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Adding Papuan local wisdom in problem-based book: The effect on student environmental literacy

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Abstract: The research aims to examine the effect of problem-based books that incorporate Papuan local wisdom on students' environmental literacy. A total of 36 students were taught using a problem-based book, which added Papuan local wisdom in the pretest and posttest research designs. They are grade VII students at a state junior high school. A total of thirty items to measure students' literacy abilities were used. The items were handed over to them to be answered twice, namely, before implementation and after the end of learning. Student responses have also been measured at the end of learning. Data were analyzed using a paired t-test. Research findings show that the value of P = 0.033 < 0.005. This finding indicates that there is an effect of using problem-based books added to Papuan local wisdom on students' environmental literacy abilities. There were 83.33% of students responding excellently and 16.67% responding well. There were no unfavorable responses from students as long as they attended the lesson. The excellent response from the students indicated that they were interested and happy to participate in learning using problem-based books, which incorporated Papuan local wisdom.

Keywords: Environmental literacy, local wisdom, student book

Abstrak: Penelitian ini bertujuan untuk menguji pengaruh buku berbasis masalah yang menggabungkan kearifan lokal Papua terhadap literasi lingkungan siswa. Sebanyak 36 siswa diajarkan menggunakan buku berbasis masalah yang ditambahkan kearifan lokal Papua dalam desain penelitian pretest dan posttest. Mereka adalah siswa kelas VII di sebuah SMP negeri. Sebanyak tiga puluh butir soal digunakan untuk mengukur kemampuan literasi siswa. Soal-soal tersebut diberikan kepada mereka untuk dijawab dua kali, yaitu sebelum pelaksanaan dan setelah pembelajaran berakhir. Respons siswa juga diukur pada akhir pembelajaran. Data dianalisis menggunakan uji t berpasangan. Hasil penelitian menunjukkan bahwa nilai P = 0,033 < 0,005. Temuan ini menunjukkan bahwa terdapat pengaruh penggunaan buku berbasis masalah yang ditambahkan kearifan lokal Papua terhadap kemampuan literasi lingkungan siswa. Terdapat 83,33% siswa yang memberikan respons sangat baik dan 16,67% memberikan respons baik. Tidak ada respons yang tidak memuaskan dari siswa selama mereka mengikuti pelajaran. Respons yang sangat baik dari para siswa menunjukkan bahwa mereka tertarik dan senang berpartisipasi dalam pembelajaran menggunakan buku berbasis masalah, yang menggabungkan kearifan lokal Papua.

Kata kunci: Literasi lingkungan, kearifan local, buku siswa

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INTRODUCTION

Today, environmental issues are still being discussed, such as waste management, availability of clean water, environmental pollution, etc. Environmental damage is caused by many human actions, including the use of pesticides that damage water quality (Syafrudin et al., 2021) and soil enzymes (Riah et al., 2014), throwing cigarette butts carelessly onto the beach which causes beach pollution (Yousefi Nasab et al., 2022), the use of bombs to catch fish (Nusantari et al., 2020), massive dumping of chemicals that cause

health problems to organisms (Costa et al., 2022), ineffective waste management that causes groundwater, air, odor pollution and marine pollution (Siddiqua et al., 2022), and many other actions. Environmental damage that is left continuously can cause very bad effects for the life of living organisms. The organism will acquire many health problems as a result of this incident. Environmental damage can be reduced by increasing environmental literacy skills (EL), even with environmental literacy students will show responsible behavior to preserve the environment.

EL in science and other disciplines is important because it increases the protection of nature (Kaya & Elster, 2019). EL includes cognitive, affective and behavioral aspects (Liang et al., 2018). Cognitive relates to the ability to detect, analyze and evaluate environmental problems based on the basic knowledge one has, affective relates to one's concern for environmental problems and behavior relates to one's ability to invite other people to care about the environment (Santiani et al., 2023). Humans have a need to live where the need continues to increase from time to time. This condition has an impact directly or indirectly on environmental changes. not only positive impacts, negative impacts of these conditions can also occur which affect environmental stability. The cultivation of EL in humans aims to be able to reduce negative effects and make them individuals who are sensitive to their environmental conditions (Kaya & Elster, 2019). An assessment of EL is needed to understand the state of the environment and its educational programs related to it (Liu et al., 2015).

