



UNLOCKING COGNITIVE POTENTIAL: ENHANCING PROBLEM-SOLVING ABILITIES THROUGH INNOVATIVE PROBLEM-BASED LEARNING MODELS

Elza Triani¹, Listyana Oktami², Delicia Inghug³, dan Nabila Nur Rizqiyah⁴

¹ Universitas Jambi, Jambi, Indonesia

² Junior high school 2 Babat Supat, Betung, Indonesia

³ Eastern Visayas State University, Tacloban City, Philippines

⁴ Universitas Bengkulu, Bengkulu, Indonesia

Corresponding author email: elzatriani02@email.com

Article Info

Received: 30 Nov 2023

Revised: 14 Jan 2024

Accepted: 30 Mar 2024

OnlineVersion: 30 Apr 2024

Abstract :

In this context, this literature review article aims to analyze how PBL can be a strong foundation in developing students' problem solving skills in the realm of science learning, as well as highlighting practical implications for education in the future. This research method uses qualitative. The data collection technique uses literature study, which is a technique used to collect data and theoretical and research sources related to the topic raised in a study. Types of secondary data obtained from published articles related to the PBL learning model in improving students' science problem solving skills. The analysis technique is carried out using a synthetic matrix. This research procedure begins with determining article search keywords, searching for literature articles on Goggle Scholar, selecting articles according to keywords, and analyzing the articles and their findings. The conclusion from the results of the literature study carried out regarding how the problem based learning model has an impact on students' problem solving skills in science learning is that by implementing this problem based learning model it will improve students' problem solving skills. This is proven by the results of 10 studies that have been analyzed.

Keywords: Education, Problem Solving, Science Learning

This is open access article under the [CC BY-NC-SA](https://creativecommons.org/licenses/by-nc-sa/4.0/) licence



INTRODUCTION

Education is one of the most basic aspects for advancing a country (Dwi et al., 2022; Fadilla et al., 2021; Kamid et al., 2021). Progress in education really depends on how planning, implementation and supporting policies are carried out continuously (Santika, 2020). This educational policy is implemented during the learning process at school which is carried out by the school community (Wicaksono et al., 2021). The importance of effective learning as the foundation for educational success is reflected in the expectations of every educational institution for graduates who meet competency standards that make the school proud. Dynamic interaction between teachers and students is a learning process that produces evidence of success in the form of graduation (Fatimah, 2023).

Learning natural sciences emphasizes the importance of practical experience to develop skills that enable scientific exploration and understanding of the surrounding environment (Darmaji et al., 2022). The importance of science lies in its role as very important preparation for students to face various challenges in this modern era (Rusilowati et al., 2019). Science as a process is a method or way of acquiring knowledge that helps students develop new understanding. Meanwhile, as a result, science is known as a body of knowledge consisting of facts obtained from research results (Kartika, 2023). At the high school level, students not only learn the concepts and practices of natural sciences, but are also given skills training that is relevant to their daily lives.

In an era that continues to develop with demands for higher adaptation and innovation skills, the ability to solve problems has become a crucial asset in the context of education and the professional world. Problem solving is not just a tool for overcoming obstacles, but is the foundation for the exploration of ideas, decision making, and progressive change in various domains of life. Learning models play an important role in forming these skills, and among various approaches, the Problem-Based Learning Model has emerged as one of the promising methods. In this case, meta-analysis becomes a valuable instrument to summarize previous research to provide a more comprehensive understanding of the effectiveness of this model in improving problem-solving skills.

A number of studies have supported the effectiveness of the Problem-Based Learning Model in stimulating students' critical thinking, creativity and collaborative abilities. However, there are doubts and variations in the results of studies that have been conducted, as well as a need to measure the extent to which these models consistently improve problem-solving skills in various educational contexts. The ever-advancing development of technology provides convenience but also presents new challenges in the lives of every individual. To face the challenges of progress in the 21st century, through the field of education, students are equipped with various skills through 21st century learning. This 21st century learning content has come to be known as 4C (Communication, Collaboration, Critical Thinking and Problem Solving, and Creativity and Innovation) (Prayogi & Estetika, 2019).

