



Integration of Local Wisdom in PBL-based Science Teaching Material to Improve Students' Environmental Literacy

Zetira Yunita Santi¹, Habiddin Habiddin^{1,2*}, Erti Hamimi³, Shinta Permata Sari¹

¹Department of Science Education, Universitas Negeri Malang, Malang, Indonesia

²Department of Chemistry, Universitas Negeri Malang, Malang, Indonesia

³Graduate School Student of the National Institute of Education, Nanyang Technological University, Singapore, Singapore

*Correspondence to: habiddin_wuni@um.ac.id

Abstract: This study investigates the effect of PBL-based science teaching materials integrated with local wisdom (PBL-LW) on improving students' environmental literacy (EL). The sample consisted of male and female students from a public Islamic junior high school in Malang, East Java, Indonesia. The one-group pretest-posttest method was employed, utilizing the Middle School Environmental Literacy Survey (MSELS) as the instrument, which covers several aspects of environmental literacy, including knowledge, environmentally conscious attitudes, cognitive skills, and ecologically responsible behavior. The data were analyzed descriptively, and the t-test and the Wilcoxon test were used to assess differences in students' environmental literacy skills. Additionally, the N-Gain test measured the extent of improvement in students' EL. The findings indicate a significant difference in students' EL following PBL-LW science instruction. This is reinforced by the N-Gain results, demonstrating the effectiveness of these teaching materials in enhancing students' EL. This study suggests the need to promote EL in the education system from an early age. This will ensure a better environment in the future and avoid the risk of ecological damage.

Keywords: green environment education; middle school environmental literacy survey; MSELS; sustainable education

Recommended citation: Santi, Z. Y., Habiddin., Hamimi, E., & Sari, S. P. (2026). Integration of Local Wisdom in PBL-based Science Teaching Material to Improve Students' Environmental Literacy. *Journal of Innovation in Educational and Cultural Research*, 7(4), 902-908.

INTRODUCTION

The current era of globalization significantly affects various aspects of life, including increasingly complex and difficult-to-predict environmental issues. Environmental degradation has been a subject of concern among scholars for several decades. Environmental degradation refers to the destruction of the environment due to resource scarcity, encompassing all biotic and abiotic components of our surroundings, including air, soil, water, plants, animals, and other living and non-living components of the Earth (Maurya et al., 2020). Environmental disasters typically arise from human negligence, mechanical malfunctions, natural disasters, technical challenges, and inadvertent releases. They result in enduring ecological issues such as the greenhouse effect and depletion of the ozone layer (Hanif et al., 2020; Park, 2022). Several observable phenomena suggest potential risks to the future environment and human life. British Petroleum reported that CO₂ emissions from petrol have been rising by approximately 1.8% annually. This has resulted in anomalous climate change, causing a substantial increase in global temperatures, wildfires, flooding, and ecological destruction (Amin et al., 2020; Keshavarzian & Tabatabaieenasab, 2022).

Evidence of environmental damage has emerged as a significant focal point in international forums (Ikhsan & Amri, 2024). The Kyoto Protocol, with over 160 parties, was ratified in 1997 and, for the first time, imposed legally binding restrictions on emissions of CO₂ and other greenhouse gases for industrialized nations (Breidenich et al., 1998). The international agreement for tackling environmental issues was followed by the Paris Agreement in 2016, with Indonesia among the signatories. As a country with rich biodiversity and culture, Indonesia faces serious environmental issues, including illegal logging, illegal hunting of protected animals, overuse of renewable energy, and careless disposal of industrial, agricultural, and livestock waste. The emergence of COVID-19 has once again raised concerns about human attitudes and behaviors towards nature (Ha et al., 2022). To address those issues, citizens should understand and care about the environment, possess the competence to analyze environmental issues, and be highly motivated to act appropriately (Hollweg et al., 2011). This suggests that environmental literacy is essential in overcoming current and future ecological problems.

