JPPIPA 11(4) (2025)

Jurnal Penelitian Pendidikan IPA

http://jppipa.unram.ac.id/index.php/jppipa/index

Problem-Based Learning Model to Increase Students' Science Literacy in Grade V Science Learning on Heat Transfer Topic

Srinita Susanto[1*], Setiawan Edi Wibowo[1], Anisa Kurniasih[1], Vitry Rayani Bethesda Saragih[1], Annisyah Yuni[1]

[1] Elementary Education, Faculty of Education and Psychology, Yogyakarta State University, D.I. Yogyakarta, Indonesia.

Received: November 22, 2024
Revised: February 20, 2025
Accepted: April 25, 2025
Published: April 30, 2025

Corresponding Author:
Srinita Susanto
srinitasusanto873@gmail.com

DOI: 10.29303/jppipa.v11i4.9793

Abstract: This study aims to analyze the influence of the problem-based learning model on students' science literacy in science lessons in class V, especially on heat materials and their transfer. This study focuses on the pre-experimental method using a one-group pretest-posttest design research design. Data collection is carried out by providing tests consisting of pretest and posttest. Sampling technique through purposive sampling. The research sample amounted to 25 students. The data analysis technique was carried out by N-Gain and T-paired sample t-test. Based on the calculation of the hypothesis test using the t-test, it indicates that there is a significant difference between the pretest and the posttest. This can be seen from the significance value (p) = 0.000 ($p < 0.05$) so that the H0 hypothesis is rejected. This illustrates that the implementation of the problem-based learning model has a positive influence on students' science literacy in science lessons. Furthermore, based on the average N-Gain value of 0.5241 located in the medium group, this result indicates that the implementation of problem-based learning model is effective in improving students' science literacy in science lessons. Thus, it is concluded that the problem-based learning model has positive influence on students' science literacy. This study will contribute to the development of effective learning strategies to optimize students' science literacy and provide recommendations for educators in the application of the problem-based learning model in elementary schools.

Keywords: Problem based learning; Science learning; Science literacy

Introduction

Education is one of the important components related to the advancement of science and technology, so it is important to prepare the young generation who have sensitivity in analyzing the problems of daily life. In addition to channeling knowledge, education also ensures that students have specific skills (Hidayah et al., 2024; Yunianto et al., 2020). Therefore, at the basic education level, science is one of the subjects that plays an essential role because it can prepare students to face the pace of science and technology development in the era of digitalization (Bergbauer, 2018; Fitria et al., 2023). Thus, the emphasis on students' science literacy in learning aims to develop students' ability to construct scientific knowledge by applying scientific methods (Chung et al., 2022).

Unfortunately, PISA 2018 ranked Indonesian students' science literacy 70th out of 78 countries with an average score of 396 (OECD, 2019). Indicating low understanding and application of science concepts in everyday life. The results of observations in class V SD also revealed that science learning is still dominated by textbook-based expository methods, less active and contextual student involvement, so that it tends to be

How to Cite:
Susanto, S., Wibowo, S. E., Kurniasih, A., Saragih, V. R. B., & Yuni, A. (2025). Problem-Based Learning Model to Increase Students' Science Literacy in Grade V Science Learning on Heat Transfer Topic. *Jurnal Penelitian Pendidikan IPA*, *11*(4), 408–415. https://doi.org/10.29303/jppipa.v11i4.9793

memorized and minimal problem-solving experiences relevant to the surrounding environment.

In fact, student involvement in the science learning process will equip students with the knowledge needed to move towards a higher level of education (Barbosa et al., 2019; Sung et al., 2016). This is in line with the purpose of learning science in elementary school, which is to foster an understanding of science concepts that can be applied in daily life. In addition science lessons also aim to foster a desire to explore and a positive attitude towards technology, the environment, and social interaction (Subali et al., 2019). Therefore, educators need to adjust learning models and methods that have the potential to support the achievement of science literacy in science learning.

The problem-based learning model is an alternative that is believed to improve students' science literacy because this model prioritizes real problem solving. Problem-based learning is a student-centered teaching and learning method to acquire knowledge, skills, and attitudes through real-life situations (Thorndahl & Stentoft, 2020). The problem-based learning model is a model that utilizes real problem from the surrounding environment as a basis to gain knowledge and develop critical thinking and problem-solving skills (Awaliyah et al., 2024; Oktaviana & Haryadi, 2020). Problem based learning is a learning model that introduces problem to students to solve and invites students to solve these problems through active learning activities with the guidance of the teacher as a facilitator (Effendi & Sutiarso, 2021). A facilitator can be considered a coach or guide who provides feedback and encouragement (Salari et al., 2018).