The results of the interviews reveal that teaching literacy to students in Papua has begun to decline or even become almost non-existent. Specifically environmental literacy, it has not been found that teaching empowers this variable. Miftahuddin et al. (2023) found that the average percentage of students' EL achievement was less than 50%. The data indicates that the student's EL is in a low condition. Survey results in Taiwan show that EL related to cognitive and behavior gets the low category and affective gets the enough category (Liang et al., 2018). EL identification data in several countries such as Turkey (Erdogan & Ok, 2011), filipina (Nuneza & Clores, 2017), Belize (Moody-Marshall, 2023), and Jordan (Sasa et al., 2022) show that EL still falls at moderate or even low. The findings from these studies indicate that EL in students still needs to be empowered. Students need to obtain various information related to the environment to support them in strengthening Elnya. Changes regarding students' EL depend on how the teacher makes decisions to teach about knowledge and issues about the environment to their students (Liu et al., 2015). The literacy level of individuals who often read books or magazines about the environment shows a high level compared to those who don't (Akçay & Şengül, 2023). Thus providing reading books related to the environment can have an impact on students' EL.

Teaching materials are learning resources that students can use in the learning process (Damopolii et al., 2022). Teaching materials are used to help students understand the subject matter, especially related to their love of the environment (Nusantari et al., 2020). Material in teaching materials can be made interesting and varied so that students can be enthusiastic in the learning process (Astuti et al., 2021; Damopolii et al., 2019). The use of appropriate teaching materials will show the success of students and can be more active in the learning process. In biology-related curricula and textbooks, concrete examples and predictions of future environmental problems should be emphasized more than

theoretical concepts (Kır, 2023). Local environmental issues related to where students live need to be added to textbooks to help them make EL different.

Local wisdom refers to the esteemed principles and values that are implemented within the governance of community life. Its primary objective is to safeguard and sustainably manage the environment, hence facilitating the growth of students' EL by offering them many advantages (Patston et al., 2018). Local wisdom encompasses a wide range of information, insights, understanding, beliefs, and norms or ethics that serve as guiding principles for human conduct within ecological communities. The Papuan people themselves are known to always try to preserve and maintain the existence of existing customs so that they can be passed on to the next generation (Iwan et al., 2020). The Papuan people have local cultural values, in the form of ethics, rules, recipes, norms, customary law and other special rules which become the local wisdom of the local community which can be integrated into textbooks (Damopolii et al., 2019). Books that integrate local wisdom can improve students' EL (Ardan, 2016; Hadi et al., 2023; Watoni et al., 2022).

Presentation of problems in student books integrated with local wisdom requires learning to succeed in its implementation. Lubis et al. (2022) have examined the use of problem based learning (PBL) combined with local wisdom. They found that the combination had an impact on changes in student EL. Suryawati et al. (2020) also found that PBL was effective in strengthening students' EL. EL is needed by students when they are involved in solving problems when implementing PBL in class. The PBL asks students to solve real-world problems and then to solve them through systematic learning so they can understand how to solve them and draw conclusions. The research aims to examine the effect of problem-based books added to Papuan local wisdom on students' environmental literacy.

METHOD

Research design

This Research is an experiment with pretest and posttest design. This research contributes to providing information on how EL changes during learning. The student books that are used are integrated with local wisdom and then follow the stages of PBL. PBL is used as a basis to support the delivery of environmental related issues. Local wisdom aims to introduce ways of solving problems based on the ways of local communities.

Sample

A total of 36 students were taught using problem-based books which added Papuan local wisdom in the pretest and posttest research designs. They are grade VII students at a state junior high school. All students are involved in science subjects with the biology topic of environmental pollution.

Design of book

The book used is a student book for learning biology topic in science subjects. Determination of the subject matter, namely about environmental pollution which includes the topic of water, soil and air pollution. The problems integrated into the book are related to local environmental problems around students. This particular issue is situated within the first phase of problem-based learning (PBL), specifically involving the process of

acquainting students with the challenge at hand. The choice of Papuan local wisdom is the use of the philosophy of the behavior of smart birds (*Amblyornis inornatus*). The male bird of this species builds its bower from forest debris. The goal is to attract females of this species. The main message of this animal's behavior is to keep the forest free of trash. In addition, several ways have been determined by local communities to manage waste into products that have economic value. Next, the book is designed in the Canva app. The design results in Canva are then saved in pdf format. The pdf is printed and given to students for them to study

Instruments and procedure

A total of thirty items to measure students' literacy abilities were used. The instrument was validated by experts, and it was stated that the instrument could be used to measure students' environmental literacy. The items were handed over to them to be answered twice, namely before implementation and after the end of learning. The evaluation of student responds has also been conducted at the completion of the learning process.

