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The Effectiveness of the STEAM-based PBL Model in Understanding Basic Electrical Concepts among Vocational High School Students

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Abstract

This research explores the effectiveness of the STEAM-based Problem-Based Learning (PBL) model in improving Vocational High School (SMK) students' understanding of basic electrical concepts. Through a literature review of 12 articles published since 2020, the study synthesizes findings on the integration of STEAM (Science, Technology, Engineering, Arts, and Mathematics) into PBL to promote deeper conceptual understanding and practical skills. The results show that the STEAM-based PBL model enhances student engagement, collaboration, and problem-solving skills by linking theory to real-life applications. This approach not only improves knowledge retention but also fosters the development of critical thinking and teamwork, which are essential for vocational students' success. The study concludes that this model is highly effective for vocational education, recommending its broader implementation to better prepare students for future challenges in technical fields. The novelty of this research lies in its focus on the combined application of STEAM and PBL in vocational education, providing a comprehensive approach to both theoretical and practical learning.

Keywords: PBL Model Effectiveness; STEAM; Concept Understanding

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INTRODUCTION

Learning is a reciprocal interaction between educators and students aimed at achieving national education standards. (Widyastuti & Airlanda, 2021). Students not only play an important role in the classroom learning process, but they also actively participate to ensure that the learning goes well (Wahyu Ariyani & Prasetyo, 2021). The government recognizes the importance of learning in improving the quality of human resources, and therefore continues to make efforts

to enhance the quality of education (Septiyowati & Prasetyo, 2021). It is hoped that teachers can choose the right learning model so that students can understand the lesson material well, especially in the subject of Basic Electricity (Amalia & Hardini, 2020). In addition, teachers are expected to achieve learning objectives through innovative and enjoyable methods for students (Ayudya & Rahayu, 2020).

The learning process involves various elements such as teachers, students, and learning materials that interact with each other (Lisnawati et al., 2022). A good understanding of the characteristics and principles of learning by teachers is very important to ensure that the learning taking place in the classroom has substantial value (Budi et al., 2021). Students who have a good understanding of concepts are able to make mature decisions in problem-solving (Ati & Setiawan, 2020). Indicators of successful concept understanding are when students can actively participate in discussions, provide various relevant answers, and solve problems effectively (Rahmadana et al., 2023).

A deep understanding of the subject matter is an important element in achieving the expected learning outcomes (Faudziah & Budiman, 2023), which enables students to identify, analyze, and solve problems creatively and logically (Riyanto et al., 2024). This sustained understanding also supports students in developing lifelong learning abilities and empowers them to contribute creatively in their future careers (Darwati & Purana, 2021).

However, students often lose interest when studying the basic theory of electricity because the teaching model applied is less engaging (Lestari & Winanto, 2022). o address this, a learning model is needed that encourages students to actively participate in the teaching and learning process (Irfani Lindawati & Rahayu, 2021). To address this, a learning model is needed that encourages students to actively participate in the teaching and learning process (Hasanah & Fitria, 2021). The improvement of students' understanding in the subject of Basic Electricity can be achieved by applying the Problem-Based Learning (PBL) model (Sari et al., 2021). The PBL model is capable of creating a challenging learning environment and stimulating the development of students' thinking skills (Masliah et al., 2023). This is because PBL involves students in real problem-solving processes, which forces them to think more critically and reflectively (Amini et al., 2021).

PBL requires students to be confronted with real problems, incomplete information, and questions that need answers (Utami & Sabri, 2020). The main principle of the PBL model is to provide challenges in the form of problems that must be solved during the learning process, with the aim of stimulating students to develop an open, reflective, and critical mindset (Prandifa et al., 2023). This approach also aims to enhance students' conceptual understanding and problem-solving skills. PBL reveals and clarifies students' thinking processes, as well as the cognitive processes involved (Idris, 2020).