This is in accordance with Vygotsky's theory of Social Constructivism which affirms that students develop their way of thinking through social interaction, the basis of knowledge is an interaction that involves sharing and comparing ideas by dialogue between students and facilitators (Boye & Agyei, 2023). In addition, problem-based learning also involves individual and group activities to stimulate curiosity, motivation, independent learning, and reflection with the source of the problem posed by the teacher or proposed by the student, so that students are motivated to be involved effectively in the analysis and understanding of the problem and how to solve it (Gorghiu et al., 2015).

Problem-based learning not only supports students in understanding and solving problems, but also supports students to explore their knowledge and skills to expand their understanding of science literacy. Science literacy includes students' expertise in understanding relevant everyday problems based on the topics they have learned, so that students can be positive and show a high level of concern for themselves and the environment (Fuad & Wilujeng, 2016). With science literacy, it inspires students to be active in the learning process and increase their curiosity, because it provides opportunities to understand and discover various applications of science in daily life (Qomaliyah et al., 2016). Therefore, mastery of science literacy is very crucial, considering that students need to be well prepared in order to be able to solve various difficulties that arise in the real world (Kurniawati & Hidayah, 2021).

Research on problem-based learning shows positive results. Several studies have shown the effectiveness of problem-based learning strategies in improving mathematics teaching and learning (Boye & Agyei, 2023). In addition, problem-based learning is an efficient learning strategy in the context of science lessons (Gorghiu et al., 2015). Problem-based learning can motivate and improve learning outcomes (Suari, 2018; Wahyuni & Setyaningtyas, 2018; Wau, 2017; Yasmini, 2021). Furthermore, the problem-based learning model is also used to improve the creative thinking of elementary school students (‘Adiilah & Haryanti, 2023; Aristanti & Fatayan, 2024), and influential in improving critical thinking skills (Affandy et al., 2024; Pamungkas & Astuti, 2019; Sujana, 2023).

However, there are not many studies that review the effect of problem-based learning models on students' science literacy in science lessons in grade V, especially on the material of heat and its transfer. Through this research, the focus to be carried out is limited by measuring aspects of science competence which include indicators of identifying problem issues, describing scientific phenomena, and applying scientific evidence. In line with OECD 2006, science literacy is divided into four dimensions, namely the dimensions of scientific knowledge, context, competence, and attitude (Fitriani et al., 2017).

Based on the background description, the purpose of this study was to analyze the influence of problem-based learning model on students' science literacy in science lessons in grade V, especially on heat materials and their displacement. It is hoped that this study will contribute to the development of effective learning strategies to optimize students' science literacy and provide recommendations for educators in the application of the problem-based learning model in elementary schools.

Method

This study focuses on pre-experimental research methods. The results of the pre-experimental research included dependent variables that were not fully bound by independent variables (Sugiyono, 2019). This condition occurred, due to the absence of control variables and the selection of samples was not carried out randomly. The research design applied is one group pretest-posttest design. In this design, first give a pretest on the sample, then treatment, and posttest at the end of learning.

Table 1. One Group Pretest-Posttest Design

Pretest	Treatment	Posttest
O_1	X	O_2

Information: O1= Initial test before action; O2= Final test after action; X = Application of Problem-Based Learning Models

The population that is the focus of this study includes all grade V classes at SDN 95 Bulo. This public primary school is located in a suburban area precisely in Walenrang sub-district with B accreditation status. School facilities and infrastructure are limited; classrooms are simple and there is no dedicated science laboratory. Learning media is generally based on simple teaching aids and textbooks.

The characteristics of students in this school come from family backgrounds with middle to lower socio-economic levels. They have a high enthusiasm for learning but are generally used to conventional lecture-based learning methods. Their science literacy skills tend to be low; most students have difficulty in connecting science concepts with real situations, as well as in developing critical questions and solutions to problems. thus the sample is class Va totaling 25 students from the entire population selected by purposive sampling technique, which is a sampling technique with a specific purpose based on teacher consideration.