The term EL was first introduced in the 1960s and refers to an individual's level of environmental knowledge and awareness. The term was then refined from its initial concept of environmental literacy to encompass observable behaviors as well (Örs, 2022). Environmental literacy includes knowledge and understanding of environmental issues, attitudes and concerns about the environment, moral and ethical considerations related to the environment, and the intention to engage in environmentally responsible behavior, along with the development of skills for data evaluation, conclusion, and opinion formation. It focuses on four

aspects: affect, behavior, knowledge, and skills (Kaya & Elster, 2019; Maurer & Bogner, 2020). In particular, the relationship between human knowledge of environmental issues and human health is called environmental health literacy (Gray, 2018).

Protecting against future environmental damage could be initiated early by building awareness in younger generations, such as lower secondary school students. The spirit of environmental literacy will protect our environment from any possible damage (Kaya & Elster, 2019). The required skills, motivation, and action to tackle environmental issues are associated with the four components of EL, namely: knowledge, affect, cognitive skills, and environmental behavior. Knowledge encompasses a positive attitude, sensitivity towards the environment, and self-efficacy. Meanwhile, cognitive skills refer to the ability to analyze environmental issues and solve problems (Hollweg et al., 2011; Stevenson et al., 2013). Science teaching at this level is a potential approach for equipping students with knowledge and skills relevant to environmental literacy. Therefore, teaching resources should be designed to familiarise students with environmental issues and foster awareness of the need to protect and utilize the environment wisely. In addition, students will find it easier to understand scientific concepts related to environmental issues that closely connect to everyday life, enabling them to apply and take more appropriate actions related to their surrounding environment (Ilhami et al., 2019). Therefore, providing science teaching materials based on Problem-Based Learning (PBL) could be an effective approach to building students' environmental literacy. For example, a game-based learning approach regarding environmental pollution measures has been developed, and further positive outcomes could be assessed (Suhartatik et al., 2026). PBL integrated with a cooperative approach was also applied in the ecosystem class and was found to be effective in improving students' critical thinking (Lailia, 2025).

As demonstrated in previous research, several studies have highlighted the positive impact of PBL-based teaching materials that integrate local wisdom. The incorporation of Rawa Bento local wisdom in an e-science module for junior high school students in Yogyakarta enhanced students' environmental literacy (Fahlevi et al., 2024). Meanwhile, a comic was also used as a PBL resource to improve students' environmental literacy (Wajdi et al., 2022). Specifically, a teaching material on environmental pollution and global warming was also found to be effective in building junior high school students' environmental awareness and literacy (Suryawati et al., 2020). In a similar study, Natural Environmental Exploration (NEE) and Lombok coastal local wisdom were used in a PBL-based teaching approach to improve students' environmental literacy (Abdillah et al., 2021; Sukri, 2023). PBL is an established approach in educational settings; therefore, introducing new or additional elements into the PBL system should be carefully considered. Findings suggest that such immersion has been largely unsuccessful (Sulistiyan et al., 2025). This study aims to investigate the contribution of PBL-based teaching materials integrating local wisdom contexts to improving students' EL. For simplicity, from this point forward, the teaching material will be referred to as PBL-LW. The PBL-LW was implemented in the topic of ecosystem and biodiversity.

METHODS

This study employs a one-group pretest-posttest design to investigate the benefits of PBL-LW for the EL of 45 seventh-grade students at a public Junior high school in Malang. Seventh-grade students, or first-year junior high school students, are equivalent to first-year lower secondary school students, aged 11-13 years. Instruments for data collection include PBL-LW for delivering PBL in the topic areas of ecosystem and biodiversity, and MSELs for measuring students' EL. The PBL-LW has met the criteria for high implementation feasibility, as assessed by two raters, with an Aiken coefficient of 0.89. This exceeds the minimum criterion for Aiken's validity, which is 0.74 (Aiken, 1985). The PBL-LW has also been registered with the digital book publisher platform under the QRCBN (Quick Response Code Book Number) 62-9557-4062-565. Students' environmental literacies were measured before and after the treatments using the MSELs, which covers 4 aspects (Cincera et al., 2023; Maurer & Bogner, 2020; Ramulumo & Shabalala, 2024; Stevenson et al., 2013; Szczytko et al., 2019).

