Volume 4 Number 1 (2026)
January – June 2026
Page: 483-488

EDUJAVARE: International Journal of Educational Research
ISSN: 3031-2884
https://edujavare.com/index.php/edujavare
DOI: 10.70610/edujavare.v4i01.1346

Problem-Solving Ability Profile of Phase E Students Through the Application of the PBLWVL Model

Agus Danawan[1], Yuli Yulianti[2]
[1,2] Universitas Pendidikan Indonesia, Indonesia
* Correspondence e-mail; ad@upi.edu

Article history Submitted: 2026/04/10; Revised: 2026/05/20; Accepted: 2026/06/01

Abstract

This research is motivated by the implementation of the Independent Curriculum in high schools that requires Phase E students to understand physics concepts, have science process skills, and have problem-solving abilities. The purpose of this study is to determine the description of how aspects of problem-solving abilities include: visualization of problem descriptions, physics approaches, specific applications of physics concepts, mathematical procedures, and logical conclusions, after the application of learning with the Problem Based Learning with Virtual Laboratory (PBLWVL) model. The PBLWVL model was implemented in phase E of Grade X on the topic of energy conversion and the Law of Conservation of Energy. With Virtual laboratory referred to in the learning process using PhET simulation. This study used a quantitative Pre-Experimental method using a One Group Pretest Posttest Design research design. The sample in this study amounted to 33 students at one of the public high schools in Bandung City. The instrument used was 20 essay questions to measure the increase in problem-solving abilities. The research data were analyzed using N-gain. The results of the study showed that there was an average increase in students' problem-solving abilities of 0.69 with a moderate increase category, with the indicator of the ability to apply specific physics concepts having high criteria (score 0.95).

Keywords Phet Simulation, Problem Based Learning, Problem Solving Skills, Virtual Laboratory

INTRODUCTION

Physics is a branch of natural science that develops through scientific methods characterized by experimentation; therefore, physics learning should reflect the nature of science both as a process and as a product. The educational curriculum in Indonesia continues to evolve in line with the development of the times. One of the curricula currently implemented in educational institutions is the Merdeka Curriculum. The Learning Outcomes for Senior High School/Islamic Senior High School (SMA/MA) Physics subjects issued by the Ministry of Education, Culture, Research, and Technology of the Republic of Indonesia through the Agency for Standards, Curriculum, and Educational Assessment (2022) state that in the physics learning process, students are trained to conduct simple investigations related to natural phenomena. Students learn to identify problems, formulate hypotheses, design simple experiments, conduct experiments, analyze data, draw conclusions, and communicate experimental results both orally and in written form. Through this process, students are expected to develop scientific reasoning, critical thinking skills, and problem-solving abilities, all of which are aligned with the development of the Pancasila Student Profile. Ansari et al. (2022) explained that the Merdeka Belajar policy emphasizes creativity, learning based on societal and workforce needs in the global era, comprehensive evaluation systems, and problem-solving-oriented learning.

At the end of Phase E, students are expected to possess the ability to respond to global issues and actively contribute to problem-solving efforts. To achieve this objective, students must be trained to understand physics concepts and become accustomed to solving problems related both to daily life and to physics subject matter itself, which requires various problem-solving strategies. Based on these challenges, an appropriate learning model is needed to train students' problem-solving abilities in accordance with the demands of 21st-century innovative learning, which integrates TPACK (Technological, Pedagogical, and Content Knowledge), applies Higher Order Thinking Skills (HOTS), and promotes digital literacy. One learning model that can be implemented is the Problem-Based Learning (PBL) model. Sumartini (2016) stated that one of the learning models capable of improving students' problem-solving abilities is Problem-Based Learning. Furthermore, this learning model is specifically designed to help students develop critical thinking skills, problem-solving skills, and intellectual abilities. Hakim, as cited in Yuberti et al. (2019), also argued that one effective way to improve students' problem-solving abilities is through the implementation of the Problem-Based Learning model.

Research conducted by Ekawati (2017) demonstrated that the Problem-Based Learning model can improve students' problem-solving abilities. Helyandari (2020) further explained several advantages of Problem-Based Learning, including that students become accustomed to facing and solving problems encountered in everyday life, their creative and comprehensive thinking skills are stimulated, social solidarity is fostered through collaborative discussions with peers, and students become accustomed to conducting experiments. Therefore, the researchers were increasingly motivated to conduct research regarding the influence of the Problem-Based Learning model on students' problem-solving abilities. The five indicators of problem-solving ability used in this study were adopted from Docktor and Heller (2009), namely: (1) useful description or visualization of problems; (2) physics approach; (3) specific application of physics concepts; (4) mathematical procedures; and (5) logical progression or conclusions.