Data was obtained by providing tests consisting of pretest and posttest. Before the test is used for data collection, a validity test was conducted first. Instrument for measuring science literacy uses a multiple-choice test, each correct answer gets a score of one and the question gets a score of zero if the answer is wrong. The test in this study was prepared based on the PISA guidelines by following the science competency indicators consisting of identifying scientific issues, explaining scientific phenomena, and using scientific evidence.

The data analysis technique was carried out with N-Gain to show that the pretest and posttest scores had increased or decreased. N-Gain is an analytical method used to measure the effectiveness of learning by comparing the increase in scores between pretest and posttest or it can be said that N-Gain is a comparison between the average gain obtained and the maximum possible gain (Hake, 1998). and previously a normality test was carried out to ensure normal sample distribution using the Shapiro-Wilk test, then to test the hypothesis with a paired sample t-test using SPSS 25 for windows.

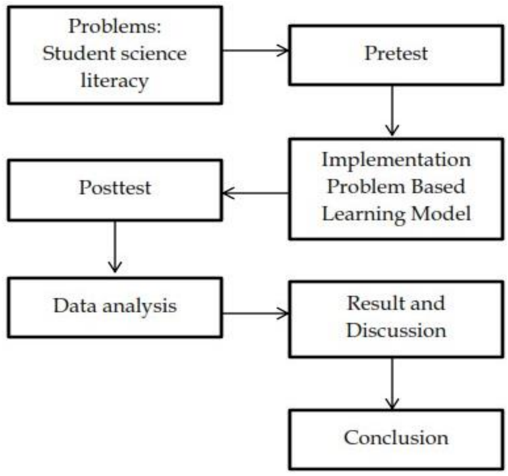

Figure 1. Research flow

Result and Discussion

Result

This study shows that the use of the Problem-Based Learning (PBL) model has an impact on students' science literacy. This statement is supported by the findings obtained by the researcher through conducting NGain tests, normality tests, and hypothesis tests. Referring to the results of descriptive statistical processing for the calculation of NGain obtained from the average number of students' pretest and posttest. After the normalized gain (NGain) calculations arer performed on the average pretest and posttest scores of students, it was found that the average NGain of 0.5241 showed that the increase in students' science literacy was in the moderate group. According to Meltzer (2002) The NGain group values ranged from $0.3 \leq g < 0.7$ to show a moderate increase. This reveals that the problem-based learning model applied has succeeded in significantly increasing students' science literacy skills, although the improvement has not reached the maximum level.

Table 2. N-Gain Score Test Results

	N	Min	Max	Sig.	Std. Deviation
NGain_score	25	.42	.65	.5241	.05421

The table above shows that the minimum N-Gain value is 0.42, while the maximum value reaches 0.65. This shows that although there are differences in students' responses to the model taught, the majority of students experience a relatively stable increase. Overall, this data indicates that the implementation of the problem-based learning model is successful in increasing students' science literacy. The majority of students experienced an increase in science literacy which was classified as a medium group in accordance with the measured N=Gain score.

Table 3. Normality Test Results with Shapiro-Willk

Test	Ststistic	df	Sig.
Pretest	.976	25	.790
Posttest	.979	25	.868

Furthermore, inferential statistical analysis is carried out to test the normality of pretest and posttest data. The results of Shapiro-Wilk normality test on the pretest and posttest data showed that the two groups of data were normally distributed. The statistical value of Shapiro-Wilk for pretest data is 0.976 with a significance value (p) = 0.790, while for posttest data the statistical value is 0.979 with p = 0.868. Therefore, in both data, the p value > 0.05 so that it can be said that no violation of the assumption of normality was found. Thus, the pretest and posttest data are normally distributed and the t-test can be performed.

The results of t-test with the Paired Sample Test showed significant differences in pretest and posttest scores. The average difference between the two scores is -20,840, which means that the average posttest score is higher than the pretest score. Std. Deviation of 1.463 indicates a slight variation in the difference in scores between students, and a Standard Error Mean of 0.293 indicates the accuracy of the average estimate of the difference.