Data Analysis

Data were analyzed using paired t-test. In addition, student responses are calculated by determining student acquisition scores. Achievement of student responses and their El is then categorized based on the categories in Table 1.

Table 1. Environmental literacy level

The score range	Category
Score > 80	Excellent environmental literacy
70 ≤ score < 80	Good environmental literacy
60 ≤ score < 70	Moderate environmental literacy
40 ≤ score < 60	Weak environmental literacy
score < 40	Very Weak environmental literacy

RESULTS AND DISCUSSION

This research has found data about students' EL as long as they are involved in learning using problem-based books, which added Papuan local wisdom. EL students experience changes during learning. This is evident from the pretest and posttest results presented in Table 2.

Table 2. Environmental literacy level

Environmental literacy	Mean	SD
Posttest	71	8.59947
Pretest	67	9.32389

Table 2 presents the results of students' EL measurements during learning. Students reach 67 when they have not been taught using problem-based books added to Papuan local

wisdom. Changes occur in students' EL after they have finished studying. EL students at the end of learning achieved an average score of 71.

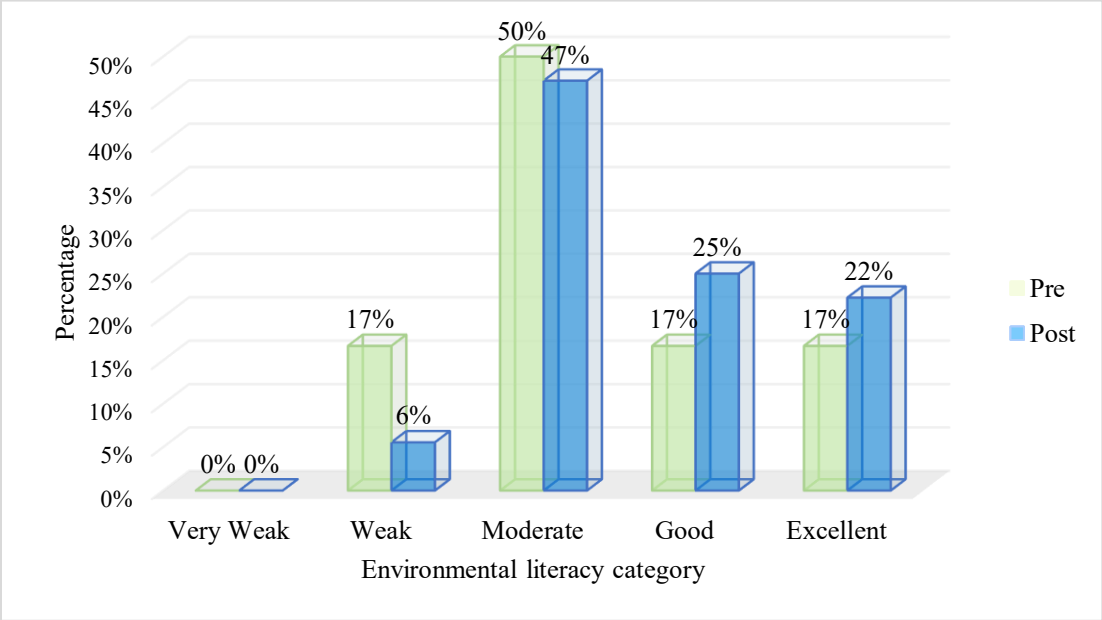

Fig. 1. Students' environmental literacy caregory

Fig. 1 reveals that the students' EL is in the weak – excellent category. Pre-EL students showed that they were more in the weak and moderate categories. Few students were found in the good and excellent categories. After they were involved in learning using problem-based books added to Papuan local wisdom, their Post-EL experienced a change for the better. EL students are dominated by good and excellent categories. Even though the post-EL shows there are weak and moderate categories, these categories are reduced compared to pre-EL.

Table 3. Normality and homogeneity data of EL

	Shapiro-Wilk			**Levene Test**			
	Statistic	**df**	**Sig.**	**Levene Statistic**	**df1**	**df2**	**Sig.**
Pre	0.977	36	0.628	0.064	1	70	0.800
Post	0.954	36	0.140				

Table 3 indicates that the EL data is normal. In addition, the homogeneity test revealed that the EL data met the homogeneous criteria. Thus, based on the results of the analysis of the two, EL data can be tested using the t test.