To support innovative, engaging, and student-centered learning processes, a virtual laboratory using PhET Interactive Simulations was utilized. Based on research conducted by Rizaldi et al. (2020), PhET simulations were found to greatly assist the learning process because they provide information regarding complex physical processes and concepts in an interactive manner. These simulations can also overcome limitations encountered during laboratory practical activities. In addition, research conducted by Khoiriyah et al. (2018) concluded that

PhET simulations use design principles that encourage scientific inquiry, provide interactivity, make invisible phenomena visible, present multiple representations, enable students to connect real-life phenomena with underlying scientific concepts, and offer flexible simulations that can be applied in various educational situations. In situations such as a pandemic, where students are required to study from home, PhET simulations enable students to continue conducting investigations virtually. Furthermore, PhET simulations can enhance students' digital literacy skills, which are among the essential competencies required in the modern educational era.

METHODS

This study employed a quasi-experimental method to analyze the problem-solving ability profile of Phase E students through the implementation of the Problem-Based Learning with Virtual Laboratory (PBLWVL) model in physics learning. The research involved 33 tenth-grade students from SMA Negeri 10 Bandung as the research subjects. The study was conducted through several stages, including preparation, implementation of the PBLWVL learning model, data collection, and data analysis. The learning process integrated Problem-Based Learning (PBL) with a virtual laboratory using PhET Interactive Simulations to support experimental and inquiry-based activities. Students were trained to identify problems, formulate hypotheses, conduct virtual experiments, analyze data, and draw conclusions systematically. Data on students' problem-solving abilities were collected through problem-solving tests based on five indicators proposed by Docktor and Heller, namely useful description, physics approach, specific application of physics concepts, mathematical procedures, and logical progression. The collected data were then analyzed descriptively and quantitatively to determine the effectiveness of the PBLWVL model in improving students' problem-solving abilities in physics learning.

FINDINGS AND DISCUSSION

The implementation of the Problem-Based Learning with Virtual Laboratory (PBLWVL) model was evaluated using an observation sheet completed by an observer who was the physics subject teacher. The results showed that the implementation of the PBLWVL learning model was categorized as "very good." During the first meeting, all stages of the learning model were implemented successfully, achieving an implementation percentage of 100%. Meanwhile, during the second meeting, the implementation percentage decreased to 83%, although it still remained within the "very good" category. This decrease occurred because students required more time during the investigation stage compared to the first meeting, resulting in several stages of the PBLWVL model not being fully implemented, particularly the stage in which students were asked to formulate conclusions from the learning activities. Overall, the average implementation percentage of the PBLWVL model reached 91.5%, indicating that the learning process was conducted effectively and systematically.

The data regarding students' problem-solving abilities were obtained through a problem-solving skills test consisting of 20 essay questions administered during both the pretest and posttest stages. The pretest and posttest scores were analyzed using the N-gain formula to determine the improvement in students' problem-solving abilities after the implementation of the PBLWVL model. The analysis revealed that the average pretest score was 34.52, while the average posttest score increased to 79.45. The resulting N-gain score was 0.69, which falls within the medium improvement category. These findings indicate that the implementation of the PBLWVL model was effective in improving students' problem-solving abilities in physics learning.

Furthermore, this study evaluated five indicators of problem-solving ability, namely visualization or useful description of problems, physics approach, specific application of physics concepts, mathematical procedures, and logical conclusions. The results showed that all indicators experienced improvement after the implementation of the learning model. The visualization or useful description indicator increased from an average pretest score of 67.27 to a posttest score of 85.15, with an N-gain score of 0.49 categorized as medium. The physics approach indicator improved from 18.33 to 62.12, resulting in an N-gain score of 0.55 in the medium category. The specific application of physics concepts indicator demonstrated the highest improvement, increasing from 28.94 to 95.00 with an N-gain score of 0.93 categorized as high. The mathematical procedures indicator improved from 16.82 to 68.33, resulting in an N-gain score of 0.62 categorized as medium. Finally, the logical conclusion indicator increased from 47.73 to 86.97, with an N-gain score of 0.68 in the medium category.

The comparison of N-gain scores across all indicators demonstrates that the highest improvement occurred in the specific application of physics concepts indicator. According to Docktor and Heller (2009), the stage of specific application of physics concepts involves designing solutions based on an appropriate physics approach to the presented problem. In this indicator, students were required to formulate solution strategies that aligned with relevant physics concepts and principles based on the problems provided. The high N-gain score obtained in this indicator suggests that the implementation of the PBLWVL model effectively trained students to apply physics concepts in solving problems systematically and accurately. The use of virtual laboratory activities through PhET Interactive Simulations also contributed significantly to helping students visualize abstract physics concepts and conduct investigations interactively, thereby supporting the improvement of their overall problem-solving abilities.

