INSECTA **Vol. 4 No. 1, 2023, pp. 91 - 103**

Available online at
INSECTA
Integrative Science Education and Teaching Activity Journal
Journal homepage : https://jurnal.iainponorogo.ac.id/index.php/insecta

Article

Literature Review on The Use of Problem Based Learning Models in Improving Physics Learning Outcomes

Mila Candra Pristianti[1*], Binar Kurnia Prahani[2]

[1,2]Universitas Negeri Surabaya, Surabaya

**Corresponding Address: mila.19029@mhs.unesa.ac.id*

Article Info

Article history:
Received: March 27, 2023
Accepted: April 25, 2023
Published: May 30, 2023

Keywords:

Learning Outcomes
Literature Review
Physics
Problem Based Learning
Student

ABSTRACT

The purpose of this study is to describe the use of PBL models to improve student learning outcomes. This research method uses library research. The data studied were obtained from Google Scholar and Scopus from 2018 to 2022 in a total of 30 articles. The scope of the data analyzed is physics learning with the PBL model and its relationship to enhancing learning outcomes. The descriptive qualitative analysis was used to analyze the data. From this study it can be concluded that: (1) The main advantage of using the PBL model is that it can stimulate students to discover new knowledge and develop it, while the disadvantages lies in requiring a lot of time to implement PBL with maximum results; (2) The PBL model is effectively used to improve student learning outcomes in face-to-face, mixed and online learning; (3) PBL model can be done in collaboration with other technologies such as digital books, PhET, augmented reality, and others. This learning model can also be a solution to increase students' interest in physics subjects that are difficult to learn. Further research can be carried out by directly implementing the PBL model to determine its effect on student learning outcomes.

INTRODUCTION

Learning and teaching activities are a process of acquiring knowledge from students and sharing knowledge with teachers, so there is an interaction between the two. Learning can be done anywhere, including schools, homes, libraries, and other places that aim to gain better knowledge (Aprianto et al., 2021; Ni'mah et al., 2021). One of the teacher's duties is to teach (Uno & Nina Lamatenggo, 2022). In carrying out learning, proper knowledge of the theory and principles of learning will determine the success of a learning process (Aspi & Syahrani, 2022). Learning is successful if the goals are achieved (Calalb, 2023; Rindiantika, 2021). Apart from the teacher's factors determining success, students are among the other factors (Juliya & Herlambang, 2021). The effectiveness of a teaching and learning process is also determined by the level of student learning motivation (Harahap et al., 2021; Radulović et al., 2022). Motivation can arise from internal factors, which include physical and psychological, while external factors include the condition of the surrounding environment

and humans, including teachers, parents, and the environment (Barelli & Levrini, 2022; Zuleni & Marfilinda, 2022).

The teacher's skills in choosing suitable learning models and methods will be essential in developing student learning outcomes. The teacher uses the learning method in interacting with students in the class (Ardiana et al., 2021; Nasution, 2018; Qudsyi et al., 2022). Learning outcomes are critical because learning success is based on the process of teaching and learning activities that can be seen from it (Botari et al., 2022; Gola et al., 2022). Learning outcomes are accomplishments that individuals make as a result of learning activities (Harefa, 2020; Reski, 2018; Telaumbanua, 2022). In order to perform well, students try to achieve the best learning results. However, according to research by Nurul (2022), learning physics is considered to contain abstract concepts, so it requires an approach that links theory to events in everyday life. With this approach, students will more easily understand the material presented.

Learning physics is different from mathematics. Physics learning does not only solve problems mathematically with formulas but there are concepts in it that students must understand (Del Barco et al., 2022; Nikat et al., 2021). An approach to material physics with everyday life can be made through simple problems that often occur (Saputra et al., 2021). Not infrequently, students also experience difficulties in solving simple physics-related problems (Mardatila et al., 2019; Rahmah, 2021; Sujarwanto et al., 2022). Thus, this study describes using PBL models to improve student learning outcomes. This research analyzed all physics education studies using the PBL model found in databases (Google Scholar and Scopus). Reinforced by Tuxtaevich et al. (2022) that a learning model that can train problem-solving skills is a scientific approach that emphasizes student-centered learning with the help of technological media, for example, PBL. This PBL model encourages students not only to have conceptual abilities but also to encourage them to solve the given problems actively (Kanyesigye et al., 2022). In addition, this learning model has an external target in the form of artifacts which become students' original work in solving problems independently (Febriani et al., 2021). However, the explanation regarding PBL is in contrast to the results of research by Pristianti & Prahani, (2022) regarding student profiles that by implementing PBL in schools it turns out that student learning outcomes in physics are still low, namely 159 students out of a total of 162 students scored in the low category. So the need for further literature review related to the PBL model to improve student learning outcomes.

The novelty of this study is that the literature review used comes from the two largest databases, namely Google Scholar and Scopus, both national and international articles. So that the literature used is very broad and the results of the review will provide accurate results. In addition, this literature review can also provide information on the success rate of applying the PBL model, especially in learning physics. Research questions from this study include:

1. What are the advantages and disadvantages of using the PBL model?
2. What is the effectiveness of the PBL model to improve students' physics learning outcomes?
3. How can the PBL model improve student learning outcomes?