Table 4. Hypothesis Test Results with Paired Sample Test

	t	df	Sig. (2-tailed)
Pretest - Posttest	-71.230	24	.000

The table above shows that the value of t = -71.230 with degrees of freedom (df) = 24 and the significance value (p) = 0.000 ($p < 0.05$) shows that the hypothesis in this study Ha is accepted and H0 is rejected, this shows a substantial difference in the results of the pretest and posttest statistically. Based on these findings, it was concluded that there was a significant increase between the pretetst and posttest results which indicated that implementation of the problem-based learning model had a positive impact on students' science literacy.

This study has limitations that need to be considered in interpreting the results. This study did not use a control group as a comparison, so the ability to draw strong causal conclusions regarding the effectiveness of the Problem-Based Learning (PBL) model is limited. Without a comparison of conventional learning models, the improvement of students' science literacy could have been influenced by other factors such as prior knowledge, the role of the teacher, or students' learning motivation.

Discussion

Based on the calculation of the hypothesis test using the t-test, it can be seen that there is a significant difference between the pretest and the posttest. This can be proven from the significance value (p) = 0.000 ($p < 0.05$) as a result of hypothesis H0 rejected. This indicates that implementation of the problem-based learning model has positive implications for students' science literacy in science subjects. The problem-based learning model involves authentic problem as a reference for students to practice problem-solving skills, critical thinking, and growing new knowledge. This is in line with previous studies that problem-based learning has a positive impact on students' science literacy skills, especially in dimension of science competence in the material reaction rate with the results of t_{count} 8.27> t_{table} 1.99 at a significance level of 0.05 (Fitriani et al., 2017). In line with this, the problem-based learning model also have an impact on improving critical thinking competence (Affandy et al., 2024; Pamungkas & Astuti, 2019; Sujana, 2023). When students are given problems, they gradually solve them by following the syntax in the problem-based learning method. The increase in science literacy is also affected by this stage (Fauziah et al., 2019). There are five stages in the application of the problem-based learning model, namely directing students to explore problem, regulating student learning patterns, guiding investigations independently and in groups, exploring and presenting the results of work, and even reviewing and reviewing the problem-solving process (Sajidan et al., 2022). In the first stage, students are faced with problems according to real situations in their daily lives, both inside and outside the school area. In the second stage, students are directed to seek information and offer solutions individually or in groups. In the third stage, educators act as facilitators and motivators, while students are encouraged to find solutions independently and responsibly in a team. In the fourth stage, students develop a report, and in the fifth stage, students re-evaluate the problem-solving process (Kurniawan et al., 2015).

Through the implementation of this learning model, students develop concepts or ideas based on their own abilities by combining skills and insights that have been mastered first (Rusman, 2014). In addition, the condition of the learning room in problem-based learning prioritizes an active learning process with the guidance of the teacher as a facilitator (Effendi & Sutiarso, 2021). With this, making students the center of learning is not on the educator. There are more optimal results when the problem-based learning model is implemented when the learning continues to arouse students' enthusiasm and motivation. This is related to the theoretical view that problem-based learning can motivate and optimize learning outcomes (Suari, 2018; Wahyuni & Setyaningtyas, 2018; Wau, 2017; Yasmini, 2021).

During the learning process, students are involved in various group activities. Students share explanations, discuss, and collaborate to solve the problems given. This approach makes it easier for students to understand material or problem that is considered difficult. In addition, each group member is a peer making students more comfortable asking friends who understand better if there is something that they do not understand. Thus, learning can take place smoothly and meaningfully. This opinion is in line with Vygotsky's theory of Social Constructivism which explains that students develop their way of thinking through social interaction, the basis of knowledge is an interaction that involves sharing and comparing ideas by dialogue between students and facilitators (Boye & Agyei, 2023).

The application of problem-based learning shows a positive impact on the teaching and learning process. Previous research revealed that effectiveness of problem-based learning strategies in increasing teaching and learning (Boye & Agyei, 2023). This model encourages students to hone deductive thinking skills, problem-solving skills, and independence (Manik et al., 2020). The advantage of problem-based learning lies in its characteristics that integrate theory and practice in real-world contexts. This approach allows students to see the relationship between learning materials and daily activities so as to foster student motivation and involvement in the learning process (Rahman & Ahmar, 2016). This shows that problem-based learning is able to create a learning environment that encourages exploration and discovery (Yanti & Wijaya, 2023).