One of the skills that is currently important for students to have in 21st century learning is problem solving skills. Problem solving skills are the main key for students in facing the complexity of the modern world. In the realm of Natural Sciences learning, it is important not only to understand basic concepts, but also to encourage students to become creative and analytical problem solvers. One learning method that has been proven effective in improving the ability to solve problems is the Problem Based Learning (PBL) approach.

PBL offers an engaging approach, allowing students to actively engage in solving real problems or authentic scenarios. By focusing on the use of science content as a tool for solving problems, this model not only deepens understanding of concepts, but also fosters problem-solving skills, critical thinking, collaboration, and independent learning. In this literature review article, we will explore related studies that explore the effectiveness of PBL in improving students' problem solving skills in science learning.

In line with the results of previous research, it was revealed that the overall influence of implementing PBL on students' mathematical problem solving abilities had a high category influence. Apart from that, the magnitude of the effect of applying the PBL model on problem solving abilities between study groups does not differ based on the characteristics of education level, class, sample size, and year of study (Musna et al., 2021). Moving on from previous research, this research analyzes the problem based learning model on problem solving abilities in natural science learning in junior high schools.

This research is important because problem-solving ability is a core skill needed in various life contexts, from education to the world of work. By using a problem-based learning model, we can strengthen individuals' abilities to identify, analyze and solve problems more effectively. Thus, this research brings urgency to improving the quality of education and work readiness of individuals. The results of this research can have broad implications in the context of education, training and professional development. Educational institutions and training organizations can use these findings to develop more effective curricula and learning programs. In addition, organizational leaders can also utilize this research to design more efficient and productive employee development strategies. This research makes an important contribution to our understanding of the effectiveness of problem-based learning models in improving problem-solving abilities. By analyzing data from multiple studies, these meta-analyses

can identify patterns and trends that may not be visible in individual studies. The results may provide new insights and in-depth understanding of the factors that influence the effectiveness of these learning models, opening the door to further innovation and improvements in education and training.

Therefore, in an effort to explore and formulate a more comprehensive view regarding the role of the Problem-Based Learning Model in improving problem-solving skills, this meta-analysis aims to be a significant contribution to the educational literature. Through synthesis and analysis of various studies, we will describe the role of PBL as a learning approach that not only has a significant impact on students' problem solving skills, but also touches on important aspects in the natural science learning process. In this context, this literature review article aims to analyze how PBL can be a strong foundation in developing students' problem solving skills in the realm of science learning, as well as highlighting practical implications for education in the future.

RESEARCH METHOD

This study is a literature analysis that uses a descriptive approach through a literature review to evaluate improvements in problem solving abilities through the application of the problem based learning model. The literature study approach is a technique that allows collecting data in the form of information, theory and research related to the topic being investigated in a study (Parinata & Puspaningtyas, 2022). The data used is secondary data, namely research articles that are relevant to current research. The article review process in this research is focused on the problem based learning model to improve problem solving skills in science lessons. The data collection instrument includes reviewing scientific articles from Google Scholar with article selection criteria based on certain keywords and a maximum publication limit of the last 10 years. A total of 10 articles, including articles from national and international levels, have been selected for review by researchers who focus on this research topic.

The analysis process uses a synthesis matrix, which is a framework in the form of tables/diagrams that allows researchers to group and classify various arguments from several articles and combine different elements to evaluate the overall impression of the articles. In this research, researchers created a table that included information such as journal name, author (year), title, and findings. The steps in this research begin with determining article search keywords, searching for literature from Google Scholar, filtering articles according to keywords, and analyzing the contents of the articles and their findings.

RESULTS AND DISCUSSION

The literature review process was carried out on selected scientific articles based on the topics studied related to the analysis of problem based learning models in improving junior high school students' problem solving skills in science learning. The number of articles reviewed was 10 articles. The following results of a review article about this research are presented in the table 1.