The achievement of learning objectives predominantly depends on educators as designers of the learning process (Rais et al., 2023). Additionally, problem-based learning is intended to help students acquire social skills and the ability to learn independently (Saputra, 2020). Problem-based learning consists of six steps or problem-solving methods: problem formulation, problem analysis, hypothesis formulation, data collection, and hypothesis testing (Regianti, 2021).

Considering the issues that have arisen, activities aimed at enhancing children's abilities by applying the STEAM method must be created (Agusniatih & R., 2022). One of the advantages of the STEAM approach is that students are taught to think broadly and use the principles of science, technology, engineering, art, and mathematics when solving problems (Santi, 2022). STEAM integrates simple scientific technology-based activities and enhances problem-solving skills, especially in the context of everyday life (Farida et al., 2023).

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The STEAM method is used in education because students' understanding of the material can be enhanced by showing the connection between the lessons they learn in school and everyday life situations (Febriansari et al., 2022). In the research Febriani et al (2023), by linking the subject matter with contemporary contexts and providing STEAM-based worksheets as learning aids, STEAM education has the potential to improve students' understanding of concepts. The striking difference between the STEAM approach and other science learning models lies in its focus on emphasizing learning how students can overcome real-life challenges through the application of scientific methods (Prabowo et al., 2015).

Mastery of basic electrical concepts not only encompasses technical skills but also requires intellectual skills that support the development of literacy in the field of electricity (Fidyarini et al., 2024). Mastery of basic electrical concepts not only encompasses technical skills but also requires intellectual skills that support the development of literacy in the field of electricity (Junaid et al., 2021). The purpose of this study is to provide basic electrical concept education to vocational high school students.

METHODS

The research design applied is a literature study aimed at evaluating the effectiveness of the Problem-Based Learning (PBL) model in improving the understanding of Basic Electricity concepts. The literature review method involves collecting data from sources related to the research topic (Parinata & Puspaningtyas, 2022), with relevant theories supporting the research focus. Data is managed and linked to these theories to establish a foundation for the study (Qorimah & Sutama, 2022). Data sources are gathered through Google Scholar using the keywords "PBL Model for Concept Understanding" and "STEAM Method for Concept Understanding," filtering articles published since 2020. Twelve relevant articles were identified based on specific criteria, including the effectiveness of PBL learning, the use of the STEAM method, and concept understanding.

The research method is a literature review, which systematically gathers and analyzes existing studies on the PBL and STEAM approaches for understanding electrical concepts. This method is qualitative, aiming to synthesize information from various academic sources to draw conclusions about the effectiveness of the teaching methods.

Data validity is ensured by carefully selecting literature that aligns with the determined criteria, such as research that specifically examines the effectiveness of PBL and STEAM in educational settings. The studies selected were published after 2020 to ensure the findings are current and relevant. The cross-referencing of theoretical frameworks with empirical findings further strengthens the validity of the conclusions drawn from the literature.

The analysis involves a thematic review of the identified literature, focusing on key themes such as the impact of PBL on concept retention, the integration of STEAM into PBL, and how these methods contribute to deeper student engagement and understanding. The articles are critically analyzed to determine patterns, common findings, and variations, which are then synthesized to form a comprehensive conclusion about the use of PBL and STEAM in vocational education.