In the context of teaching science or science, problem-based learning shows significant efficiency. This is supported by findings that state that problem-based learning is an efficient learning strategy in the context of science lessons (Gorghiu et al., 2015). This can be understood that problem based learning model facilitates the development of students' scientific understanding through investigation and experimentation. This model provides opportunities for students to hone their scientific process skills such as observing, analyzing, and deducing. Implementing a problem-based learning model during science or science learning activities also supports the development of students' science literacy. This statement can be evidenced by findings that explain that students involved in learning that integrate the Problem Based Learning model show an improvement in their skills in identifying scientific problems, describing phenomena scientifically, and applying scientific facts (Handayani et al., 2018). In line with the goals of science learning or science which emphasizes the understanding and use of science concepts in various daily activities.

Based on the average results, the NGain value reached 0.5241, located in the medium group, which means that this finding indicates that the implementation of problem-based learning model is effective in honing students' science literacy in science lessons. Through the stages of problem-based learning, students are trained to produce various ideas, develop different perspectives in looking at problems, create unique solutions, and develop ideas in detail. Previous findings also reveal that the problem-based learning model substantially sharpens the creativity of elementary school students (‘Adiilah & Haryanti, 2023; Aristanti & Fatayan, 2024). In line with these findings, students learning using the problem-based learning model showed an increase in their capacity to produce original ideas and innovative solutions to the problems they faced (Andirasdini & Fuadiyah, 2024). The problem-based learning model encourages students to explore various solutions, and develop divergent thinking. The characteristics of problem-based learning encourage exploration and discovery in line with the cognitive development of elementary school children.

The effectiveness of problem-based learning model can also be seen through the learning process directly involving students to research complex problems related to heat matter and its transfer, independent and group exploration, and conducting practicum activities related to heat matter and its transfer. Directly provide understanding and experience related to science literacy, because science literacy emphasizes the importance of recognizing and understanding the context of science application, as well as the ability to apply science in solving real problems encountered. In this case, the problem-solving process in problem-based learning encourages students to develop creativity through concrete and meaningful learning experiences (Chrysti Suryandari et al., 2018). This approach also supports the development of students' social skills and communication skills through group interaction and collaboration.

The findings from this study contribute to the development of a problem-based learning model in science or science learning at elementary school level, especially heat materials and their transfer. This study emphasizes that the problem-based learning model is known as an effective learning strategy to hone students' science literacy, not only encouraging students to master scientific concepts, but also involving students in the process of exploration, discussion, and deep reflection. Thus, students are more skilled at understanding science material meaningfully and relating it to the context of daily life.

Problem-Based Learning (PBL) is a student-centered learning approach that uses real problems as a context for developing critical thinking skills, problem solving, and building new knowledge. PBL does not only aim to deliver material, but encourages students to actively identify what they know, what they need to learn, and how they manage newly acquired information to solve problems. According to Hmelo-Silver (2004), PBL places students in the role of "active learners" who must collaborate, develop hypotheses, seek additional information, and evaluate solutions based on evidence. In the context of science literacy, this is in line with the scientific abilities that students need such as asking science-based questions, designing investigations, and interpreting data critically.

Science literacy is not just about memorizing facts, but about understanding principles, applying them in various situations, and thinking scientifically in dealing with real problems. The application of the PBL model in science learning is expected to strengthen the three main domains of science literacy, namely: Cognitive: improving understanding of scientific concepts such as forms of heat transfer (conduction, convection, radiation); Science Process: developing the ability to design simple experiments on heat transfer; and Scientific Attitude: familiarizing students to make evidence-based decisions and think critically about the phenomena around them.

Thus, Problem-Based Learning has the potential to be an effective strategy to improve students' science literacy, not only in terms of knowledge, but also critical thinking skills and scientific attitudes, all of which are an important part of 21st century competencies.

Conclusion

Based on the findings, it is shown that the implementation of the problem-based learning model has proven effective in improving students' science literacy skills in science lessons, especially in heat and displacement materials. Therefore, elementary science teachers can utilize the PBL model as an alternative learning that encourages students to think critically, actively discuss, and relate the material to everyday life. Thus, the findings of this study are concluded that the problem-based learning model has a positive influence on students' science literacy in science lessons in class V.

Acknowledgments
I would like to thank the lecturers and peers who have provided input and constructive criticism during the writing process.