Table 4. Paired sample t test of EL

		Paired Differences					t	df	Sig.
		Mean	SD	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Post - Pre	3.738	10.089	1.682	0.324	7.152	2.223	35	0.033

The data in Table 3 indicates that pre-EL and post-EL have differences (0.033 < 0.05). This data reveals that the integration of Papuan local wisdom into problem-based books has had an effect on students' EL. Changes in student EL during learning indicate that these variables are improved during the learning process.

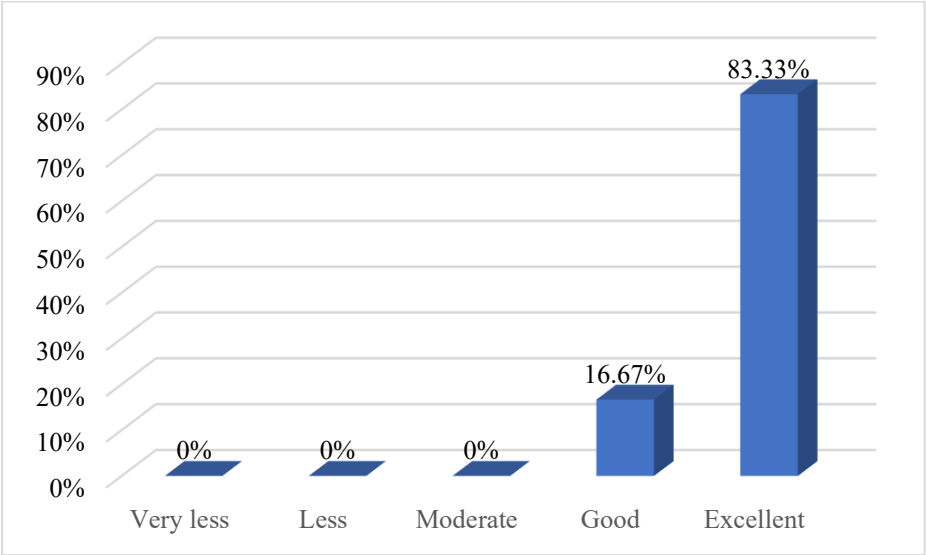

Fig. 2. Category of student response

Student responses (Figure 2), dominated by the "Excellent" (83.33%) and "Good" (16.67%) categories, indicate that integrating Papuan local wisdom into problem-based science learning contributes to students' environmental literacy. Local wisdom provides a concrete context that helps students understand the relationships among human activities, ecosystems, and environmental sustainability. Learning does not stop at abstract concepts, but moves toward a more concrete understanding of environmental systems. The high number of positive responses indicates that teacher learning has enabled students to identify environmental issues, understand their impacts, and link solutions to the scientific knowledge they have learned, thereby increasing their interest in learning about environmental issues. The integration of local context strengthens students' ability to interpret environmental issues relevant to their daily lives. When students have a good understanding and positive attitudes, the risk of environmentally damaging behavior can be reduced, and they will respond positively to the implemented teaching. Local wisdom

serves as a social and cultural value that strengthens the internalization of environmental ethics from an early age (Damopolii et al., 2024).

This research has revealed that students' EL can be corrected in different ways. The different way is to change student books to be integrated with local wisdom. Environmental issues are included in this problem-based book. The purpose of including this problem is to stimulate students to think about solving environmental problems. The complex environmental challenges facing humanity require scientifically and environmentally literate citizens (Kinslow et al., 2019). Students are looking for solutions on how to overcome environmental problems that surround them. For example, waste management, clean water issues and how to ban luda areca palm waste. The student book provides examples of how local communities turn waste into useful products. Waste can be recycled to be used as a product that has economic value. In another case, the people of Papua have a tradition of eating areca nut. However, in some cases, people make luda betel nut in any place. The local community made a rule to protect the environment by prohibiting the disposal of luda bananas indiscriminately. The ban was made because to prevent pollution from getting out of control (Abelouah et al., 2021; Rossi et al., 2023).

The most special local wisdom presented in this book is about how the smart bird "*Amblyornis inornatus*" collects trash in the forest. This bird collects garbage to make a nest. The goal is for the partner to be attracted to the male bird. The meaning taken from this bird's behavior is that birds alone can collect and process waste into something useful for themselves. As humans, we only litter, but we can process the waste into useful items. Also added to this book is how the Papuan people process waste into products that have economic value. When products from the local community are integrated into learning, it makes students interested in learning (Gao et al., 2020).