Table 1. *Selected Article Data*

No	Article Title	Author	Publication Year
1	The Urgency of the Science, Technology, Engineering, Arts, and Math (STEAM) Learning Model for Students	Winda Amelia dan Arita Marini	2022
2	The Influence of the Application of the STEAM Approach on Static Fluid Material on the Conceptual Understanding of 11th Grade Students at SMA Negeri 1 Jangka	Rauzatul Jannah dan M Taufiq	2022
3	The Effectiveness of Science Learning Using the Problem-Based Learning Model on Critical Thinking Skills	Debi Hardian Saputra, Ermila Mahariyanti dan Irwansah	2024
4	The Effectiveness of the Problem Based Learning (PBL) Model on Concept Understanding and Learning Outcomes in the Straight Line Equation Material for Eighth Grade at SMP Negeri 2 Tapian Dolok	Elnita Nababan, Yanty Maria Marbun, dan Belsasar Sihombing	2024
5	Study on the Integration of STEAM in the Problem-Based Learning Model on Students' Adversity Quotient in Mathematics Education	Salsabila Naura Sari, Dita Nurdianti, dan Bagus Surya Maulana	2022
6	Improving Understanding of Mathematical Concepts using a Steam (Science, Technology, Engineering, Arts, and Mathematics) Based Online Approach	Via Arti Oktaviani, Dyah Lyesmaya, dan Luthfi Hamdani Maula	2020
7	The Effectiveness of the Problem Based Learning (PBL) Model in PAI Subjects for Eighth Grade at SMP Muhammadiyah Bondowoso	Kholifah Nur Rohman Ariyanto, Siti Nursyamsiyah, dan Badrut Tamami	2023
8	The Application of the STEAM Approach to Atomic Structure Material on Understanding Chemistry Concepts	Anik Pujiati	2020
9	The Effectiveness of the Basic Problem-Based Learning Method in Improving Pancasila Education Learning Outcomes	Aprillia Dian Rahayu dan Zaka Hadikusuma Ramadan	2024
10	Problem Based Learning Model Based on Monopoly Game Media in Improving Elementary School Students' Understanding	Alfauziah Rahmadani, Andy Ariyanto, Nafiah Nur Shofia Rohmah, Yulia Maftuhah Hidayati, dan Anatri Desstya	2023
11	The Effectiveness of the Problem Based Learning Model in the Basic Electricity and Electronics Subject in Class X at SMK Negeri 1 Bukit Tinggi	Suci Aldia dan Riki Mukhaiyar	2020

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RESULTS AND DISCUSSION

Effectiveness of the STEAM-based PBL Model

The combination of Problem-Based Learning (PBL) with the STEAM approach (Science, Technology, Engineering, Arts, and Mathematics) has proven to be a highly effective strategy in enhancing various aspects of learning. There are several reasons and evidence supporting the STEAM-based PBL model, as follows: The STEAM-based PBL (Project-Based Learning) model helps students develop modern skills such as critical thinking, problem-solving, collaboration, and idea-sharing, which are essential in today's world. This model enhances student motivation and engagement by assigning projects relevant to real-life situations and student interests, fostering a deeper enthusiasm for learning. The STEAM approach integrates multiple disciplines, allowing students to see the connections between areas such as Technology (programming), Engineering (product design), Science (physics concepts), and Arts (aesthetic elements) in a single comprehensive project. Through PBL, students not only memorize facts but also gain a deeper understanding of concepts, applying their knowledge to real-world problems, which reinforces their learning and helps them internalize what they have learned.

The STEAM-based PBL model has been proven to enhance students' understanding of basic electrical concepts. Students involved in this approach will face real-world situations that require practical solutions, which in turn will encourage their active engagement in the learning process. In the study by Jannah and Rahma (2022), the improvement in conceptual understanding is reflected in the research results, where the use of STEAM learning resulted in an average final exam score of 81, compared to the control group that used the scientific learning approach, which only achieved an average score of 77. This is due to the PBL approach, which encourages students to explore and understand the material in depth.

The STEAM-based PBL model also shows a significant increase in student motivation and engagement. Students feel more motivated and engaged in learning when they see a direct relevance between the lessons and real-world applications. The results of Haridiana et al. (2024) indicate that the STEAM method can enhance students' mathematical modeling abilities in static electricity material by applying a problem-based learning model.

These findings affirm that the STEAM-based PBL model is an effective method for teaching basic electrical concepts to vocational high school students. The integration of PBL with the STEAM approach not only enhances conceptual understanding but also develops practical skills and higher-order thinking that are highly needed in the workforce. Successful implementation requires training for teachers to adopt the STEAM-based PBL approach, as well as support from schools and the government in the form of adequate resources and facilities.