Author Contributions
Conceptualization, S. S.; methodology, S. S.; validation, S. E. W.; formal analysis, S. S.; investigation, S. S. and A. Y.; resources, A. K. and V. R. B. S.; data curation, S. S.: writing—original draft preparation, A. K.; writing—review and editing, S. S.: visualization, V. R. B. S. All authors have read and agreed to the published version of the manuscript.

Funding
Researchers independently funded this research.

Conflicts of Interest
The authors declare no conflict of interst.

References

'Adiilah, I. I., & Haryanti, Y. D. H. (2023). Pengaruh Model Problem Based Learning Terhadap Kemampuan Berpikir Kreatif Siswa Pada Pembelajaran IPA. *Papanda Journal of Mathematics and Sciences Research (PJMSR*, *2*(1), 49–56. https://doi.org/10.56916/pjmsr.v2i1.306

Affandy, H., Sunarno, W., & Suryana, R. (2024). Integrating Creative Pedagogy Into Problem-Based Learning : The Effects on Higher Order Thinking Skills in Science Education. *Thinking Skills and Creativity*, *53*(June), 101575. https://doi.org/10.1016/j.tsc.2024.101575

Andirasdini, I. F., & Fuadiyah, S. (2024). Pengaruh Model Pembelajaran Problem Baseed Learning Terhadap Keterampilan Berpikir Kreatif Peserta Didik Pada Pembelajaran Biologi : Literature Review. *Biodik: Jurnal Ilmiah Pendidikan Biologi*, *10*(2), 156–161. https: 10.22437/biodik.v10i2.33827. 156

Aristanti, A. P., & Fatayan, A. (2024). The Effect of the UbD-Based Problem-Based Learning Model on the Critical Thinking Skills of Grade IV Students in IPAS Subject at Elementary School Anastasya. *Mimbar Sekolah Dasar*, *11*(2), 268–280. https://doi.org/10.53400/mimbar-sd.v11i2.71794

Awaliyah, N. P., Hastuti, W. S., Wibowo, S. E., & Hidayat, P. (2024). The Effect of Problem Based Learning (PBL) Model on Students' Critical Thinking Ability in Sound Wave Material. *Mimbar PGSD Undiksha*, *12*(1), 101–107. https://doi.org/10.23887/jjpgsd.v12i1.62280 The

Barbosa, V., Leme, R., Angela, M., & Yunes, M. (2019). Life Satisfaction and Academic Performance of Elementary School Students. *Psico-USF*, *24*(2), 323–335. http://dx.doi.org/10.1590/1413-82712019240209

Bergbauer, A. (2018). Social Interaction Determinants of South African Reading Literacy Achievement : Evidence from prePIRLS 2011. *International Journal of Instruction*, *11*(2), 555–568.

http://dx.doi.org/10.12973/iji.2018.11238a

Boye, E. S., & Agyei, D. D. (2023). Effectiveness of problem-based learning strategy in improving teaching and learning of mathematics for pre-service teachers in Ghana. *Social Sciences and Humanities Open*, *7*(1), 100453. https://doi.org/10.1016/j.ssaho.2023.100453

Chrysti Suryandari, K., Sajidan, Budi Rahardjo, S., Kun Prasetyo, Z., & Fatimah, S. (2018). Project-based science learning and pre-service teachers' science literacy skill and creative thinking. *Cakrawala Pendidikan*, *37*(3), 345–355. https://doi.org/10.21831/cp.v38i3.17229

Chung, C., Cai, L., Wen, T., Yi, H., Ming, C., Chang, H., & Han, P. (2022). Augmenting the effect of virtual labs with " teacher demonstration " and " student critique " instructional designs to scaffold the development of scientific literacy. In *Instructional Science* (Vol. 50, Issue 2). Springer Netherlands. https://doi.org/10.1007/s11251-021-09571-4

Effendi, R., & Sutiarso, S. (2021). Pengembangan LKPD Matematika Berbasis Problem Based Learning di Sekolah Dasar. *Jurnal Basicedu*, *5*(2), 920–929. https://doi.org/10.31004/basicedu.v5i2.846.