A pre-test measuring students' initial EL was administered before the implementation of PBL-LW. Teaching on ecosystems and biodiversity was delivered over several PBL-LW sessions. Upon completion of the class, a post-test was also administered to assess students' final level of EL. Data on students' environmental literacy were analyzed descriptively using the MSELs indicators provided in Table 1.

Table 1. Aspects of EL

EL Component	Instrument Type	Number of Questions
Ecological Knowledge	Multiple Choice	17 items
Attitude Towards the Environment	Likert Scale	25 items
Cognitive Ability	Multiple Choice	10 items
Environmentally Responsible Behavior	Likert Scale	12 items
Total		64 items

Meanwhile, the effectiveness of the PBL-LW was measured using paired t-tests and Wilcoxon signed-rank tests. The paired t-test was used for those who met the prerequisite tests for homogeneity and normality (Kolmogorov-Smirnov and Shapiro-Wilk tests). For those not meeting the two criteria, a nonparametric test, the Wilcoxon signed-rank test, was employed. Ecological knowledge and environmentally responsible behavior were normally distributed, with p-values > 0.05: 0.063 and 0.086, respectively. Meanwhile, attitudes towards the environment and cognitive ability were not normally distributed, with p-values <0.05: 0.020 and 0.001, respectively. In addition, the N-gain test was administered to measure students' EL before and after participating in science instruction using the PBL-LW.

RESULT AND DISCUSSION

Figure 1 presents a screenshot of the PBL-LW content.

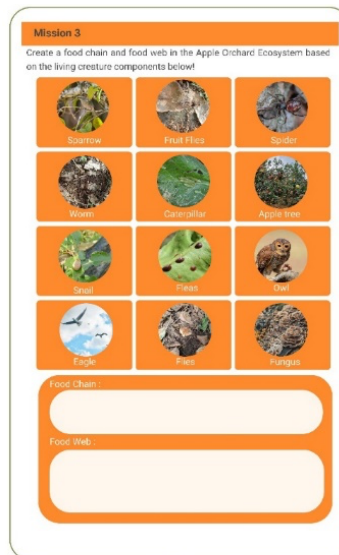


Figure 1. Content screenshot

This PBL-LW is equipped with features to enhance students' knowledge of both the material and the integrated local wisdom, thereby improving their environmental literacy. The figure illustrates the food chain involved in an apple orchard in Malang and the surrounding area. Presenting the apple orchard to teach the concept of the food chain will enhance students' understanding and their initiative to preserve the future of the apple stock in Malang. Malang is well known as the apple city of Indonesia and supplies apples nationwide. With this approach, the learning outcome related to the food chain could be obtained. At the same time, the spirit of EL is gradually instilled in students' mindsets. The effectiveness of this teaching material was assessed by measuring the improvement in students' EL. Table 2 presents the distribution of students' environmental literacy scores, ranked from lowest to highest, between the pre-test and post-test.

Table 2. The minimum and maximum EL scores at the two tests

Indicator	Min		Max	
	Pre-test	Post-test	Pre-test	Post-test
Ecological knowledge	41.18	58.82	82.35	100.00
Attitude towards the environment	40.80	58.40	93.60	96.00
Cognitive ability	10.00	20.00	100.00	100.00
Environmentally responsible behavior	40.00	61.67	100.00	100.00

Table 2 shows a consistent increase in minimum scores across indicators from pre-test to post-test, with increases ranging from 10 to 21. The most notable enhancement was in 'environmentally responsible behavior,' while cognitive ability showed the least improvement, with only 10 points increased. The maximum scores across all aspects nearly reached the optimum of 100, except for "attitude towards the environment," which was only slightly below 100. Although the pre-test scores were also high, only two aspects achieved optimal scores. The high scores depicted in Table 2 are supported by improvements in students' average environmental literacy scores. Figure 2 illustrates the enhancement of students' EL scores before and after experiencing PBL-LW-based science instruction.