The problems and solutions presented in problem-based books added to Papuan local wisdom have been useful for changing students' EL. The combination of PBL and local wisdom can help student performance (Peranginangin et al., 2019). EL has components of knowledge, behavior and attitudes. Students' knowledge increases with the environmental problems presented in the book. Beh-viour students experience change when they can gain knowledge of how local people turn waste into useful products. The attitude of students changes when they can instill noble values from local wisdom to protect their environment. When Books (Santoso et al., 2023), PBL (Hidayanti & Wulandari, 2023), and local wisdom (Hermawan et al., 2022; Wahyuni et al., 2022) are combined in an innovative product, it provides benefits to students' EL changes. Any change in student EL can have a contribution to environmental preservation in the future.

The results of this study indicate that a learning approach that places environmental issues as the primary context can encourage students to think actively, analytically, and contextually about the environment. Students not only receive information but also engage in problem-solving processes related to the real environmental conditions around them. This strengthens their environmental literacy. In Vygotsky's theory, effective learning occurs when students construct knowledge through interactions with meaningful social and cultural contexts (Hikmawati et al., 2021; Tzuriel, 2021). The integration of Papuan local wisdom into problem-based textbooks serves as scaffolding that connects scientific concepts to students' real-life experiences of the environment. Contexts such as waste management, clean water conservation, and local community practices in preserving the

environment create authentic learning situations. This environment allows students to construct deeper understandings, as the material is no longer abstract but connected to their social realities (Nunaki et al., 2023).

The PBL used in this study encouraged students to identify problems, analyze information, and formulate solutions independently and collaboratively (Aristaningsih et al., 2025; Silahooy et al., 2024). In the context of this study, environmental issues such as waste and the clean water crisis served as triggers for ecologically relevant problems. When students were confronted with these problems, they not only memorized concepts but also learned to apply scientific principles in decision-making. Meanwhile, the integration of Papuan local wisdom strengthened the socio-cultural context of learning. Local values related to the relationship between humans and nature helped students understand that the environment is not only a scientific object but also part of a cultural value system that must be preserved (Damopolii et al., 2024). This condition increased the material's relevance and strengthened the connection between science and everyday life. The significant increase in EL can also be attributed to place-based education theory. This theory emphasizes that learning will be more meaningful when connected to students' local environments (Flanagan et al., 2019). Papuan local wisdom, such as community-based waste management practices and customary norms for maintaining environmental cleanliness, provides a concrete and relevant context for students' lives. The use of biological examples, such as the behavior of Amblyornis inornatus, as metaphors for environmental material management strengthens the connection between scientific knowledge and natural phenomena. This approach not only enhances conceptual understanding but also strengthens students' emotional attachment to the environment.

The changes in EL before and after the instruction indicate that students have strong abilities to recognize environmental issues, understand their impacts, and connect them to appropriate scientific actions. Problem-based books contextualized with local wisdom help students build a more systematic understanding of ecosystems, pollution, and environmental sustainability. When students understand environmental issues in context and in relation to local values, they are better able to internalize preventive actions such as reducing waste, maintaining cleanliness, and conserving natural resources. Overall, these data confirm that problem-based books integrated with local wisdom not only improve the quality of responses to learning but also directly strengthen EL and foster preventive attitudes towards environmental damage among junior high school students.

CONCLUSION

The research concludes tha the integrated Papua local wisdom into problem-based book have effect on student environmental literacy. Mean of student' environmental literacy in posttest is 71 (Good Category). The domination of students in learning gave a very good response to the use of science books which added about Papuan local wisdom. No negative responses were found. Utilizing local wisdom for problem-based science teaching contributes to preventing environmental damage by enhancing students' environmental literacy. Environmental issues can be integrated into teaching, and students can find solutions by gaining an understanding of the local wisdom provided by teachers.