Table 1. Results of an article review regarding students' problem solving skills using the problem based learning model

No.	Journal Name	Author (Year)	Title	Findings
1.	TEACHING : Jurnal Inovasi Keguruan dan Ilmu Pendidikan	(Wahyuningsih et al., 2023)	Upaya Peningkatan Keterampilan Pemecahan Masalah Dan Hasil Belajar Peserta Didik Menggunakan Model Problem Based Learning [Efforts to Improve Problem Solving Skills and Student Learning Outcomes Using the Problem Based Learning Model]	The results of research in class 1 of Muhammadiyah Pakel Elementary School for the 2022/2023 academic year show that the application of the problem based learning model has a positive impact on students' problem solving skills. There was a significant increase in the percentage of students' overall problem solving skills in mathematics

No.	Journal Name	Author (Year)	Title	Findings
2.	JPPSI: Jurnal Pendidikan dan Pembelajaran Sains Indonesia	(Sumiantari et al., 2019)	Pengaruh Model Problem Based Learning Terhadap Kemampuan Pemecahan Masalah IPA Siswa Kelas VIII SMP [The Influence of the Problem Based Learning Model on the Science Problem Solving Ability of Class VIII Middle School Students]	subjects, especially in plane material. Research findings show that students taught using the PBL model have superior problem solving abilities compared to those taught using the STAD type cooperative model. This can be seen from the average posttest score for the PBL group of 74.50, which is in the sufficient category, while the group taught with the STAD model got a score of 45.94 which is in the very low category.
3.	Jurnal Pendidikan MIPA	(Mariana et al., 2022)	Pengaruh Model Problem Based Learning terhadap Peningkatan Pemecahan Masalah Siswa pada Pembelajaran IPA [The Influence of the Problem Based Learning Model on Increasing Student Problem Solving in Science Learning]	From the research results, it can be concluded that the use of the Problem Based Learning model has an impact on students' ability to solve problems in class VIII SMP Kartikatama Metro.
4.	JUPE: Jurnal Pendidikan Mandala	(Azizi et al., 2019)	Penerapan Model Problem Based Learning Untuk Meningkatkan Kemampuan Memecahkan Masalah Dan Sikap Peduli Lingkungan Siswa SMP Darul Aminin NW Aikmual Tahun 2019 [Application of the Problem Based Learning Model to Improve Problem Solving Ability and Environmental Care Attitudes of Darul Aminin NW Aikmual Middle School Students in 2019]	From the research results, it appears that the increase in problem solving abilities of students who received PBL (0.440) was higher than those who did not receive PBL (0.281), with a significant difference ($t_{count} (56) = 2.213 > t_{table} = 1.671$). Apart from that, the environmental care attitude of students who take part in PBL is also higher than those who do not take part in PBL. Thus, the Problem Based Learning Model has a significant impact on improving the problem-solving abilities and environmental care attitudes of junior high school students.
5.	UPENJI: Jurnal Pendidikan Jompa Indonesia	(Nuningsih et al., 2022)	Implementasi Pembelajaran Problem Based Learning Untuk Meningkatkan kemampuan Pemecahan Masalah Siswa	The research results showed that students' ability to solve problems showed improvement in several aspects after the learning cycle was carried out.

No.	Journal Name	Author (Year)	Title	Findings
6.	Jurnal Kumparan Fisika	(Santoso et al., 2020)	[Implementation of Problem Based Learning to Improve Students' Problem Solving Abilities] Upaya Meningkatkan Motivasi Belajar Dan Kemampuan Pemecahan Masalah Siswa Melalui Model Problem Based Learning Berbantu Alat Peraga Konsep Gerak Lurus [Efforts to Increase Students' Learning Motivation and Problem Solving Ability through the Problem Based Learning Model Assisted by Props for the Concept of Straight Motion]	Applying the Problem Based Learning model with the help of teaching aids can increase students' learning activities, learning motivation and problem solving abilities.
7.	ORBITA. Jurnal Hasil Kajian, Inovasi, dan Aplikasi Pendidikan Fisika	(Anggraini et al., 2022)	Analisis Effect Size Pengaruh Model Problem Based Learning Terhadap Keterampilan Berpikir Kritis Dan Pemecahan Masalah [Effect Size Analysis of the Influence of the Problem Based Learning Model on Critical Thinking and Problem Solving Skills]	From the research results, it is proven that the problem based learning model has a significant influence on critical thinking and problem solving skills in science and physics learning, with an average effect size value of 1.3 and 1.16 respectively, which is included in the very high category. . Based on education level, the largest impact was seen in elementary school for critical thinking skills, while for problem solving skills, the largest impact was seen in junior high school. When viewed from class level, the most significant impact occurred in grade V of elementary school, and based on subjects, the largest impact occurred in science subjects. Thus, it was found that the application of the problem based learning model had a high impact on students' critical thinking and problem solving skills in learning science and physics.

