learn to think and solve their own problems.

The results of the study showed that there was a significant difference between the experimental class and the control class after receiving treatment in the form of implementing the PBL model. The experimental class showed problem-solving ability for an average pretest score of 58 and an average posttest of 85. The control class obtained an average pretest of 52 and an average posttest of 72. Based on the data, the increase in the average problem-solving ability of the experimental class was greater when compared to the increase in the average control class.

The results of the study showed that the application of the PBL model contributed significantly to students' critical thinking and problem-solving skills. The PBL model provides opportunities for students to actively identify problems, formulate questions, develop hypotheses, seek alternative solutions, and critically evaluate the results. This problem-based learning process requires students to think reflectively, analytically, and creatively in dealing with real situations, thus encouraging the development of high-level thinking skills. The syntax of the PBL model, such as identifying fundamental questions, designing solutions, conducting investigations, and evaluating results, is in line with indicators of critical thinking and

problem-solving skills, which ultimately have a positive impact on the quality of learning.

Conclusion

The results of the research and analysis of the hypothesis testing data obtained are concluded as follows:

Analysis of critical thinking skills with the Problem Based Learning model experienced a significant difference. The average pre-test score was 56 and the average post-test score was 83. The percentage of each indicator of critical thinking skills in students showed good results. The average critical thinking skills of students from the five indicators including: giving simple explanations, building basic skills, providing conclusions, making further explanations and arranging strategies obtained a percentage of 82%.

Analysis of problem-solving skills with the Problem Based Learning model experienced a significant difference. The average pre-test score was 58 and the average post-test score was 85. The percentage of each indicator of problem-solving skills in students showed good results. The average problem-solving skills from the four indicators including: understanding problems, planning solutions, calculating and re-checking obtained a percentage of 70%.

The results of data processing with hypothesis testing analysis using the MANOVA test obtained a sig value <0.05 so that it can be stated that critical thinking and problem solving skills have an effect on the Problem Based Learning model on the main material of Dynamic Electricity in class XII MIA SMA Swasta Imelda Academic Year 2024/2025.

Author Contributions

All authors have contributed to the completion of this manuscript.

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Conflicts of Interest

The authors declare no conflict of interest

References

Akbar, A., Disman, & Kusnendi. (2019). The Role of Problem Solving, Problem-Based Learning, and Critical Thinking in the Era of Globalization. *Advances in Social Science, Education and Humanities Research*, 15-17. https://doi.org/10.2991/assehr.k.200130.070

Arends, R. I. (2012). *Learning to Teach.* New York: McGraw-Hill.

Arifin, Z. M. (2024). Adaptasi dan Implementasi Kurikulum Pendidikan di Indonesia. *Jurnal Digdaya: Pendidikan, Pengajaran dan Kebudayaan*, 4(1) 13-20. https://doi.org/10.31004/cdj.v4i1.12433

Arzak, K. A., & Prahani, B. K. (2023). The physics problem solving skills profile of high school students in elasticity material and the implementation of augmented reality book-assisted PBL model. *Momentum: Physics Education Journal*, 7(1). 66-77. https://doi.org/10.21067/mpej.v7i1.6704

As-Syauqi, M. A., Rachmadiarti, F., & Budiyanto, M. (2024). Profile of College Students' Critical Thinking Skills Assisted by Problem-Based Learning Models on Electromagnetic Material. *IJORER : International Journal of Recent Educational Research*, 5(1). 168-181. https://doi.org/10.46245/ijorer.v5i1.543

Astuti, N. H., Rusilowati, A., Subali, B., & Marwoto, P. (2020). Analisis Kemampuan Pemecahan Masalah Model Polya Materi Getaran, Gelombang, . *Unnes Physics Education Journal*, 1(1). 1-8.