REFERENCES

Abelouah, M. R., Ben-Haddad, M., Alla, A. A., & Rangel-Buitrago, N. (2021). Marine litter in the central Atlantic coast of Morocco. *Ocean & Coastal Management*, *214*, 105940. https://doi.org/10.1016/j.ocecoaman.2021.105940

Akçay, S., & Şengül, H. (2023). A Study on Environmental Literacy of Middle School Students. *Ahmet Keleşoğlu Eğitim Fakültesi Dergisi*, *5*(1), 139–169. https://doi.org/10.38151/akef.2023.48

Ardan, A. S. (2016). The Development of Biology Teaching Material Based on the Local Wisdom of Timorese to Improve Students Knowledge and Attitude of Environment In Caring the Persevation of Environment. *International Journal of Higher Education*, *5*(3), 190–200. https://doi.org/10.5430/ijhe.v5n3p190

Aristaningsih, A., Erari, S. S., Rumalolas, N., Rahman, S. R., Nasir, N. I. R. F., Nunaki, J. H., & Damopolii, I. (2025). Learning The Human Digestive System Through The Use of Problem-Based Learning: Efforts to Improve Student Activities and Outcomes. *Report of Biological Education*, *6*(1), 24–37. https://doi.org/10.37150/nppkxm41

Astuti, Y., Zaini, M., & Putra, A. P. (2021). Development of Popular Scientific Book on the Type of Shrimp in Coastal Waters of Tabanio for Enhancing Critical Thinking Skills of Senior High School Students. *BIO-INOVED : Jurnal Biologi-Inovasi Pendidikan*, *3*(1), 44–2. https://doi.org/10.20527/bino.v3i1.9555

Costa, L. L., Fanini, L., Ben-Haddad, M., Pinna, M., & Zalmon, I. R. (2022). Marine Litter Impact on Sandy Beach Fauna: A Review to Obtain an Indication of Where Research Should Contribute More. *Microplastics*, *1*(3), 554–571. https://doi.org/10.3390/microplastics1030039

Damopolii, I., Botutihe, V. T., & Nunaki, J. H. (2019). The contribution of science process skill towards students cognitive achievement through guided inquiry-based learning. *Journal of Physics: Conference Series*, *1317*, 012184. https://doi.org/10.1088/1742-6596/1317/1/012184

Damopolii, I., Nunaki, J. H., Jeni, J., Rampheri, M. B., & Ambusaidi, K. A. (2024). An Integration of Local Wisdom into a Problem-based Student Book to Empower Students' Conservation Attitudes. *Participatory Educational Research*, *11*(1), 158–177. https://doi.org/10.17275/per.24.10.11.1

Damopolii, I., Nunaki, J. H., Nusantari, E., & Kandowangko, N. Y. (2019). Integrating local resources into inquiry-based teaching materials to training students' science process skills. *AIP Conference Proceedings*, *2120*, 060003. https://doi.org/10.1063/1.5115703

Damopolii, I., Paiki, F. F., & Nunaki, J. H. (2022). The development of comic book as marker of augmented reality to raise students' critical thinking. *TEM Journal*, *11*(1), 348–355. https://doi.org/10.18421/TEM111-44

Erdogan, M., & Ok, A. (2011). An Assessment of Turkish Young Pupils' Environmental Literacy: A nationwide survey. *International Journal of Science Education*, *33*(17), 2375–2406. https://doi.org/10.1080/09500693.2010.550653

Flanagan, C., Gallay, E., Pykett, A., & Smallwood, M. (2019). The Environmental Commons in Urban Communities: The Potential of Place-Based Education. *Frontiers in Psychology*, *10*, 226. https://doi.org/10.3389/fpsyg.2019.00226

Gao, X., Li, P., Shen, J., & Sun, H. (2020). Reviewing assessment of student learning in interdisciplinary STEM education. *International Journal of STEM Education*, *7*, 24. https://doi.org/10.1186/s40594-020-00225-4

Hadi, K., . D., Susantini, E., & Kunjtoro, S. (2023). Integrating Local Wisdom and Character Education in Biology Learning during the COVID-19 Pandemic. *2nd Paris Van Java International Seminar on Health, Economics, Social Science and Humanities*, 237–243. https://doi.org/10.18502/kss.v8i4.12904

Hermawan, I. M. S., Arjaya, I. B. A., & Diarta, I. M. (2022). BE-RAISE: A Blended-Learning Model Based on Balinese Local Culture to Enhance Student's Environmental Literacy. *Jurnal Pendidikan IPA Indonesia*, *11*(4), 552–566. https://doi.org/10.15294/jpii.v11i4.39475

Hidayanti, I., & Wulandari, F. (2023). The Effect of Problem-Based Learning Based Ethnoscience on Science Literacy Ability of Elementary School. *Edunesia: Jurnal Ilmiah Pendidikan*, *4*(3), 967–982. https://doi.org/10.51276/edu.v4i3.475