Overall, the STEAM-based PBL model offers a holistic and integrative learning approach that not only enhances students' academic achievements but also prepares them with the skills necessary for success in the future. The effective implementation of this model can bring positive changes in vocational education and provide long-term benefits for students. Additionally, the effectiveness of the STEAM-based PBL model highly depends on good planning and proper execution, including effective teacher guidance and adequate resource support. Therefore, this model has the potential to become a very powerful tool for improving the quality of education and preparing students to face the challenges ahead.

Understanding Basic Electrical Concepts

Conceptual understanding is the ability to comprehend, interpret, and apply the basic ideas or principles of a particular field of study or topic. This understanding goes beyond merely memorizing facts; it includes the ability to identify relationships between concepts, understand the application of these concepts in various situations, and use this knowledge to solve problems or make appropriate decisions.

Understanding concepts is very important for the learning process and student development. A deep understanding of basic concepts builds a strong foundation for advanced learning. When students have a solid understanding of basic concepts, they can more easily comprehend and master more complex concepts in the future. Conceptual understanding allows

students to develop problem-solving skills. By applying the concepts they have understood in various contexts, students can face and resolve problems or situations they have never encountered before.

Understanding the concept of electrical testing tools is an important foundation in operating and comprehending the devices and instruments used to measure, analyze, and verify various electrical parameters in the context of electronic systems or devices. By utilizing various tools such as multimeters, oscilloscopes, power supplies, function generators, LCR meters, insulation testers, and earth ground testers, professionals in the field of electrical engineering can conduct comprehensive and accurate testing. This helps them ensure optimal performance and the safety of the electrical and electronic systems they handle.

In the study by Prayuda & Eliza (2020), students showed a lack of motivation in participating in the learning process, partly due to their tendency to feel bored with the course of the learning process. In several basic competencies of the subject Fundamentals of Electricity, the material taught can actually be presented in a tangible form. One of the basic competencies that can be illustrated in the learning process is the properties of active components. Where the equipment and materials used include diodes, transistors, and thyristors. However, educators face difficulties in illustrating concrete examples related to the material and encounter challenges in facilitating students' understanding due to a lack of media support in the learning process. As a result, students have difficulty understanding the material, which affects their learning outcomes.

The E-phase electrical testing measuring instrument is generally equipped with various features and functions that allow its use in different contexts, ranging from simple measurements to more complex testing. Features that are often possessed by this tool include the ability to measure phase voltage, phase current, and power factor. Additionally, some tools may also be equipped with extra features such as harmonic monitoring, harmonic measurement, and wave analysis.

With a strong understanding of the basic concepts related to the E-phase electrical testing measuring instrument, technicians have the ability to effectively utilize the tool in various activities, including maintenance, troubleshooting, and electrical system development. This understanding allows them to take appropriate preventive actions, quickly detect potential problems, and ensure optimal performance of the electrical systems they are handling.

CONCLUSION

This research concludes that the STEAM-based PBL (Problem-Based Learning) model is effective in enhancing Vocational High School (SMK) students' understanding of basic electrical concepts. It significantly improves student engagement by integrating Science, Technology, Engineering, Arts, and Mathematics, allowing students to develop holistic and contextual understanding through real-life problem-solving. The model encourages collaboration among students and fosters interactions with educators, enhancing social skills, communication, and teamwork, which are essential for the workforce. By bridging theory and practice, this approach not only helps students grasp conceptual knowledge but also equips them with practical skills applicable to various work situations. Therefore, the STEAM-based PBL model is highly recommended for broader application in technical and vocational education.

REFERENCES

Agusniatih, A., & R., S. M. (2022). Implementasi Pembelajaran STEAM melalui Kegiatan Fun Cooking Sebagai Pembelajaran Abad 21. *Jurnal Obsesi : Jurnal Pendidikan Anak Usia Dini*, *6*(6), 6502–6512. https://doi.org/10.31004/obsesi.v6i6.3418