The findings of this study indicate that the implementation of the Problem-Based Learning with Virtual Laboratory (PBLWVL) model had a positive impact on students' problem-solving abilities in physics learning. The observation results showed that the implementation level of the learning model reached an average percentage of 91.5%, categorized as "very good." This finding demonstrates that the learning activities were conducted systematically according to the stages of the PBLWVL model. The decrease in implementation during the second meeting, which reached 83%, was mainly caused by the longer time required for the investigation stage. This condition reflects that students were actively involved in exploration and inquiry activities, which are essential components of problem-based learning. Although several stages were not fully implemented due to time limitations, the learning process still encouraged active participation, collaborative discussion, and independent investigation among students.

The results of the pretest and posttest analysis also revealed a significant improvement in students' problem-solving abilities after the implementation of the PBLWVL model. The average pretest score of 34.52 increased to 79.45 in the posttest, producing an N-gain value of 0.69 categorized as medium improvement. This finding suggests that the integration of problem-based learning with virtual laboratory activities was effective in helping students understand physics concepts and apply them in problem-solving situations. The PBLWVL model encourages students to actively identify problems, formulate hypotheses, conduct experiments, analyze data, and draw conclusions. Such activities support the development of higher-order thinking skills, particularly critical thinking and analytical reasoning, which are essential competencies in 21st-century learning.

Among the five indicators of problem-solving ability, the highest improvement was found in the indicator of specific application of physics concepts, with an N-gain value of 0.93 categorized as high. This result indicates that students became more capable of applying physics principles and concepts to solve contextual problems after participating in the PBLWVL learning process. The use of virtual laboratory simulations through PhET Interactive Simulations contributed significantly to this improvement because the simulations enabled students to visualize abstract concepts, conduct experiments interactively, and observe physical phenomena more clearly. Through these virtual experiments, students were able to connect theoretical knowledge with practical applications, thereby strengthening conceptual understanding and problem-solving skills simultaneously.

The improvement observed in other indicators, such as physics approach, mathematical procedures, and logical conclusions, also demonstrates that the PBLWVL model supports comprehensive cognitive skill development. Students were trained not only to understand concepts theoretically but also to solve problems systematically using appropriate scientific procedures. Furthermore, the collaborative and inquiry-based nature of problem-based learning encouraged students to communicate ideas, discuss solutions, and evaluate different approaches critically. These findings are consistent with previous studies suggesting that Problem-Based Learning combined with technology-based learning media can improve students' engagement, scientific reasoning, and problem-solving performance. Therefore, the implementation of the PBLWVL model can be considered an effective and innovative learning strategy for enhancing physics learning outcomes and preparing students to face complex real-world problems in the digital era.

CONCLUSION

Based on the results of the research and discussion conducted regarding the effect of the Problem-Based Learning with Virtual Laboratory (PBLWVL) model on students' problem-solving abilities in the topic of energy sources, it can be concluded that the implementation of the PBLWVL model resulted in an improvement in students' problem-solving abilities categorized within the medium criteria. Among the assessed indicators, the highest level of improvement was achieved in the specific application of physics concepts indicator, demonstrating that students became more capable of applying physics principles to solve contextual problems systematically. Furthermore, for future research, it is recommended that researchers consider allocating more effective learning time management so that all stages of the learning process can be implemented completely and optimally.

REFERENCES

Ansari, A. H., Alpisah, & Yusuf, M. (2022). Konsep dan Rancangan Manajemen Kurikulum Merdeka di Tingkat Sekolah Menengah Pertama. Pusat Publikasi Pendidikan IPS FKIP ULM, 34-45.

Arikunto. (2015). Prosedur Penelitian Suatu Pendekatan Praktik. Jakarta: Rineka Cipta.

Docktor, J., & Heller, K. (2009). Robust Assesment Instrument for Student Problem Solving. Proceding of the Narst.

Ekawati, N. E. (2017). Peningkatan Kemampuan Pemecahan Masalah Fisika dengan Model Pembelajaran Problem Based Learning. Jurnal Komunikasi Pendidikan.

Grant, M., & Tamim, S. (2019). PBL in K - 12 Education. USA: John Wiley & Sons.

Helyandari, B. H., Sahidu, H., & Hikmawati. (2020). Pengaruh Model Pembelajaran Problem Based Learning Terhadap Hasil Belajar Peserta Didik MA Darul Hikmah Darek Tahun Pelajaran 2019/2020. KONSTAN: Jurnal Fisika dan

Kemendikbudristek. (2022). Capaian Pembelajaran Fisika SMA/MA paket C, BSKAP, Jakarta.

Kemendikbudristek. (2021). Modul PPG, Pembelajaran Inovasi Abad 21, Jakarta.

Khoriyah, I., Rosidin, U., & Suana, W. (2018). Perbandingan Hasil Belajar Menggunakan PhET Simulation dan KIT Optika Melalui Inkuiri Terbimbing. Jurnal Pembelajaran Fisika.

Riduwan. (2011). Skala Pengukuran Variabel Penelitian. Bandung: Alfabeta.

Sugiyono. (2015). Metode Penelitian Pendidikan. Bandung: Alfabeta.