Fauziah, N., Andayan, Y., & Hakim, A. (2019). Peningkatan Literasi Sains Peserta Didik Melalui Pembelajaran Berbasis Masalah Berorientasi Green Chemistry pada Materi Laju Reaksi. *Jurnal Pijar MIPA*, *14*(2), 31–35. https://doi.org/10.29303/jpm.v14i2.1203

Fitria, Y., Alwi, N. A., Eliasni, R., Chandra, & Kharisma, A. (2023). Graphic Organizer-Based Science Literacy Learning Models in Elementary Schools. *Jurnal Pendidikan IPA Indonesia*, *12*(1), 123–134. https://doi.org/10.15294/jpii.v12i1.41004

Fitriani, D., Milama, B., & Irwandi, D. (2017). Pengaruh Model Pembelajaran Berbasis Masalah terhadap Kemampuan Literasi Sains Siswa pada Materi Laju Reaksi. *EDUSAINS*, *9*(2), 117–126. https://doi.org/10.15408/es.v9i2.1402

Fuad, M., & Wilujeng, I. (2016). Pengembangan SSP zat dan energi berbasis keunggulan lokal untuk meningkatkan literasi sains dan kepedulian lingkungan. *Jurnal Inovasi Pendidikan IPA*, *2*(1), 66–75. https://doi.org/10.21831/jipi.v2i1.8369

Gorghiu, G., Cristea, S., Petrescu, A., & Monica, L. (2015). Problem-Based Learning - An Efficient Learning Strategy In The Science Lessons Context. *Procedia Social and Behavioral Sciences*, *191*, 1865–1870. https://doi.org/10.1016/j.sbspro.2015.04.570

Hake, R. R. (1998). Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. *American Journal of Physics*, *1*(66), 64–74. https://doi.org/10.1119/1.18809

Handayani, G., & Indrayanti, R. (2018). Hubungan Keterampilan Proses Sains Terintegrasi dan Kemampuan Membaca Pemahaman Terhadap Literasi Sains Pada Mahasiswa Calon Guru Biologi. *Biosfer: Jurnal Pendidikan Biologi (BIOSFERJPB)*, *11*(1), 21–31. https://doi.org/10.21009/biosferjpb.11-1.3

Hidayah, A., Rokhimawan, M. A., & Suherman, R. (2024). Implementation of Ethnoscience-Based PjBL on Science Literacy Learning Outcomes. *Journal of Innovation in Educational and Cultural Research*, *5*(3), 398–407. https://doi.org/10.46843/jiecr.v5i3.1278

Kurniawan, T., Rokhmat, J., & Ardhuha, J. (2015). Perbedaan Hasil Belajar Melalui Penerapan Model Dengan Pembelajaran Konvensional Pada Siswa Kelas VIII SMPN 1 Labuapi Tahun Ajaran 2013/2014. *Jurnal Pendidikan Fisika Dan Teknologi*, *1*(2), 123–128. https://doi.org/10.29303/jpft.v1i2.247

Kurniawati, & Hidayah, N. (2021). Pengaruh Pembelajaran Problem Based Learning Berbasis Blended Learning terhadap Kemampuan Literasi Sains. *Bioedusiana*, *6*(2). https://doi.org/10.37058/bioed.v6i2.3090

Manik, P., Saraswati, S., Ngurah, G., & Agustika, S. (2020). Kemampuan Berpikir Tingkat Tinggi Dalam Menyelesaikan Soal HOTS Mata Pelajaran Matematika. *Jurnal Ilmiah Sekolah Dasar*, *4*(2), 257–269. https://doi.org/10.23887/jisd.v4i2.25336

OECD. (2019). *PISA 2018 Results (Volume I): What Students Know and Can Do: Vol. I*. OECD Publishing. https://doi.org/10.1787/5f07c754-en.

Oktaviana, D., & Haryadi, R. (2020). Pengaruh Model Pembelajaran Problem Based Learning (PBL) terhadap Kemampuan Pemecahan Masalah Mahasiswa. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *9*(4), 1076–1085. https://doi.org/10.24127/ajpm.v9i4.3069

Pamungkas, D., & Astuti, S. (2019). Peningkatan Keterampilan Berpikir Kritis dan Hasil Belajar Matematika Pada Siswa Kelas IV Melalui Penerapan Model Problem Based Learning. *Jurnal Ilmiah Sekolah Dasar*, *3*(2). https://doi.org/10.23887/jisd.v3i2.17774