Amalia, G. R., & Hardini, A. T. A. (2020). Efektivitas Model Problem Based Learning Berbasis Daring terhadap Hasil Belajar IPA Kelas V Sekolah Dasar. *Jurnal Ilmiah Wahana Pendidikan*, *6*(3), 424–431. https://doi.org/10.5281/zenodo.3977422

e-ISSN 0216-0847
https://journal.unnes.ac.id/journals/LIK

Amini, J. N., Irwandi, D., & Bahriah, E. S. (2021). the Effectiveness of Problem Based Learning Model Based on Ethnoscience on Student'S Critical Thinking Skills. *JCER (Journal of Chemistry Education Research)*, *5*(2), 77–87. https://doi.org/10.26740/jcer.v5n2.p77-87

Ati, T. P., & Setiawan, Y. (2020). Efektivitas Problem Based Learning-Problem Solving Terhadap Kemampuan Berpikir Kritis dalam Pembelajaran Matematika Siswa Kelas V. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *4*(1), 294–303. https://doi.org/10.31004/cendekia.v4i1.209

Ayudya, M. S., & Rahayu, T. S. (2020). Efektivitas Model Problem Based Learning Dan Think Pair Share Ditinjau Dari Kemampuan Berpikir Kritis Siswa Kelas 5 Dalam Pelajaran Matematika Dasar. *Jurnal Pendidikan Tambusai*, *4*(1), 272–281. https://jptam.org/index.php/jptam/article/view/458

Darwati, I. M., & Purana, I. M. (2021). Problem Based Learning (PBL) : Suatu Model Pembelajaran Untuk Mengembangkan Cara Berpikir Kritis Peserta Didik. *Widya Accarya*, *12*(1), 61–69. https://doi.org/10.46650/wa.12.1.1056.61-69

Farida, N., Ningsih, R. W., Inta, A., & Ndruru, J. (2023). Pengaruh Model Pembelajaran STEAM terhadap Perkembangan Kognitif Anak Usia 5-6 Tahun. *Journal on Education*, *06*(01), 10383–10399.

Faudziah, W. S., & Budiman, I. A. (2023). Efektivitas Penggunaan Model Problem Based Learning (PBL) terhadap Kemampuan Berpikir Kritis Matematis Siswa SD. *Papanda Journal of Mathematics and Science Research*, *2*(1), 22–29. https://doi.org/10.56916/pjmsr.v2i1.272

Fidyarini, L., Zairina, N., Supiani, Parhan, Pala, N., Mahsup, Muhibbin, Sitisaini, Hidayat, T., Zainuddin, Mursalim, & Nurmala, S. (2024). Peningkatan Hasil Belajar Siswa Dengan Menggunakan Model Problem Based Learning Berbantuan Media Canva. *Jurnal Sains dan Teknologi*, *7*(1), 75–81.

Hasanah, M., & Fitria, Y. (2021). Pengaruh Model Problem Based Learning Terhadap Kemampuan Kognitif IPA pada Pembelajaran Tematik Terpadu. *Jurnal Basicedu*, *5*(3), 1509–1517. https://jbasic.org/index.php/basicedu/article/view/968

Idris, N. W. (2020). Pengaruh Model Pembelajaran Berbasis Masalah Terhadap Kemampuan Berpikir Kritis Peserta Didik. *Jurnal Sains dan Pendidikan Fisika*, *16*(1), 39. https://doi.org/10.35580/jspf.v16i1.15284

Irfani Lindawati, Y., & Rahayu, A. (2021). Efektifitas Model Pembelajaran Problem Based Learning pada Pembelajaran Jarak Jauh. *Indonesian Journal of Social Sciences and Humanities*, *2*(1), 1–8. https://journal.publication-center.com/index.php/ijssh/article/view/716/173

Junaid, M., Salahudin, S., & Anggraini, R. (2021). Pengaruh Model Pembelajaran Problem Based Learning Terhadap Pemahaman Konsep Ipa Siswa Di Smpn 17 Tebo. *Physics and Science Education Journal (PSEJ)*, *1*(April), 16. https://doi.org/10.30631/psej.v1i1.709

Lestari, S., & Winanto, A. (2022). Efektivitas Model Pembelajaran Inquiry dan Problem Based Learning terhadap Kemampuan Memecahkan Masalah Matematika Siswa Sekolah Dasar. *Jurnal Basicedu*, *6*(6), 9967–9978. https://doi.org/10.31004/basicedu.v6i6.4203