METHODS

This form of research involves a literature review, hence library research is used. Secondary data from literature reviews in the form of articles from journals that can be accounted for on a national and international scale (Acciarini et al., 2023; Maman et al., 2021; Sanjaya et al., 2022). The data studied were obtained from Google Scholar and Scopus. Because Scopus is the largest database for various topics and is multidisciplinary (Purnell, 2022). The scope of the data studied is related to learning physics with a PBL model and its relation to improving learning outcomes. Data were collected using limited data from 2018 to

2022 after collecting various publications linked to PBL models and enhancing learning outcomes. A literature review was used to examine data using descriptive qualitative analysis. This study use a qualitative methodology to generate descriptive data (Rosairo, 2023). Adapted from Miles & Huberman (1994), the stages of data analysis in qualitative research are generally shown in Figure 1.

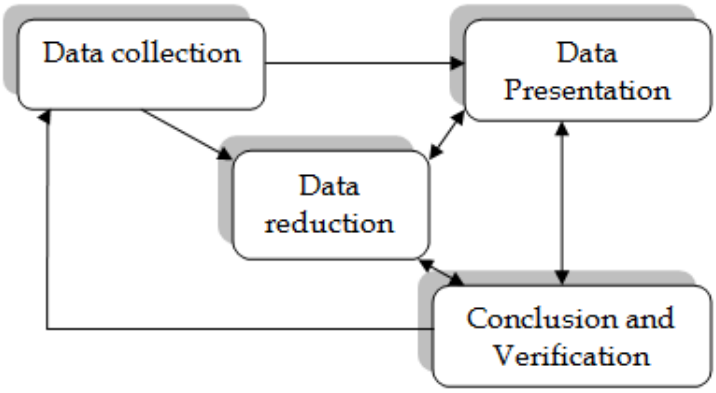

Figure 1. Qualitative data analysis chart

Four phases are involved in the analysis of qualitative data, namely:

1. To gather the data required to accomplish research goals, data collection is the process of gathering data in the field (both from journal studies and trials).
2. Data reduction involves summarizing, selecting the key elements, and concentrating on crucial elements to create a clear picture from the data collected and to make it simpler for the researcher to access the data that follows.
3. Narrative text in the form of succinct descriptions, charts, and relationships between individuals is the most frequently utilized type of data presentation in qualitative research.
4. Verification and conclusion concern novel discoveries that have never been made previously.

RESULTS AND DISCUSSION

This PBL model is a learning model that invites students to explore their thinking skills, because basically PBL is problem oriented and students are required to be able to solve it based on the knowledge students have. PBL was originally developed as a response to the fact that many young doctors who had just graduated from medical school in Ontario, Canada in the 1960s had very rich and broad knowledge (Devi et al., 2021). The main purpose of this PBL model is to develop student's skills and the ability to build their own knowledge (Fathurohman et al., 2021). Research by Bektiarso & Dewi, (2021) emphasizes that the teacher as a facilitator plays an important role to help students become independent and create a classroom environment where students receive systematic instruction in conceptual, strategic, and reflective reasoning which will ultimately make students more successful in subsequent investigations. Wibowo, (2021) also emphasizes that group work is an important part of PBL for several reasons. Group work can develop a social spirit and physics learning community so that students feel comfortable developing ideas and asking questions. Group work can improve communication skills. In the end, group work is interesting and motivates students to be actively involved in physics learning and can improve their learning outcomes. However, groups do not always function effectively without guidance (Simamora & Sianipar, 2022). The teacher can provide facilities and monitor the interaction of each group.

It can be understood that PBL has strong characteristics to present learning that originates from a real problem in physics. From these problems it is expected to be able to motivate students to develop their abilities, thus making students more challenged to gain new knowledge which in turn can improve their learning outcomes (Kanyesigye et al., 2022;

Nuñez et al., 2022). The advantages of the PBL model include that the PBL model can stimulate students to discover new knowledge and develop it (Singh & Dutt, 2022). PBL can encourage students to apply their knowledge in the real world and lifelong learning. Problem solving in PBL does not only give students awareness to depend on the teacher's presence, but also depends on students' intrinsic motivation (Khusaeri, 2022). PBL can motivate, encourage and develop the knowledge learned to be applied in solving real life problems based on scientific principles. PBL can also increase students' self-confidence to be skilled at solving problems independently, so that the teacher is only a facilitator (Malan, 2022). So there is great potential that PBL can improve student learning outcomes. On the other hand there is disadvantages that can be observed from using the PBL model in physics learning are that it takes a lot of time to implement PBL with maximum results because when students have no interest and lack of confidence so that they perceive that the problem to be investigated is difficult. Furthermore, it will arise in students who are reluctant to try to solve the problem. The ability to understand the problems of different students also influences the implementation of the PBL model, so that PBL teaching has not been able to show students' problem solving steps in a systematic way (Gunawan et al., 2019; Yusdarina, 2019). How to solve students' problems can be observed through the ongoing learning process, in this case it will reflect the mindset of students (Herliana et al., 2020).

The PBL model can be implemented by integrating other technologies. PBL models and the addition of animated video have a positive effect on student physics learning outcomes (Pawlak et al., 2020). The PhET simulation developed to meet the eligibility requirements can be used in physics learning activities using the PBL model to improve critical thinking and student learning outcomes (Darta, 2020). Website-based physics learning in the classroom can be integrated with the PBL model which is oriented towards investigative activities (Hindriyani et al., 2020). An example of the results of website development with the PBL model for physics learning can be seen in Figure 2 and 3.