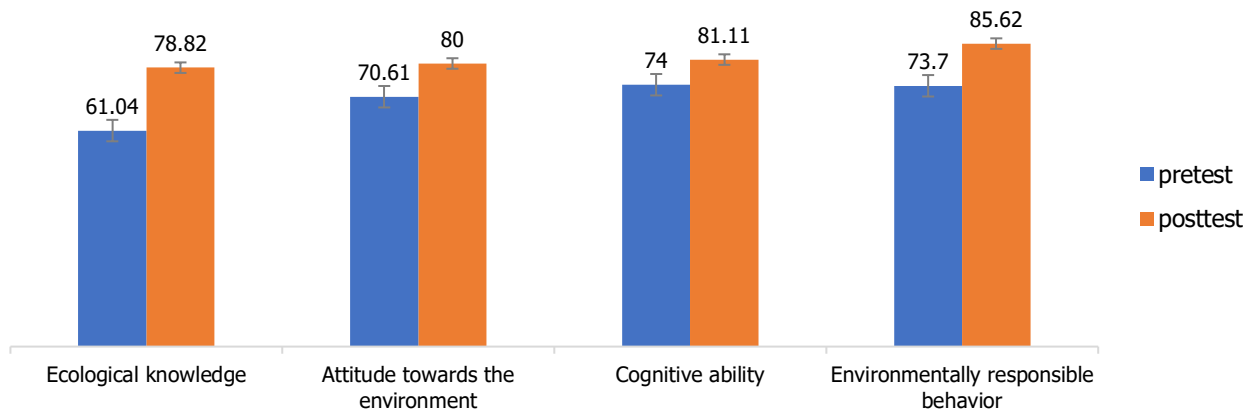


Figure 2. Improvement in EL

Figure 2 shows a significant improvement in students' EL scores across all aspects. The most notable improvement is in ecological knowledge, which increases by almost 20 points, while cognitive ability shows the smallest increase, by only about 8 points. However, on average, students' EL scores improved significantly, rising from 69.83 (moderate) to 81.39 (high). This improvement serves as evidence that science teaching using a PBL-LW significantly promoted students' EL. This is also supported by N-Gain scores for ecological knowledge, attitude towards the environment, cognitive ability, and environmentally responsible behavior, all of which are 0.456, 0.319, 0.273, and 0.453, respectively. The average N-Gain score of 0.375 implies that the handbook improved students' EL by 37.5%. The statistical procedures, including the Paired Samples T-test and the Wilcoxon Signed-Rank Test, confirmed the significance of the outcomes. The significance values for the two tests were 0.00 and 0.01, respectively. The results of this study align with previous findings. A teaching resource focused on environmental awareness literacy is effective. A comparable study employed Natural Environmental Exploration (NEE) and Lombok Coastal local wisdom within a PBL framework to enhance students' environmental literacy (Abdillah et al., 2021; Sukri, 2023). The integration of Rawa Bento local knowledge into an e-science module for junior high school students in Yogyakarta improved students' environmental literacy (Fahlevi et al., 2024). Simultaneously, a comic was employed as a PBL instructional resource to enhance students' environmental literacy (Wajdi et al., 2022).

Future studies should examine how larger systems, such as communities, relate to personal environmental literacy. A study in China found that environmental knowledge moderated the relationship between nature identification and pro-environmental behavior only in cities with elevated sustainability levels (Jia & Wang, 2024). However, despite the positive outcome of this study, further efforts to develop a more valid and robust instrument to measure students' environmental literacy should be pursued (Saarna & Laius, 2025). Some studies explored more specific areas to uncover deeper insights into environmental literacy, including health literacy (Fiore et al., 2024; Gray, 2018; Urstad et al., 2022), water environmental literacy (Irvin et al., 2019; McCarroll & Hamann, 2020; Yu et al., 2021), ocean literacy (Ashley et al., 2019; Kelly et al., 2022; Molloy et al., 2021; Thorkelsdóttir et al., 2026), sustainability knowledge (Fošner, 2025), eco-literacy (Kazazoglu, 2025; Koçoğlu et al., 2023), and others.