Hikmawati, H., Gunawan, G., Sahidu, H., & Kosim, K. (2021). Effect of Local Culture Based Learning in Science on Critical Thinking and Student Communication Skills. *Journal of Science and Science Education*, *2*(1), 8–16. https://doi.org/10.29303/jossed.v2i1.713

Iwan, I., Istisaroh, I., Sirait, S. H. K., & Damopolii, I. (2020). The development of teaching materials oriented problem-based learning integrating Tifa to train student's critical thinking skills. *AIP Conference Proceedings*, *2215*, 030006. https://doi.org/10.1063/5.0000587

Kaya, V., & Elster, D. (2019). A Critical Consideration of Environmental Literacy: Concepts, Contexts, and Competencies. *Sustainability*, *11*(6), 1581. https://doi.org/10.3390/su11061581

Kinslow, A. T., Sadler, T. D., & Nguyen, H. T. (2019). Socio-scientific reasoning and environmental literacy in a field-based ecology class. *Environmental Education Research*, *25*(3), 388–410. https://doi.org/10.1080/13504622.2018.1442418

Kır, M. (2023). Environmental Literacy In Biology Curriculum. *International Journal of Eurasian Education and Culture*, *8*(23), 2383–2396. https://doi.org/10.35826/ijoecc.784

Liang, S.-W., Fang, W.-T., Yeh, S.-C., Liu, S.-Y., Tsai, H.-M., Chou, J.-Y., & Ng, E. (2018). A Nationwide Survey Evaluating the Environmental Literacy of Undergraduate Students in Taiwan. *Sustainability*, *10*(6), 1730. https://doi.org/10.3390/su10061730

Liu, S.-Y., Yeh, S.-C., Liang, S.-W., Fang, W.-T., & Tsai, H.-M. (2015). A National Investigation of Teachers' Environmental Literacy as a Reference for Promoting Environmental Education in Taiwan. *The Journal of Environmental Education*, *46*(2), 114–132. https://doi.org/10.1080/00958964.2014.999742

Lubis, S. P. W., Suryadarma, I. G. P., Paidi, P., & Yanto, B. E. (2022). The Effectiveness of Problem-based learning with Local Wisdom oriented to Socio-Scientific Issues. *International Journal of Instruction*, *15*(2), 455–472. https://doi.org/10.29333/iji.2022.15225a

Miftahuddin, M., Roshayanti, F., & Siswanto, J. (2023). Profile of environmental literacy students of SMPN 3 Teluk Keramat. *Indonesian Journal of Education*, *3*(1), 44–54.