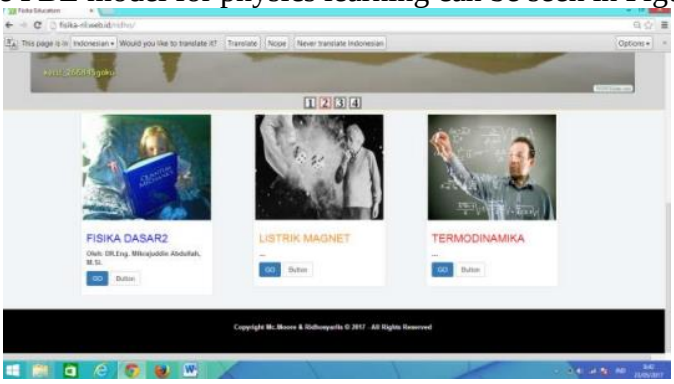

Figure 2. The home display of web-enhanced with problem-based learning model
Source: (Diani & Syarlisjiswan, 2018)

Figure 3. The display of student exercises
Source: (Diani & Syarlisjiswan, 2018)

Website-based physics learning can help students explore material more broadly and independently to solve problems. This can be one way to make the PBL model in physics more effective in improving student learning outcomes. So it can be concluded that computer technology is effective to be applied as media in the PBL model. According to the facts and analysis, utilizing the PBL model, which contains five learning phases, students are more active, and their learning outcomes increase. Physics learning outcomes are the results achieved after carrying out learning activities, these results are shown in the form of letters, which can usually be seen in the list of values in physics subjects (Pane et al., 2021; Prima, 2020; Safitriani & Hidayat, 2020). To find out the learning outcomes achieved by students in the teaching and learning process, measurement and evaluation will be carried out (Sumalong et al., 2021). Many national and international research journals with higher physics learning outcomes are summarized in Table 1 for the review.

Table 1. Top 10 results from literature review journals

No	Source Journal	Citation	Learning Types	Results of Literature Review
1	Jurnal Pendidikan Fisika dan Teknologi Vol. 4 No. 1, 2018: 111-120. (Munandar et al., 2018)	57	Face-to-face learning	Journal results: PBL models and the addition of animated media have a positive effect on student physics learning outcomes Review results: The use of PBL can be an alternative solution to improve physics learning outcomes
2	Jurnal Pendidikan Fisika dan Teknologi Vol. 4 No. 2, 2018: 283-290. (Pitriah et al., 2018)	9	Face-to-face learning	Journal results: PBL, with the help of three-dimensional teaching aids, can improve student learning outcomes in physics lessons Review results: PBL is effective to apply because it is proven to improve student learning outcomes
3	AIP *Conference Proceedings* Vol. 2014 Article No. 020046 2018: 1-6 (Nizami & Mahmudi, 2018)	6	Face-to-face learning	Journal results: The percentage of implementation of learning by teachers using PBL at each meeting has increased and is in an outstanding category from the first meeting to the last meeting Review results: The application of PBL can have a positive impact on student interest and learning outcomes
4	Jurnal Ikatan Alumni Fisika Universitas Negeri Medan Vol. 4 No. 2, 2018: 1-3. ISSN: 2461-1247. (Tanjung, 2018)	4	Face-to-face learning	Journal results: The average class value given PBL shows a higher category than conventional learning. Review results: With PBL, students are more active in discussing, asking questions, and enthusiastically completing assignments.
5	*Journal of Physics: Conference Series* Vol. 1140 No. 1 2018: 1-9 ISSN: 1742-6588 (Perwitasari, 2018)	1	Mixed learning	Journal results: PBL in blended learning has more influence on student learning outcomes than direct instruction learning Review results: PBL combined with blended learning can be used by teachers to overcome the limitations of space and time in learning at school and can be used as alternative learning to improve student learning outcomes

No	Source Journal	Citation	Learning Types	Results of Literature Review
6	*Journal of Physics: Conference Series* Vol. 1116 No. 3 2018: 1-9 ISSN: 1742-6588 (Rochman, 2018)	0	Face-to-face learning	Journal results: Students' ability to solve problems and learning outcomes in each cycle is increasing, and this is due to students' better critical thinking skills after applying the PBL model Review results: Learning the history of physics by applying PBL can improve student learning outcomes
7	Jurnal Pendidikan Fisika Vol. 7 No. 1 2019: 17-25 ISSN: 2550-0325 (Puspitasari, 2019)	149	Face-to-face learning	Journal results: Student learning outcomes and tests of critical thinking skills show high scores after using the PBL model assisted by printed and electronic modules Review results: The application of PBL in the 21st century with the use of printed and electronic modules is effective for application in physics learning
8	*Computers & Education* Vol. 142 Article No. 103635, 2019 ISSN: 0360-1315 (Fidan & Tuncel, 2019)	108	Face-to-face learning	Journal results: The experimental results of this study show that students who use augmented reality (AR) technology in PBL have a much higher learning achievement value when compared to only PBL and teacher-based teaching in the classroom. Review results: The use of AR in PBL learning is a potential and effective tool to activate students' positive emotions
9	Jurnal Kumparan Fisika Vol. 2 No.3 2019: 169-176 ISSN: 2655-1403 (Paradina et al., 2019)	20	Face-to-face learning	Journal results: In the PBL model, the teacher acts as a facilitator while students are active and learn independently can improve student learning outcomes on the concept of harmonic vibration material Review results: Problem-based physics learning is highly recommended because it can be used as experimental or simulation-based learning that adjusts the characteristics of the material in physics so that students can analyze actual natural phenomena
10	*Asia-Pacific Forum on Science Learning and Teaching* Vol. 20 No. 1 2019: 1-45 ISSN: 1609-4913 (Putranta & Wilujeng, 2019)	15	Face-to-face learning	Journal Results: Assisted PBL learning tools, the Aiken V validity score, reliability results, and student response results from evidence this Review results: PBL, with the help of PhET, can improve critical thinking and student learning outcomes in the chapter on work and energy