CONCLUSION

This study demonstrates that PBL-based science teaching materials integrated with local wisdom are highly feasible for use in junior high school science instruction. The empirical test provided significant evidence that the PBL-LW improved students' environmental literacy. Students' environmental literacy was categorized as strong following science instruction that utilized the handbook. The statistical procedures and the N-Gain test also confirmed the PBL-LW's positive contribution to improving students' environmental literacy. This study offers a promising approach to promoting students' environmental literacy by drawing on local wisdom. Given Indonesia's rich culture and biodiversity, this approach is suitable for application. However, the weak experimental design in this study could limit the transferability of its results. Therefore, it is recommended to employ a stronger experimental design with broader population coverage to obtain more convincing results.

ACKNOWLEDGEMENT

We extend our gratitude to the members of H-CERG (Habiddin – Chemistry Education Research Group (<https://habiddin.com/my-research-group-h-cERG>)) for their fruitful discussions and contributions during this research, which culminated in this successful project..

REFERENCES

- Abdillah, R. R., Al-Muhdhar, M. H. I., & Biruni, I. B. (2021, March). Fostering students' problem solving skills and environmental literacy through PBL with natural environmental exploration approach. In *AIP Conference Proceedings* (Vol. 2330, No. 1, p. 030009). AIP Publishing LLC. <https://doi.org/10.1063/5.0043190>
- Aiken, L. R. (1985). Three coefficients for analyzing the reliability and validity of ratings. *Educational and psychological measurement*, 45(1), 131-142. <https://doi.org/10.1177/0013164485451012>
- Amin, M. S., Permanasari, A., & Hamidah, I. (2020). Integrasi low carbon education dalam kurikulum pendidikan calon guru IPA di Indonesia sebagai upaya revitalisasi peran pendidikan IPA dalam merespons tantangan ekologis di masa depan. *JlPI (Jurnal IPA Dan Pembelajaran IPA)*, 4(2), 231-243. <https://doi.org/https://doi.org/10.24815/jipi.v4i2.17965>
- Ashley, M., Pahl, S., Glegg, G., & Fletcher, S. (2019). A change of mind: Applying social and behavioral research methods to the assessment of the effectiveness of ocean literacy initiatives. *Frontiers in Marine Science*, 6, 288.
- Breidenich, C., Magraw, D., Rowley, A., & Rubin, J. W. (1998). The Kyoto Protocol to the United Nations Framework Convention on Climate Change. *American Journal of International Law*, 92(2), 315-331. <https://doi.org/DOI: 10.2307/2998044>
- Cincera, J., Roman, K., & Bogner, F. X. (2023). The perceived effect of environmental and sustainability education on environmental literacy of Czech teenagers. *Environmental Education Research*, 29(9), 1276-1293. <https://doi.org/10.1080/13504622.2022.2107618>
- Fahlevi, A., Jumadi, J., Wilujeng, I., & Titisari, G. (2024). Fostering Environmental Literacy through Innovative Learning: Using PBL-based Science E-books Integrated with Local Potential of Rawa Bento. *Journal of Innovative Physics Teaching*, 2(1 SE-Articles), 1-10. <https://doi.org/10.24036/jipt/vol2-iss1/40>
- Fiore, M., Lorini, C., Bonaccorsi, G., Paoli, S., Vaccaro, G., Verani, M., Federigi, I., Ferrante, M., & Carducci, A. (2024). Development and validation of the Environmental Health Literacy Index: a new tool to assess the environmental health literacy among university students. *European Journal of Public Health*, 34(5), 1001-1007. <https://doi.org/10.1093/eurpub/ckae120>
- Fošner, A. (2025). Sustainability literacy as a key to a better future: A look at higher education. *Sustainability*, 17(3), 987.
- Gray, K. M. (2018). From content knowledge to community change: a review of representations of environmental health literacy. *International journal of environmental research and public health*, 15(3), 466. <https://doi.org/10.3390/ijerph15030466>
- Ha, C., Huang, G., Zhang, J., & Dong, S. (2022). Assessing ecological literacy and its application based on linguistic ecology: a case study of Guiyang City, China. *Environmental Science and Pollution Research*, 29(13), 18741-18754. <https://doi.org/10.1007/s11356-021-16753-7>
- Hanif, M. A., Nadeem, F., Bhatti, I. A., & Tauqeer, H. M. (2020). Environmental Disasters. In *Environmental Chemistry: A Comprehensive Approach* (pp. 469-478). <https://doi.org/10.1002/9781119651055.ch11>
- Hollweg, K. S., Taylor, J. R., Bybee, R. W., Marcinkowski, T. J., McBeth, W. C., & Zoido, P. (2011). Developing a framework for assessing environmental literacy. Washington, DC: North American Association for Environmental Education, 122.
- Ikhsan, I., & Amri, A. (2024). Corruption and Environmental Damage: Evidence from Panel Data in ASEAN-6. *International Journal of Energy Economics and Policy*, 14(1 SE-Articles), 447-451. <https://doi.org/10.32479/ijeep.15208>
- Ilhami, A., Riandi, R., & Sriyati, S. (2019, February). Implementation of science learning with local wisdom approach toward environmental literacy. In *Journal of Physics: Conference Series* (Vol. 1157, No. 2, p. 022030). IOP Publishing. <https://doi.org/10.1088/1742-6596/1157/2/022030>
- Irvin, V. L., Rohlman, D., Vaughan, A., Amantia, R., Berlin, C., & Kile, M. L. (2019). Development and validation of an environmental health literacy assessment screening tool for domestic well owners: The water environmental literacy level scale (WELLS). *International journal of environmental research and public health*, 16(5), 881. <https://doi.org/10.3390/ijerph16050881>