Qomaliyah, E. N., Sukib, & Loka, I. N. (2016). Pengaruh Model Pembelajaran Inkuiri Terbimbing Berbasis Literasi Sains terhadap Hasil Belajar Materi Pokok Larutan Penyangga. *Jurnal Pijar MIPA*, *XI*(2), 105–109. https://doi.org/10.29303/jpm.v11i2.111

Rahman, A., & Ahmar, A. S. (2016). The influence of cooperative learning models on learning outcomes based on students ' learning styles The influence of cooperative learning models on learning outcomes based on students' learning styles. *World Transactions on Engineering and Technology Education*, *14*(3). https://doi.org/10.26858/wtetev14i3y2016p6425430

Rusman. (2014). *Model-model Pembelajaran (Mengembangkan Profesionalisme Guru)*. Raja Grafindo Persada.

Sajidan, Suratno, Atmojo, I. R. W., Saputri, D. Y., & Etviana, R. (2022). Problem-Based Learning-Collaboration (PBL-C) Model in Elemantary School Science Learning in the Industrial Revolution Era 4.0 and Indonesia Society 5.0. *Jurnal Pendidikan IPA Indonesia*, *11*(3), 477–488. https://doi.org/10.15294/jpii.v11i3.30631

Salari, M., Roozbehi, A., Zarifi, A., & Tarmizi, R. A. (2018). Pure PBL , Hybrid PBL and Lecturing : which one is more effective in developing cognitive skills of undergraduate students in pediatric nursing course ? *BMC Medical Education*, *18*(1), 195. https://doi.org/10.1186/s12909-018-1305-0

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

Subali, B., Aminah, N. S., & Sumintono, B. (2019). Method In The Natural Science Subject In Elementary. *Jurnal Pendidikan IPA Indonesia*, *8*(1), 41–53. https://doi.org/10.15294/jpii.v8i1.16010

Sugiyono. (2019). *Metode Penelitian Pendidikan*. Alfabeta.

Sujana, I. W. (2023). Problem Based Learning Models Helped by Student Worksheets Improve Higher Order Thinking Skills. *International Journal of Elementary Education*, *7*(2), 187–195. https://doi.org/10.23887/ijee.v7i2.61715

Sung, Y., Chang, K., & Liu, T. (2016). Computers & Education The effects of integrating mobile devices with teaching and learning on students ' learning performance : A meta-analysis and research synthesis. *Computers & Education*, *94*, 252–275. https://doi.org/10.1016/j.compedu.2015.11.008

Thorndahl, K. L., & Stentoft, D. (2020). Thinking Critically About Critical Thinking and Prob- lem-Based Learning in Higher Education : A Scoping Review. *Interdisciplinary Journal of Problem-Based Learning*, *14*(1), 1–21. https://doi.org/10.14434/ijpbl.v14i1.28773

Wahyuni, I., & Setyaningtyas, E. W. (2018). Penerapan Model PBL Berbantuan Role Playing untuk Meningkatan Motivasi dan Hasil Belajar IPS. *Jurnal Ilmiah Sekolah Dasar*, *2*(4), 356–363. https://doi.org/10.23887/jisd.v2i4.16152

Wau, M. P. (2017). Pengaruh Model Problem Based Learning terhadap Hasil Belajar IPS pada Siswa Kelas Kabupaten Ngada. *Journal of Education Technology*, *1*(4), 239–245. https://doi.org/10.23887/jet.v1i4.12860

Yanti, N. F. Y., & Wijaya, A. (2023). Pengaruh Penerapan Model Pembelajaran Problem-Based Learning terhadap Kemampuan Berpikir Kritis Matematis Siswa. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika, 12(*1), 1213–1225. https://doi.org/10.24127/ajpm.v12i1.6750

Yasmini, I. G. K. (2021). Penerapan Model Pembelajaran Problem Based Learning untuk Meningkatkan Motivasi Belajar IPA. *Journal of Education Action Research*, *5*(2), 159–164. https://doi.org/10.23887/jear.v5i2.33603

Yunianto, T., Suyadi, S., & Suherman, S. (2020). Pembelajaran abad Pengaruhnya terhadap pembentukan karakter akhlak melalui pembelajaran STAD dan PBL dalam kurikulum 2013. *Premiere Educandum: Jurnal Pendidikan Dasar Dan Pembelajaran*, *10*(December), 203–214. https://doi.org/10.25273/pe.v10i2.6339