Some journal results from Table 1 state that the PBL model is beneficial for increasing student understanding, giving students the potential to be more interested in physics subjects. This improved understanding will aid pupils in achieving successful learning outcomes (Kristianto & Gandajaya, 2023). Students are not bored with teaching physics which is considered too mathematical and difficult to understand because, with PBL, students are directed to solve problems close to their lives (Suari, 2018; Sulisworo & Basriyah, 2021).

This research can provide information regarding the success rate of implementing the PBL model in physics learning and potential research related to PBL in the future.

The series of learning using the PBL model in a structured manner consists of five phases. The PBL model phase begins with giving problems, organizing students, guiding investigations, developing work, and evaluating (Abarang & Delviany, 2021; Auly, 2020; Zhang, 2023). Besides improving student learning outcomes, using the PBL model for physics in learning can also improve students' conceptual understanding through generating inferences and problem solving (Kumullah et al., 2018; Parwata et al., 2023). Students are better trained to think critically because they are involved in solving authentic problems (Herayanti et al., 2020; Yulianti & Gunawan, 2019). The PBL model is positively feasible, and students react well to the learning model. The learning procedure physics, particularly the PBL model, can be classified as a practical innovation since it allows students to actively learn, which is important for skill development and knowledge acquisition (Shofiyah & Wulandari, 2018). The PBL model of knowledge focuses on solving problems from contexts, which leads to the restoration of the scientific method inside the natural sciences framework (Reinsini et al., 2021; Sari et al., 2019).

CONCLUSION

From this study it can be concluded that: (1) The main advantage of using the PBL model is that it can stimulate students to discover new knowledge about physics and develop it, while the weakness lies in requiring a lot of time to implement PBL with maximum results; (2) The PBL model is effectively used to improve student physics learning outcomes in face-to-face, mixed and online learning. The PBL model can be used as an alternative to face-to-face and online learning; (3) PBL model can be done in collaboration with other technologies such as digital books, 3D, PhET, augmented reality, ethnoscience learning, LKS, and others. This learning model can also be a solution to increase students' interest in physics subjects that are difficult to learn. Learning was carried out online during the COVID-19 pandemic, so a PBL model was urgently needed to help students understand.

The implications of this research can be a reference in developing a physics learning model that can improve student learning outcomes and become a reference for researchers who raise topics related to the PBL model. The limitation of this research is the limited access to several journals. Further research can be carried out by directly implementing the PBL model to determine its effect on student learning outcomes.

AKNOWLEDGMENT

The authors would like to thank the supervisors who provided valuable suggestions and input until this paper was completed.

REFERENCES

Abarang, N., & Delviany, D. (2021). Peningkatan hasil belajar peserta didik dengan menggunakan model pembelajaran problem based learning (PBL). *Jurnal Pendidikan Dan Profesi Keguruan, 1*(2). https://doi.org/10.24853/fbc.2.2.1-7

Acciarini, C., Cappa, F., Boccardelli, P., & Oriani, R. (2023). How can organizations leverage big data to innovate their business models? A systematic literature review. *Technovation, 123*, 102713. https://doi.org/10.1016/j.technovation.2023.102713

Aprianto, A., Praherdhiono, H., & Wedi, A. (2021). Pengaruh pembelajaran berbasis masalah dengan penguatan keterampilan fleksibilitas terhadap hasil belajar kognitif. *Edcomtech: Jurnal Kajian Teknologi Pendidikan*, *6*(2), 264–274. https://doi.org/10.17977/um039v6i12021p264

Ardiana, D. P. Y., Widyastuti, A., Susanti, S. S., Halim, N. M., Herlina, E. S., Nugroho, D. Y., Dewi Fitria, V., & Yuniwati, I. (2021). *Metode pembelajaran guru*. Medan: Yayasan Kita Menulis.

Aspi, M., & Syahrani, S. (2022). Profesional guru dalam menghadapi tantangan perkembangan teknologi pendidikan. *Adiba: Journal of Education*, *2*(1), 64–73.