No.	Journal Name	Author (Year)	Title	Findings
8.	ORBITA. Jurnal Hasil Kajian, Inovasi, dan Aplikasi Pendidikan Fisika	(Aini et al., 2020)	Pengaruh Model Pembelajaran Perolehan Konsep Berbasis Masalah Terhadap Kemampuan Pemecahan Masalah Dan Pemahaman Konsep Fisika Peserta Didik Kelas Xi Mia Man 1 Mataram [The Influence of the Problem-Based Concept Acquisition Learning Model on the Problem Solving Ability and Understanding of Physics Concepts of Students in Class Xi Mia Man 1 Mataram]	The results of hypothesis testing show a significance value of 0.00. Using a significance level of 0.05, the results show that the value $0.00 < 0.05$, indicates rejection of H_0 and acceptance of H_a . Therefore, it can be concluded that the problem-based concept acquisition learning model has an influence on the problem-solving abilities and understanding of physics concepts of class XI MIA MAN1 Mataram students.
9.	Diklabio: Jurnal Pendidikan dan Pembelajaran Biologi	(Liayunika & Sri, 2019)	Penerapan Model Pembelajaran Berbasis Masalah Untuk Meningkatkan Kemampuan Memecahkan Masalah Kelas VIIE SMPN 6 Kota Bengkulu [Application of the Problem-Based Learning Model to Improve Problem Solving Ability for Class VIIE SMPN 6 Bengkulu City]	The findings of this research are that the Problem Based Learning model is successful in improving students' ability to solve problems.
10.	JOHME: Journal of Holistic Mathematics Education	(Simanjuntak & Sudibjo, 2019)	Meningkatkan Keterampilan Berpikir Kritis Dan Kemampuan Memecahkan Masalah Siswa Melalui Pembelajaran Berbasis Masalah [Improving Students' Critical Thinking Skills And Problem Solving Abilities Through Problem-Based Learning]	From the research results, it was concluded that the application of Problem Based Learning was successful in improving students' critical thinking skills and ability to solve problems.

Based on the data in Table 1 of the 10 articles that have been researched, it is illustrated that the problem-based learning model is effective in improving students' ability to solve problems in science subjects. Increase in Problem Solving Ability: Several studies indicate that problem-focused learning can improve students' ability to solve problems because it emphasizes real situations and the application of knowledge in practical contexts. Student Motivation and Engagement: PBL is often associated with increased student motivation and engagement. This approach makes learning more interesting because

it involves students in solving problems that are relevant to their daily lives. Collaborative Skills Development: PBL often involves group work or joint projects, which has the potential to improve students' social and collaborative skills. Contextual Learning Experiences: Problem-based learning often places knowledge in a practical context, allowing students to better understand and apply knowledge in real-life situations.

Of course, there are several factors that can influence the effectiveness of the Problem-Based Learning Model (PBL). Some of these include the level of teacher understanding and training in implementing PBL which can influence its effectiveness. Teachers who are well trained in PBL concepts and methods tend to implement this model more effectively. Then student involvement, student activity in the PBL learning process is also an important factor. If students are actively involved in problem solving and discussion, this can improve learning outcomes. Then design a case or problem scenario. The cases or scenarios presented must be relevant to students' real-life contexts and complex enough to stimulate critical thinking and creativity. PBL that is well integrated into the learning curriculum can be more effective because students can see the relationship between the material studied and applications in the real world.