Cahyono, B. D., & Dwikoranto. (2021). Implementasi Model Pembelajaran Problem Based Learning untuk Meningkatkan Kemampuan Berfikir Kritis pada Siswa. *IPF: Inovasi Pendidikan Fisika*, 5(3). 1-7. Retrieved from https://ejournal.unesa.ac.id/index.php/inovasi-pendidikan-fisika/article/view/36693

Fitria, D., Lufri, Imran, A., & Ahda, Y. (2022). Studi Literature Model Problem Based Learning. *International Journal Of Humanities Education And Social Sciences (IJHESS)*, 1(6(. 908-920. https://doi.org/10.55227/ijhess.v1i6.177

Hidayati, A., Munasir, & Sudibyo, E. (2024). Development of Problem-Based Learning Model Physics Learning Tools to Improve Critical Thinking Skills of High School Students. *IJORER : International Journal of Recent Educational Research* , 5(1). 77-89. https://doi.org/10.46245/ijorer.v5i1.496

Kardoyo, Nurkhin, A., Muhsin, & Pramusinto, H. (2022). Problem-Based Learning Strategy: Its Impact on Students' Critical and Creative Thinking Skills. *European Journal of Educational Research*, 9(3). 1141-1150. https://doi.org/10.12973/eu-jer.9.3.1141

Kholifah, L. N., & Dwikoranto. (2022). Penerapan Model Pembelajaran Problem Based Learning untuk Meningkatkan Kemampuan Berfikir Kreatif Siswa. *Inovasi Pendidikan Fisika*, 6(1). 17-23. https://doi.org/10.31004/basicedu.v6i5.3784

Kinasih, R. A., Prahani, B. K., Wibowo, F. C., & Costu, B. (2023). Profile of students' PhysicsProblem Solving Skills and Implementation PBL Model Assisted by 3D Digital Module to Improve Problem Solving Skills. *JPPPF (Jurnal Penelitian dan Pengembangan*

Pendidikan Fisika, 9(2). 245-256. https://doi.org/10.21009/1.09207

Neswary, S. B., & Prahani, B. K. (2022). Profile of Students' Physics Critical Thinking Skills and Application of Problem Based Learning Models Assisted by Digital Books in Physics Learning in High School. *Jurnal Penelitian Pendidikan IPA*, 8(2). 781-789. https://doi.org/10.29303/jppipa.v8i2.1444

Rahmadita, N., Mubarok, H., & Prahani, B. K. (2021). Profile of Problem-based Learning (PBL) Model Assisted by PhET to Improve Critical Thinking Skills of High School Students in Dynamic Electrical Materials . *Jurnal Penelitian Pendidikan IPA*, 7(4). 618-624. https://doi.org/10.29303/jppipa.v7i4.799

Samadun, & Dwikoranto. (2022). Improvement of Student's Critical Thinking Ability sin Physics Materials Through The Application of Problem-Based Learning. *IJORER : International Journal of Recent Educational Research*, 3(5). 534-545. https://doi.org/10.46245/ijorer.v3i5.247

Sugiyono. (2013). *Metode Penelitian Kuantitatif, Kualitatif, dan R&D*. Bandung: Alfabeta.

Sundari, D. P., & Sarkity, D. (2021). Keterampilan Berpikir Kritis Siswa SMA pada Materi Suhu dan Kalor dalam Pembelajaran Fisika. *Journal of Natural Science and Integration*, 4(2). 149-161. http://dx.doi.org/10.24014/jnsi.v4i2.11445

Susanto, & Azizah, H. M. (2025). Pembelajaran untuk Meningkatkan Kompetensi 4C (Communication, Collaboration, Critical Thinking dan Creative Thinking) untuk Menyongsong Era Abad 21. *Sejahtera: Jurnal Inspirasi Mengabdi Untuk Negeri*, 4(1). 231-242. https://doi.org/10.58192/sejahtera.v4i1.3028

Tohani, E., & Aulia, I. (2022). Effects of 21st Century Learning on the Development of Critical Thinking, Creativity, Communication, and Collaboration Skills. *Journal of Nonformal Education*, 8(1). 46-53. https://doi.org/10.15294/jne.v8i1.33334

Winataputra. (2019). *Teori Belajar dan Pembelajaran*. Jakarta: Universita Terbuka.

Yadi, Farhan, Sofyan, H., & Surjono, H. D. (2023). Enhancement of Critical Thinking Skills Vocational Students in Indonesia using Problem Based Learning Stem by E-Learning. *Jurnal Pendidikan Teknik Mesin*, 10(1). 64-77. https://doi.org/10.36706/jptm.v10i1.144