Auly, R. (2020). *The implementation of problem-based learning module to improve the students' learning outcomes and perceptions*. *1460*(1), 012066. https://doi.org/10.1088/1742-6596/1460/1/012066

Barelli, E., & Levrini, O. (2022). Computational simulations at the interface of physics and society: A teaching-learning module for high-school students. *Il Nuovo Cimento C*, *45*(6), 1–4. https://doi.org/10.1393/ncc/i2022-22213-6

Bektiarso, S., & Dewi, D. (2021). *Effect of problem based learning models with 3D thinking maps on creative thinking abilities and physics learning outcomes in high school*. Journal of Physics: Conference Series, *1832*(1), 012027. https://doi.org/10.1088/1742-6596/1832/1/012027

Botari, A., Botari, J. C., da Rocha Brito, C., & Ciampi, M. M. (2022). Educational tools and interventional analysis of meaningful learning: Case studies applied to teaching acoustic physics in the discipline of environmental comfort. *IEEE Revista Iberoamericana de Tecnologias Del Aprendizaje*, *17*(2), 115–124. https://doi.org/10.1109/RITA.2022.3166860

Calalb, M. (2023). The constructivist principle of learning by being in physics teaching. *Athens Journal of Education*, *10*(1), 139–152. https://doi.org/10.30958/aje.10-1-8

Darta, I. K. (2020). Upaya meningkatkan hasil belajar fisika melalui model pembelajaran berbasis masalah (problem based learning) pada siswa kelas XI IPA SMA Negeri 1 Marga. *Indonesian Journal of Educational Development*, *1*(2), 229–239. https://doi.org/10.37541/cer.v2i1.402

Del Barco, M. A. H., Moreno, A. M. C., & Airado-Rodríguez, D. (2022). An approach to epistemic emotions in physics' teaching-learning. The case of pre-service teachers. *Heliyon*, *8*(11). https://doi.org/10.1016/j.heliyon.2022.e11444

Devi, V. M., Susilawati, S., & Gunada, I. W. (2021). Pengembangan perangkat pembelajaran fisika model berbasis masalah pada materi elastisitas untuk meningkatkan kemampuan generik sains peserta didik. *ORBITA: Jurnal Kajian, Inovasi Dan Aplikasi Pendidikan Fisika*, *7*(1), 109–114. https://doi.org/10.31764/orbita.v7i1.3822

Diani, R., & Syarlisjiswan, M. R. (2018). Web-enhanced course based on problem-based learning (PBL): Development of interactive learning media for basic physics II. *Jurnal Ilmiah Pendidikan Fisika Al-Biruni*, *7*(1), 105–116. https://doi.org/10.24042/jipfalbiruni.v7i1.2849

Fathurohman, A., Susiloningsih, E., & Arianti, A. (2021). *Physics module based on STEM problem based learning on newton's motion law material for senior high school*. Journal of Physics: Conference Series, *1869*(1), 012155. https://doi.org/10.1088/1742-6596/1869/1/012155

Febriani, F., Tawil, M., & Sari, S. S. (2021). Pengaruh model pembelajaran berbasis masalah terhadap keterampilan pemecahan masalah peserta didik dalam pembelajaran fisika ditinjau dari gender. *Al-Musannif*, *3*(2), 67–82. https://doi.org/10.56324/al-musannif.v3i2.42

Fidan, M., & Tuncel, M. (2019). Integrating augmented reality into problem based learning: The effects on learning achievement and attitude in physics education. *Computers & Education*, *142*, 103635. https://doi.org/10.1016/j.compedu.2019.103635

Gola, N., Subiki, S., & Nuraini, L. (2022). Profil respon siswa penggunaan e-modul fisika berbasis android (andromo). *Jurnal Pembelajaran Fisika*, *11*(2), 53–58. https://doi.org/10.19184/jpf.v11i2.31558

Gunawan, G., Harjono, A., Herayanti, L., & Husein, S. (2019). Problem-based learning approach with supported interactive multimedia in physics course: Its effects on critical thinking disposition. *Journal for the Education of Gifted Young Scientists*, *7*(4), 1075–1089. https://doi.org/10.17478/jegys.627162

Harahap, H. S., Hrp, N. A., Nasution, I. B., Harahap, A., Harahap, A., & Harahap, A. (2021). Hubungan motivasi berprestasi, minat dan perhatian orang tua terhadap kemandirian siswa. *Edukatif: Jurnal Ilmu Pendidikan*, *3*(4), 1133–1143. https://doi.org/10.31004/edukatif.v3i4.463

Harefa, D. (2020). Perbedaan peningkatan hasil belajar fisika siswa menggunakan model pembelajaran think talk write dengan model pembelajaran time token. *Jurnal Inovasi Pendidikan Dan Sains*, *1*(2), 35–40. https://doi.org/10.51673/jips.v1i2.365

Herayanti, L., Widodo, W., Susantini, E., & Gunawan, G. (2020). The effectiveness of blended learning model based on inquiry collaborative tutorial toward students' problem-solving skills in physics. *Journal for the Education of Gifted Young Scientists*, *8*(3), 959–972. https://doi.org/10.17478/jegys.675819

Herliana, F., Astra, I., Supriyati, Y., & Mazlina, H. (2020). *The differences in physics learning outcomes based on gender after using blended problem-based learning model*. Journal of Physics: Conference Series, *1460*(1), 012125. https://doi.org/10.1088/1742-6596/1460/1/012125

Hindriyani, A., Kusairi, S., & Yuliati, L. (2020). Kemampuan memecahkan masalah rangkaian arus searah pada pembelajaran berbasis masalah disertai penilaian formatif. *Jurnal Pendidikan: Teori, Penelitian, dan Pengembangan*, *5*(9), 1237–1242. https://doi.org/10.17977/jptpp.v5i9.14003

Juliya, M., & Herlambang, Y. T. (2021). Analisis problematika pembelajaran daring dan pengaruhnya terhadap motivasi belajar siswa. *Genta Mulia: Jurnal Ilmiah Pendidikan*, *12*(1), 281–294.