Lisnawati, T., Suroyo, S., & Pribadi, B. A. (2022). Efektivitas Model Pembelajaran Kelompok dan Problem Based Learning pada Studi Sosial Terhadap Hasil Belajar Siswa Berdasarkan Gaya Belajar Siswa Sekolah Dasar. *Jurnal Basicedu*, *6*(2), 2912–2921. https://doi.org/10.31004/basicedu.v6i2.2521

Masliah, L., Nirmala, S. D., & Sugilar, S. (2023). Keefektifan Model Pembelajaran Problem Based Learning (PBL) terhadap Kemampuan Literasi dan Numerasi Peserta Didik di Sekolah Dasar. *Jurnal Basicedu*, *7*(1), 1–10. https://doi.org/10.31004/basicedu.v7i1.4106

Prabowo, A. Z., Satoto, K. I., & Martono, K. T. (2015). Perancangan dan Implementasi Augmented Reality sebagai Media Promosi Penjualan Perumahan. *Jurnal Teknologi dan Sistem Komputer*, *3*(1), 161–170. https://doi.org/10.14710/jtsiskom.3.1.2015.161-170

Prandifa, R., Arsih, F., & Alberida, H. (2023). Pengaruh Model Pembelajaran Problem Based Learning (PBL) Terhadap Kemampuan Berpikir Kritis Siswa Pada Pembelajaran Biologi Di SMP Negeri 3 Bolaang. *Jspb Bioedusains*, *7*, 407–417. http://ejurnal.unima.ac.id/index.php/bioedusains/article/view/7756

Rahmadana, J., Khawani, A., & Roza, M. (2023). Penerapan Model Problem Based Learning untuk Meningkatkan Kemampuan Berpikir Kritis Peserta Didik Sekolah Dasar. *Jurnal Basicedu*, *7*(1), 224–230. https://doi.org/10.31004/basicedu.v7i1.4278

Regianti, A. M. (2021). Peran Profesionalisme Guru Dalam Penggunaan Model Pembelajaran Berbasis Masalah Pada Mata Pelajaran Matematika. *Universitas Muhammadiyah Sidoarjo*, 1–6.

Santi, E. L. (2022). Pendekatan STEAM Pada Project Based Learning Mewujudkan Merdeka Belajar Untuk Meningkatkan Kreativitas Siswa. *Jurnal Pendidikan Dasar*, *3*(2), 77–81. http://jurnal.umpwr.ac.id/index.php/jpd/article/view/2240

Sari, Y. K., Juandi, D., Tamur, M., & Adem, A. M. G. (2021). Meta-Analysis: Mengevaluasi Efektivitas Problem Based Learning Pada Kemampuan Pemahaman Matematis Siswa. *Journal of Honai Math*, *4*(1), 1–18. https://doi.org/10.30862/jhm.v4i1.144

Septiyowati, T., & Prasetyo, T. (2021). Efektivitas Model Pembelajaran Problem Based Learning Dan Discovery Learning Terhadap Kecakapan Berfikir Kritis Siswa Sekolah Dasar. *Jurnal Basicedu*, *5*(3), 1231–1240. https://jbasic.org/index.php/basicedu/article/view/893

Sitompul, N. N. S. (2021). Pengaruh Model Pembelajaran Problem Based Learning terhadap Peningkatan Kemampuan Berpikir Kritis Matematis Siswa SMP Kelas IX. *GAUSS: Jurnal Pendidikan Matematika*, *4*(1), 45–54. https://doi.org/10.30656/gauss.v4i1.3129

Wahyu Ariyani, O., & Prasetyo, T. (2021). Efektivitas Model Pembelajaran Problem Based Learning dan Problem Solving terhadap Kemampuan Berpikir Kritis Siswa Sekolah Dasar. *Jurnal Basicedu*, *5*(3), 1149–1160. https://doi.org/10.31004/basicedu.v5i3.892