- Jia, F., & Wang, W. (2024). City-level sustainable development impacts on environmental literacy: feelings toward nature, environmental knowledge, and pro-environmental behavior. *Environmental Education Research*, 30(8), 1263–1278. <https://doi.org/10.1080/13504622.2024.2315573>
- Kaya, V. H., & Elster, D. (2019). A critical consideration of environmental literacy: Concepts, contexts, and competencies. *Sustainability*, 11(6), 1581. <https://doi.org/10.3390/su11061581>
- Kazazoglu, S. (2025). Environmental education through eco-literacy: Integrating sustainability into English language teaching. *Sustainability*, 17(5), 2156. <https://doi.org/10.3390/su17052156>
- Kelly, R., Evans, K., Alexander, K., Bettiol, S., Corney, S., Cullen-Knox, C., ... & Pecl, G. T. (2022). Connecting to the oceans: supporting ocean literacy and public engagement. *Reviews in fish biology and fisheries*, 32(1), 123-143. <https://doi.org/10.1007/s11160-020-09625-9>
- Keshavarzian, M., & Tabatabaieinasab, Z. (2022). The Effects of Electricity Consumption on CO₂ Emissions in Iran. *Technology and Economics of Smart Grids and Sustainable Energy*, 7(1), 14. <https://doi.org/10.1007/s40866-022-00140-3>
- Koçoğlu, E., Egüz, Ş., Tösten, R., Demİ, F. B., & Tekdal, D. (2023). Perception of ecological literacy in education: A scale development study. *International Journal of Education and Literacy Studies*, 11(3), 3-9.
- Lailia, A. N. (2025). Implementation of Problem-Based STAD Learning to Improve Students' Critical Thinking Skills on Ecosystems. *STEM Education International*, 1(2), 48-61. <https://doi.org/10.71289/aqrr9653>
- Maurer, M., & Bogner, F. X. (2020). Modelling environmental literacy with environmental knowledge, values and (reported) behaviour. *Studies in Educational Evaluation*, 65, 100863. <https://doi.org/https://doi.org/10.1016/j.stueduc.2020.100863>
- Maurya, P. K., Ali, S. A., Ahmad, A., Zhou, Q., Castro, J. D. S., Khan, E., & Ali, H. (2020). An introduction to environmental degradation: Causes, consequence and mitigation. *Environmental degradation: Causes and remediation strategies*, 1, 1-20.
- McCarroll, M., & Hamann, H. (2020). What we know about water: A water literacy review. *Water*, 12(10), 2803. <https://doi.org/10.3390/w12102803>
- Molloy, O., Ashley, M., & McCrossan, C. (2021). A Framework for the assessment of the effectiveness of ocean literacy initiatives. In *Ocean literacy: Understanding the ocean* (pp. 41-64). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-030-70155-0_3
- Örs, M. (2022). A measurement of the environmental literacy of nursing students for a sustainable environment. *Sustainability*, 14(17), 11003. <https://doi.org/10.3390/su141711003>
- Park, S. (2022). The politics of 21st century environmental disasters. *Environmental Politics*, 31(1), 1–7. <https://doi.org/10.1080/09644016.2021.2024718>
- Ramulumo, M., & Shabalala, N. P. (2025). Comparing Environmental Literacy in Stem and Non-Stem Preschools: Evaluating the Impact on Young Children's Understanding and Attitudes. *International Journal of Early Childhood*, 57(2), 447-462. <https://doi.org/10.1007/s13158-024-00405-1>
- Saarna, R., & Laius, A. (2025). The sustainability literacy assessment instruments: a systematic literature review. *International Journal of Sustainability in Higher Education*. <https://doi.org/10.1108/IJSHE-01-2025-0048>
- Stevenson, K. T., Peterson, M. N., Bondell, H. D., Mertig, A. G., & Moore, S. E. (2013). Environmental, Institutional, and Demographic Predictors of Environmental Literacy among Middle School Children. *PLOS ONE*, 8(3), e59519. <https://doi.org/10.1371/journal.pone.0059519>
- Suhartatik, S., Sari, S. P., Maysara, M., & Qomaliyah, E. N. (2026). Interactive PowerPoint Based on Game-Based Learning on Environmental Pollution for Junior High School Students. *STEM Education International*, 2(1), 30-46. <https://doi.org/10.71289/stem.v2i1.18>
- Sukri, A. (2023). Enculturation of Lombok coastal local wisdom in PBL as a conservation learning strategy to improve students' environmental literacy. *Jurnal Penelitian Pendidikan IPA*, 9(8), 6733-6741. <https://doi.org/10.29303/jppipa.v9i8.5744>
- Sulistiyani, L. M., Habiddin, H., Yahmin, Y., Tamara, R., & and Majid, S. (2025). Is immersing blended-problem-based learning fostering students' higher-order thinking skills? *The Journal of Educational Research*, 1–7. <https://doi.org/10.1080/00220671.2025.2490016>