https://doi.org/10.54443/injoe.v3i1.47
Moody-Marshall, R. (2023). An investigation of environmental awareness and practice among a sample of undergraduate students in Belize. *Environmental Education Research*, *29*(7), 911–928. https://doi.org/10.1080/13504622.2022.2079613
Nunaki, J. H., Lettu, F. F., Jeni, J., Sari, R., Sahertian, N. E., Damopolii, I., & Latjompoh, M. (2023). Encouraging Students' Critical Thinking Using Problem-Based Book Integrated Daily Problems and Solutions about Environmental Pollution. *Journal of Curriculum and Teaching*, *12*(6), 218. https://doi.org/10.5430/jct.v12n6p218
Nuneza, M. B., & Clores, M. A. (2017). Environmental Literacy of K–10 Student Completers. *International Journal of Environmental & Science Education*, *12*(5), 1195–1215. http://www.ijese.net/makale/1885.html
Nusantari, E., Utina, R., Katili, A. S., Tamu, Y., & Damopolii, I. (2020). Effectiveness of Environmentally-Based Science Learning towards Environmentally-Friendly Character of Students in Coastal Area. *International Journal of Instruction*, *13*(3), 233–246. https://doi.org/10.29333/iji.2020.13316a
Patston, T. J., Cropley, D. H., Marrone, R. L., & Kaufman, J. C. (2018). Teacher implicit beliefs of creativity: Is there an arts bias? *Teaching and Teacher Education*, *75*, 366–374. https://doi.org/10.1016/j.tate.2018.08.001
Peranginangin, S. A., Saragih, S., & Siagian, P. (2019). Development of Learning Materials through PBL with Karo Culture Context to Improve Students' Problem Solving Ability and Self-Efficacy. *International Electronic Journal Of Mathematics Education*, *14*(2), 265–274. https://doi.org/10.29333/iejme/5713
Riah, W., Laval, K., Laroche-Ajzenberg, E., Mougin, C., Latour, X., & Trinsoutrot-Gattin, I. (2014). Effects of pesticides on soil enzymes: A review. *Environmental Chemistry Letters*, *12*(2), 257–273. https://doi.org/10.1007/s10311-014-0458-2
Rossi, A., Wu, M., Wolde, B. T., Zerbe, K. W., Hsu, T. T. D., Giudicelli, A., & Da Silva, R. (2023). Understanding the factors affecting the quantity and composition of street litter: Implication for management practices. *Heliyon*, *9*, e14245. https://doi.org/10.1016/j.heliyon.2023.e14245
Santiani, S., Rusilowati, A., Sudarmin, S., & Ngabekti, S. (2023). Fit-Model Sustainable Competencies of Palangka Raya Indonesia Peat Lands in the Environmental Literacy (P-PSEL) Questionnaire for Teacher-Candidates. *Polish Journal of Environmental Studies*, *32*(2), 1781–1788. https://doi.org/10.15244/pjoes/157496
Santoso, D., Syukur, A., Zulkifli, L., & Zulhalifah. (2023). The suitability of natural science teaching materials based on Mangrove ecosystems to improve environmental literacy of junior high school students in the South coast of East Lombok. *AIP Conference Proceedings*, 100016. https://doi.org/10.1063/5.0123388
Sasa, T., Ahmad, W., Bahtiti, N. H., Abujaber, M., Adeyleh, A., & Miri, O. (2022). Assessment Level of Environmental Literacy among Applied Science Private University (ASU) Students. *WSEAS Transactions On Environment And Development*, *18*, 1005–1011. https://doi.org/10.37394/232015.2022.18.97
Siddiqua, A., Hahladakis, J. N., & Al-Attiya, W. A. K. A. (2022). An overview of the environmental pollution and health effects associated with waste landfilling and open dumping. *Environmental Science and Pollution Research*, *29*(39), 58514–58536. https://doi.org/10.1007/s11356-022-21578-z

Silahooy, P. V., Nunaki, J. H., Jeni, J., Wambrauw, H. L., Nasir, N. I. R. F., Damopolii, I., Siregar, N. N., & Budirianto, H. J. (2024). Papuan local wisdom and problem-based learning: Integrated into student books and its effect on students' conservation attitudes. *Inornatus: Biology Education Journal*, *4*(1), 57–68. https://doi.org/10.30862/inornatus.v4i1.568

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. https://doi.org/10.15294/jpii.v9i2.22892

Syafrudin, M., Kristanti, R. A., Yuniarto, A., Hadibarata, T., Rhee, J., Al-onazi, W. A., Algarni, T. S., Almarri, A. H., & Al-Mohaimeed, A. M. (2021). Pesticides in Drinking Water—A Review. *International Journal of Environmental Research and Public Health*, *18*(2), 468. https://doi.org/10.3390/ijerph18020468

Tzuriel, D. (2021). The Socio-Cultural Theory of Vygotsky. In D. Tzuriel, *Mediated Learning and Cognitive Modifiability* (pp. 53–66). Springer International Publishing. https://doi.org/10.1007/978-3-030-75692-5_3

Wahyuni, A. L. E., Arrohman, D. A., Wilujeng, I., Widowati, A., & Suyanta, S. (2022). Application of Integrated STEM-Based Student Worksheet Local Potential of Pagar Alam Tea Plantation to Improve Students' Environmental Literacy. *Jurnal Penelitian Pendidikan IPA*, *8*(3), 1252–1257. https://doi.org/10.29303/jppipa.v8i3.1260

Watoni, E. S., Ngabekti, S., & Wijayati, N. (2022). Development of Lombok Island Environmental Change E-Module to Improve Environmental Literacy and Data Literacy of High School Students. *Journal of Innovative Science Education*, *11*(2), 156–169. https://doi.org/10.15294/JISE.V10I1.51081

Yousefi Nasab, A., Oskoei, V., Rezanasab, M., Alinejad, N., Hosseinzadeh, A., & Kashi, G. (2022). Cigarette butt littering consequences: A study of pollution rate on beaches and urban environments. *Environmental Science and Pollution Research*, *29*(30), 45396–45403. https://doi.org/10.1007/s11356-022-19155-5