Kanyesigye, S. T., Uwamahoro, J., & Kemeza, I. (2022). The effect of professional training on in-service secondary school physics' teachers' motivation to use problem-based learning. *International Journal of Learning, Teaching and Educational Research*, *21*(8). https://doi.org/10.26803/ijlter.21.8.16

Khusaeri, A. (2022). Peningkatan keaktifan dan hasil belajar peserta didik dalam proses pembelajaran fisika materi fluida dinamis dengan model pembelajaran berbasis masalah (problem based learning). *Global Journal Science IPA*, *1*(1), 31–37.

Kristianto, H., & Gandajaya, L. (2023). Offline vs online problem-based learning: A case study of student engagement and learning outcomes. *Interactive Technology and Smart Education*, *20*(1), 106–121. https://doi.org/10.1108/ITSE-09-2021-0166

Kumullah, R., Djatmika, E. T., & Yuliati, L. (2018). Kemampuan berpikir kritis dan penguasaan konsep siswa dengan problem based learning pada materi sifat cahaya. *Jurnal Pendidikan: Teori, Penelitian, Dan Pengembangan*, *3*(12), 1583–1586.

Malan, I. H. (2022). Penerapan model pembelajaran berbasis masalah untuk meningkatkan hasil belajar peserta didik pada konsep gaya di kelas VII SMP Negeri 35 Halmahera Selatan. *Jurnal Ilmiah Wahana Pendidikan*, *8*(5), 237–248.

Maman, M., Rachman, M. S., Irawati, I., Hasbullah, H., & Juhji, J. (2021). Karakteristik peserta didik: sebuah tinjauan studi kepustakaan. *Geneologi PAI: Jurnal Pendidikan Agama Islam*, *8*(1), 255–266.

Mardatila, A., Novia, H., & Sinaga, P. (2019). Penerapan pembelajaran fisika menggunakan multi representasi untuk meningkatkan kemampuan kognitif dan pemecahan masalah siswa SMA pada pokok bahasan gerak parabola. *Omega: Jurnal Fisika Dan Pendidikan Fisika*, *5*(2), 33–33. https://doi.org/10.31758/OmegaJPhysPhysEduc.v5i2.33

Munandar, H., Sutrio, S., & Taufik, M. (2018). Pengaruh model pembelajaran berbasis masalah berbantuan media animasi terhadap kemampuan berpikir kritis dan hasil belajar fisika siswa SMAN 5 Mataram tahun ajaran 2016/2017. *Jurnal Pendidikan Fisika Dan Teknologi*, *4*(1), 111–120. https://doi.org/10.29303/jpft.v4i1.526

Nasution, M. K. (2018). Penggunaan metode pembelajaran dalam peningkatan hasil belajar siswa. *Studia Didaktika*, *11*(01), 9–16.

Nikat, R. F., Loupatty, M., & Zahroh, S. H. (2021). Kajian pendekatan multirepresentasi dalam konteks pembelajaran fisika. *JURNAL Pendidikan Dan Ilmu Fisika*, *1*(2), 45–53. https://doi.org/10.52434/jpif.v1i2.1449

Ni'mah, D. Z., Chamalah, E., & Azizah, A. (2021). Fleksibilitas dan aksesibilitas digitalisasi pembelajaran bahasa dan sastra indonesia di masa pandemi covid-19. *Jurnal Ilmiah SEMANTIKA*, *3*(01), 84–90. https://doi.org/10.46772/semantika.v3i01.570

Nizami, A. W., & Mahmudi, A. (2018). *Problem-solving-based learning to improve students' learning interest*. *2014*(1), 020046. https://doi.org/10.1063/1.5054450

Nuñez, R. P., Hernández-Suarez, C., & Suarez, A. G. (2022). *Training action for physics teachers: An application of problem-based learning*. Journal of Physics: Conference Series, *2159*(1), 012017. https://doi.org/10.1088/1742-6596/2159/1/012017

Nurul, D. (2022). Analisis kesulitan kemampuan pemecahan masalah pada pesera didik dalam pembelajaran fisika. *Jurnal Inovasi Dan Teknologi Pendidikan (JURINOTEP)*, *1*(1), 20–30. https://doi.org/10.24036/jppf.v8i1.115191

Pane, J., Manurung, E. E., & Nainggolan, J. (2021). Pengaruh model pembelajaran berbasis masalah terhadap hasil belajar fisika pada materi cahaya kelas VIII SMP Negeri 2 Tambusai TP. 2020/2021. *Jurnal Pendidikan Dan Kewirausahaan*, *9*(2), 493–504. https://doi.org/10.47668/pkwu.v9i2.233