The availability of resources and institutional support are also factors that may influence the effectiveness of the PBL learning model. Facilities, reading materials, access to technology, and other resources that support the PBL teaching and learning process can influence its effectiveness. Support from schools or educational institutions for the implementation of PBL is also a key factor. This may include managerial support, adequate learning time, and recognition of PBL success. Evaluation methods that are appropriate to the PBL approach are important for measuring student achievement. Evaluations that focus on conceptual understanding, problem-solving skills, and collaboration can support the effectiveness of PBL.

Providing good feedback to students about their performance in PBL can improve the learning process. The involvement and relevance of PBL in students' social and cultural contexts can influence their motivation and involvement in the learning process. A classroom culture that encourages collaboration, sharing ideas, and open discussion can support the effectiveness of PBL. Keeping these factors in mind can help in designing and implementing more effective Problem-Based Learning Models, as well as understanding the variability in outcomes across various educational contexts.

Findings showing the effectiveness of PBL in improving problem-solving skills may encourage more educational institutions to adopt this model in their curricula. These implications can lead to an increase in the overall quality of education. The implications for teacher training are important. Educational institutions can focus on comprehensive training to prepare teachers to implement PBL effectively, paying attention to understanding concepts, case design, and managing the learning process.

The implication of these findings is the need for a more holistic evaluation approach in educational institutions. Evaluation is not only limited to mastery of facts, but also to the ability to apply this knowledge in a real context. The importance of the findings from this meta-analysis is realizing that the Problem-Based Learning Model has great potential in improving important skills such as problem solving, collaboration, and critical thinking among students. These implications provide a strong basis for educational institutions to consider integrating PBL in an effort to improve the quality of education.

CONCLUSION

The conclusion from the literature analysis regarding the impact of the problem based learning model on students' problem solving skills in science learning is that applying this learning model will improve students' problem solving skills. This finding is supported by the results of the analysis of 10 studies that have been evaluated. In conclusion, the results of this meta-analysis provide strong support for the effectiveness of the Problem-Based Learning Model in improving students' problem solving skills. The emerging implications provide a strong basis for educational institutions to consider PBL as an effective method in improving the quality of education and preparing students for future success.

ACKNOWLEDGMENTS

We would like to express our infinite gratitude to all parties who have helped and supported this research.