- Suryawati, E., Suzanti, F., Zulfarina, Z., Putriana, A. R., & Febrianti, L. (2020). The implementation of local environmental problem-based learning student worksheets to strengthen environmental literacy. *Jurnal Pendidikan IPA Indonesia*, 9(2), 169-178.
- Szczytko, R., Kathryn, S., M. Nils, P., John, N., & and Strnad, R. L. (2019). Development and validation of the environmental literacy instrument for adolescents. *Environmental Education Research*, 25(2), 193–210. <https://doi.org/10.1080/13504622.2018.1487035>
- Thorkelsdóttir, R. B., Jónsdóttir, J. G., Garefi, I., Korompoki, I. V., Serban, A., Bouros, M., & Soares, J. (2026). Strategies to Overcome the Challenges of Integrating Ocean Literacy into School Curricula. *Sustainability*, 18(3), 1374. <https://doi.org/10.3390/su18031374>
- Urstad, K. H., Andersen, M. H., Larsen, M. H., Borge, C. R., Helseth, S., & Wahl, A. K. (2022). Definitions and measurement of health literacy in health and medicine research: a systematic review. *BMJ Open*, 12(2), e056294. <https://doi.org/10.1136/bmjopen-2021-056294>
- Wajdi, M., Jamaluddin, A. Bin, Nurdianti, N., & Maghfirah, N. (2022). The effectiveness of problem-based learning with environmental-based comic in enhancing students environmental literacy. *International Journal of Evaluation and Research in Education (IJERE)*, 11(3), 1049–1057. <http://doi.org/10.11591/ijere.v11i3.22140>
- Yu, J. H., Lin, H. H., Lo, Y. C., Tseng, K. C., & Hsu, C. H. (2021). Measures to cope with the impact of climate change and drought in the island region: A study of the water literacy awareness, attitude, and behavior of the Taiwanese public. *Water*, 13(13), 1799. <https://doi.org/10.3390/w13131799>