Paradina, D., Connie, C., & Medriati, R. (2019). Pengaruh model pembelajaran problem based learning terhadap hasil belajar siswa di kelas X. *Jurnal Kumparan Fisika*, *2*(3 Desember), 169–176. https://doi.org/10.33369/jkf.2.3.169-176

Parwata, I. G. A. L., Jayanta, I. N. L., & Widiana, I. W. (2023). Improving metacognitive ability and learning outcomes with problem-based revised bloom's taxonomy oriented learning activities. *Emerging Science Journal*, *7*(2), 569–577. https://doi.org/10.28991/ESJ-2023-07-02-019

Pawlak, A., Irving, P. W., & Caballero, M. D. (2020). Learning assistant approaches to teaching computational physics problems in a problem-based learning course. *Physical Review Physics Education Research*, *16*(1), 010139. https://doi.org/10.1103/PhysRevPhysEducRes.16.010139

Perwitasari, D. (2018). *Problem-based blended learning in computer and basic network learning in vocational high schools*. Journal of Physics: Conference Series, *1140*(1), 012016. https://doi.org/10.1088/1742-6596/1140/1/012016

Pitriah, P., Sutrio, S., & Taufik, M. (2018). Pengaruh model pembelajaran berbasis masalah berbantuan alat peraga tiga dimensi terhadap hasil belajar fisika peserta didik tahun pelajaran 2017/2018. *Jurnal Pendidikan Fisika Dan Teknologi*, *4*(2), 283–290. https://doi.org/10.29303/jpft.v4i2.566

Prima, N. (2020). *Preliminary study of development of students worksheet using creative problem based learning model in physics learning on senior high school*. Journal of Physics: Conference Series, *1481*(1), 012069. https://doi.org/10.1088/1742-6596/1481/1/012069

Pristianti, M. C., & Prahani, B. K. (2022). Profile of students' physics problem solving skills and problem based learning implementation supported by website on gas kinetic theory. *Jurnal Pendidikan Progresif*, *12*(1), 375–393. https://doi.org/10.23960/jpp.v12.i1.202229

Purnell, P. J. (2022). The prevalence and impact of university affiliation discrepancies between four bibliographic databases—Scopus, Web of Science, Dimensions, and Microsoft Academic. *Quantitative Science Studies*, *3*(1), 99–121. https://doi.org/10.1162/qss_a_00175

Puspitasari, A. D. (2019). Penerapan media pembelajaran fisika menggunakan modul cetak dan modul elektronik pada siswa SMA. *JPF (Jurnal Pendidikan Fisika) Universitas Islam Negeri Alauddin Makassar*, *7*(1), 17–25.

Putranta, H., & Wilujeng, I. (2019). *Physics learning by PhET simulation-assisted using problem based learning (PBL) model to improve students' critical thinking skills in work and energy chapters in MAN 3 Sleman*. Asia - Pacific Forum on Science Learning and Teaching, *20*(1), 1–44.

Qudsyi, H., Indriaty, L., Herawaty, Y., Khaliq, I., & Setiawan, J. (2022). Pengaruh metode pembelajaran kooperatif (cooperative learning) dan motivasi belajar terhadap prestasi belajar siswa SMA. *Proyeksi: Jurnal Psikologi*, *6*(2), 34–49. https://doi.org/10.30659/p.6.2.34-49

Radulović, B., Županec, V., Stojanović, M., & Budić, S. (2022). Gender motivational gap and contribution of different teaching approaches to female students' motivation to learn physics. *Scientific Reports*, *12*(1), 18224. https://doi.org/10.1038/s41598-022-23151-7

Rahmah, N. (2021). Model pencampuran konsep fisika dan penalaran matematika dalam memecahkan masalah fisika. *Jurnal Penelitian Pembelajaran Fisika*, *12*(1), 47–55. https://doi.org/10.26877/jp2f.v12i1.7929

Reinsini, C. E., Susila, I. W., & Cholik, M. (2021). Application of problem-based learning to enhance students learning outcomes in basic competencies of maintaining brake systems. *International Journal for Educational and Vocational Studies*, *3*(2), 139–145. https://doi.org/10.29103/ijevs.v3i2.3470

Reski, A. (2018). Pengaruh fasilitas belajar terhadap motivasi dan hasil belajar fisika mahasiswa. *Musamus Journal of Science Education*, *1*(1), 001–008. https://doi.org/10.35724/mjose.v1i1.859

Rindiantika, Y. (2021). Pentingnya pengembangan kreativitas dalam keberhasilan pembelajaran: Kajian teoretik. *INTELEGENSIA: Jurnal Pendidikan Dan Pembelajaran*, *6*(1), 53–63.

Rochman, S. (2018). *Implementation of problem based learning models in history of physics courses to promoting student learning result*. *1116*(3), 032025. https://doi.org/10.1088/1742-6596/1116/3/032025

Rosairo, R. (2023). Narrative approach in qualitative research. *Journal of Agricultural Sciences–Sri Lanka*, *18*(1). https://doi.org/10.4038/jas.v18i1.10094

Safitriani, V., & Hidayat, S. (2020). Meningkatkan aktivitas dan hasil belajar siswa melalui model pembelajaran berbasis masalah berbantuan LKS. *Jurnal Ilmiah IKIP Mataram*, *7*(2), 209–214.