REFERENCES

- Aini, H., Sutrio, & Doyan, A. (2020). Pengaruh Model Pembelajaran Perolehan Konsep Berbasis Masalah Terhadap Kemampuan Pemecahan Masalah Dan Pemahaman Konsep Fisika Peserta Didik Kelas Xi Mia Man 1 Mataram. *ORBITA. Jurnal Hasil Kajian, Inovasi, Dan Aplikasi Pendidikan Fisika*, 6(1), 181–187.
- Amin, A., Alimni, A., Kurniawan, D. A., Triani, E., & Pratama, W. A. (2022). Implications of Teacher Interpersonal Communication Ability on Student Learning Motivation in Islamic Religious Education Lessons During Pandemic. *Journal of Education Research and Evaluation*, 6(1), 156–167. <https://doi.org/10.23887/jere.v6i1.39547>
- Anggraini, D., Putri, H., Fauziah, N., & Wati, W. W. (2022). Analisis Effect Size Pengaruh Model Problem Based Learning Terhadap Keterampilan Berpikir Kritis Dan Pemecahan Masalah. *ORBITA. Jurnal Hasil Kajian, Inovasi, Dan Aplikasi Pendidikan Fisika*, 8(November), 205–211.
- Azizi, A., Rasyidi, M., Studi, P., Ilmu, P., Alam, P., Test, I., Masalah, K. M., & Peduli, S. (2019). Penerapan Model Problem Based Learning Untuk Meningkatkan Kemampuan Memecahkan Masalah Dan Sikap Peduli Lingkungan Siswa SMP Darul Aminin NW Aikmual Tahun 2019. *JUPE: Jurnal Pendidikan Mandala*, 4(5).
- Darmaji, D., Astalini, A., Kurniawan, D. A., & Triani, E. (2022). The effect of Science Process Skills of Students Argumentation Skills. *Jurnal Inovasi Pendidikan IPA*, 8(1), 78–88. <https://doi.org/10.21831/jipi.v8i1.49224>
- Dwi, M., Ernawati, W., Sanova, A., Kurniawan, D. A., & Triani, E. (2022). Students' Attitude Towards Science and Its Implications on Science Learning Outcomes of Junior High School Students. *Jurnal Pendidikan Progresif*, 12(2), 898–911. <https://doi.org/10.23960/jpp.v12.i2.20223>
- Ekantini, A. (2020). Efektivitas Pembelajaran Daring pada Mata Pelajaran IPA di Masa Pandemi Covid-19: Studi Komparasi Pembelajaran Luring dan Daring pada Mata Pelajaran IPA SMP. *Jurnal Pendidikan Madrasah*, 5(2), 187–194. <https://doi.org/10.14421/jpm.2020.52-04>
- Fadilla, A. N., Relawati, A. S., & Ratnaningsih, N. (2021). Jurnal jendela pendidikan. *Jendelaedukasi.Id*, 01(02), 48–60.
- Fatimah, S. (2023). Materi Cahaya Dan Optik Dengan Metode Pendekatan CTL Demonstrasi Pada Peserta Didik Kelas VIII / B SMP Negeri 1 Kapuas Kuala Tahun Pelajaran 2021 / 2022. *Jurnal Pahlawan*, 19(1), 1–5.
- Kamid, Sabil, H., Syafmen, W., & Triani, E. (2021). A Study of Problem Based Learning and mathematics Process Skills in Elementary School. *Jurnal Ilmiah Sekolah Dasar*, 5(2), 359–368.
- Kamid, Syaiful, Ramalisa, Y., Sufri, & Triani, E. (2022). Comparison and Correlation Between Attitude and Process Skills in School in Indonesia. *Jurnal Pendidikan Progresif*, 12(2), 511–528. <https://doi.org/10.23960/jpp.v12.i2.202210>
- Kartika, R. W. (2023). Meningkatkan Hasil Belajar Ipa Siswa Smp Melalui Penerapan Model Pembelajaran Berbasis Proyek Pada Materi Bioteknologi. *Jurnal Fusion*, 3(04).
- Liayunika, T., & Sri, I. (2019). Penerapan Model Pembelajaran Berbasis Masalah Untuk Meningkatkan Kemampuan Memecahkan Masalah Kelas VIII SMPN 6 Kota Bengkulu. *Diklabio: Jurnal Pendidikan Dan Pembelajaran Biologi*, 3(1), 41–48.
- Mariana, E., Wardany, K., & Asih, D. A. S. (2022). Pengaruh Model Problem Based Learning terhadap Peningkatan Pemecahan Masalah Siswa pada Pembelajaran IPA. *Jurnal Pendidikan MIPA*, 12(3), 395–401.
- Musna, R. R., Juandi, D., & Jupri, A. (2021). A meta-analysis study of the effect of Problem-Based Learning model on students' mathematical problem solving skills. *Journal of Physics: Conference Series*, 1882(1). <https://doi.org/10.1088/1742-6596/1882/1/012090>
- Nawahdani, A. M., Triani, E., Azzahra, M. Z., Maison, M., Kurniawan, D. A., & Melisa, D. (2022). Hubungan Minat dan Motivasi Belajar Siswa terhadap Mata Pelajaran Fisika. *Jurnal Penelitian Dan Pengembangan Pendidikan*, 6(1), 12–18. <https://doi.org/10.23887/jppp.v6i1.41986>
- Nuningsih, A., Nasir, M., & Olahairullah. (2022). Implementasi Pembelajaran Problem Based Learning Untuk Meningkatkan Kemampuan Pemecahan Masalah Siswa. *UPENJI: Jurnal Pendidikan Jompa Indonesia*, 1(3), 78–84.