Sanjaya, L., Bunyamin, M., Meganingtyas, D., & Haeruman, L. (2022). *Trends of web-based instructional (wbi) in physics learning: a literature review*. Journal of Physics: Conference Series, *2377*(1), 012082. https://doi.org/10.1088/1742-6596/2377/1/012082

Saputra, H., Mansyur, J., & Supriyatman, S. (2021). Pengaruh pendekatan conceptual problem solving (cps) terhadap kemampuan representasi dan pemecahan masalah fisika siswa. *JPFT (Jurnal Pendidikan Fisika Tadulako Online)*, *9*(1), 7–14.

Sari, R., Perdana, R., Wilujeng, I., & Kuswanto, H. (2019). *The implementation of problem-based learning model with online simulation to enhance the student's analytical thinking skill in learning physics*. Journal of Physics: Conference Series, *1233*(1), 012030. https://doi.org/10.1088/1742-6596/1233/1/012030

Shofiyah, N., & Wulandari, F. E. (2018). Model problem based learning (PBL) dalam melatih scientific reasoning siswa. *Jurnal Penelitian Pendidikan IPA*, *3*(1), 33–38. https://doi.org/10.26740/jppipa.v3n1.p33-38

Simamora, E. D. M., & Sianipar, L. K. (2022). Mengupayakan minat belajar fisika siswa dengan model pembelajaran berbasis masalah. *Jurnal Pengembangan Pembelajaran dan Riset Fisika (JPPRF)*, *1*(1), 9–18.

Singh, S., & Dutt, S. (2022). Effecting the change: Problem based learning (pbl) as a pedagogy to improve achievement in physics in relation to cognitive styles. *ECS Transactions*, *107*(1), 8361. https://doi.org/10.1149/10701.8361ecst

Suari, N. P. (2018). Penerapan model pembelajaran problem based Learning untuk meningkatkan motivasi belajar IPA. *Jurnal Ilmiah Sekolah Dasar*, *2*(3), 241–247. https://doi.org/10.23887/jisd.v2i3.16138

Sujarwanto, E., Susanti, E., & Makiyah, Y. S. (2022). Bagaimana sikap dan pendekatan transitional novice terhadap penyelesaian masalah fisika? *Jurnal Pendidikan Fisika*, *11*(1), 40–47. https://doi.org/10.24114/jpf.v11i1.30602

Sulisworo, D., & Basriyah, K. (2021). *Problem based learning using open educational resources to enhance higher order thinking skills in physics learning*. *1783*(1), 012108. https://doi.org/10.1088/1742-6596/1783/1/012108

Sumalong, O., Kade, A., & Muslimin, M. (2021). Pengaruh model pembelajaran berbasis masalah dalam strategi penalaran kausal berbasis etnosains terhadap hasil belajar fisika. *Jurnal Kreatif Online*, *9*(2), 64–71.

Tanjung, Y. I. (2018). Pengaruh model pembelajaran berbasis masalah teknik polya terhadap hasil belajar dan aktivitas mahasiswa pada mata kuliah fisika matematika II. *Jurnal Ikatan Alumni Fisika Universitas Negeri Medan*, *4*(2), 1–3.

Telaumbanua, D. (2022). Analisis kualitas pembelajaran dan hasil belajar fisika. *Educativo: Jurnal Pendidikan*, *1*(1), 278–282. https://doi.org/10.56248/educativo.v1i1.38

Tuxtaevich, B. S., Bakhtiyorovich, G. R., Gulomjonovna, A. M., Umaralievna, B. S., & Bakhtiyarovna, S. G. (2022). Principles of selection of materials on the problem method of teaching physics in secondary schools. *Texas Journal of Multidisciplinary Studies*, *7*, 283–288.

Uno, H. B., & Nina Lamatenggo, S. (2022). *Tugas Guru dalam pembelajaran: Aspek yang memengaruhi*. Yogyakarta: Bumi Aksara.

Wibowo, F. (2021). *Unveil problem based learning on physics learning: A literature review*. Journal of Physics: Conference Series, *2019*(1), 012045. https://doi.org/10.1088/1742-6596/2019/1/012045

Yulianti, E., & Gunawan, I. (2019). Model pembelajaran problem based learning (PBL): Efeknya terhadap pemahaman konsep dan berpikir kritis. *Indonesian Journal of Science and Mathematics Education*, *2*(3), 399–408. https://doi.org/10.24042/ijsme.v2i3.4366

Yusdarina, Y. (2019). Pengembangan perangkat model pembelajaran berbasis masalah dalam meningkatkan minat dan pemahaman konsep fisika siswa kelas X SMK Muhammadiyah Bungoro. *Karst: Jurnal Pendidikan Fisika dan Terapannya*, *2*(1), 8–17. https://doi.org/10.46918/karst.v3i2.770

Zhang, C. (2023). Influences of problem-based online learning on the learning outcomes of learners. *International Journal of Emerging Technologies in Learning*, *18*(1). https://doi.org/10.3991/ijet.v18i01.36705

Zuleni, E., & Marfilinda, R. (2022). Pengaruh motivasi terhadap pemahaman konsep ilmu pengetahuan alam siswa. *Educativo: Jurnal Pendidikan*, *1*(1), 244–250. https://doi.org/10.56248/educativo.v1i1.34