- Parinata, E. F. to load citeproc-js engine D., & Puspaningtyas, N. D. (2022). Studi Literatur: Kemampuan Komunikasi Matematis Mahasiswa Pada Materi Integral. *Jurnal Ilmiah Matematika Realistik*, 3(2), 94–99.
- Prayogi, R. D., & Estetika, R. (2019). Kecakapan Abad 21: Kompetensi Digital Pendidik Masa Depan. *Jurnal Manajemen Pendidikan*, 14(2), 144–151. <https://doi.org/10.15330/jpnu.5.1.40-46>
- Ramli, S., Novanda, R., Sobri, M., Triani, E., & Septi, S. E. (2022). The Effect of Student Responses on Environmental Care Characters and Student Learning Outcomes. *Eurasian Journal of Educational Research*, 99, 112–126. <https://doi.org/10.14689/ejer.2022.99.007>
- Rusilowati, A., Taufiq, M., & Astuti, B. (2019). Penerapan Media Pembelajaran IPA Menggunakan Aplikasi Make It pada Siswa Sekolah Dasar. *Jurnal Profesi Keguruan*, 5(1), 15–22.
- S, B. R., Agus, K. D., Elza, T., & Rahmat, P. (2021). Evaluation of the Results of Attitudes and Self-Efficacy of Middle School Students in Science Subjects. *Journal of ...*, 5(4), 525–535.
- Santika, I. W. E. (2020). Pendidikan Karakter pada Pembelajaran Daring. *Indonesian Values and Character Education Journal*, 3(1), 8–19.
- Santoso, B., Putri, D. H., & Medriati, R. (2020). Upaya Meningkatkan Motivasi Belajar Dan Kemampuan Pemecahan Masalah Siswa Melalui Model Problem Based Learning Berbantu Alat Peraga Konsep Gerak Lurus. *Jurnal Kumparan Fisika*, 3(1), 11–18.
- Simanjuntak, M. F., & Sudibjo, N. (2019). Kemampuan Memecahkan Masalah Siswa Melalui Pembelajaran Berbasis Masalah [Improving Students ' Critical Thinking Skills And Problem Solving Abilities Through Problem-Based Learning]. *JOHME: Journal of Holistic Mathematics Education*, 2(2), 108–118.
- Sumiantari, N. L. E., Suardana, I. N., & Selamet, K. (2019). Pengaruh Model Problem Based Learning Terhadap Kemampuan Pemecahan Masalah IPA Siswa Kelas VIII SMP. *JPPSI: Jurnal Pendidikan Dan Pembelajaran Sains Indonesia*, 2(1), 12–22.
- Triani, E., Darmaji, & Astalini. (2023). IDENTIFIKASI KETERAMPILAN PROSES SAINS DAN KEMAMPUAN. *Jurnal Pendidikan Dan Pembelajaran IPA Indonesia*, 13(1), 9–16.
- Wahyuningsih, Y., Aprilia, N., & Wulandari, R. S. (2023). Upaya Peningkatan Keterampilan Pemecahan Masalah Dan Hasil Belajar Peserta Didik Menggunakan Model Problem Based Learning. *TEACHING: Jurnal Inovasi Keguruan Dan Ilmu Pendidikan*, 3(2), 145–152. <https://doi.org/10.51878/teaching.v3i2.2379>
- Wicaksono, L. Y., Putri, B. C., & Matondang, M. M. (2021). Identifikasi Tingkat Pemahaman Materi Gerak Lurus pada Siswa Kelas X MIPA SMAN 1 Muaro Jambi. *Schrödinger: Journal of Physics Education*, 2(1), 13–16. <https://doi.org/10.37251/sjpe.v2i1.455>
- Zurweni, Kurniawan, D. A., & Triani, E. (2022). A Comparative study: Cooperative Learning in Science Learning. *Jurnal Pendidikan Dan Pengajaran*, 55(1), 115–126.