



Problem Based Learning on Socio-Scientific Issues to Strengthen Students' Environmental Care Character at Ban Buketamong School Friendship 128, Cho Airong, Narathiwat, Thailand

Taufik Hidayat^{1*}, Ainun Mardiyah Lubis¹, Syahrudin Aritonang¹, Maryam bnesa², Darwis Lubis¹

¹ Department of Physics Education, Universitas Muhammadiyah Tapanuli Selatan, Padangsidimpuan, Indonesia.

² Department of Mathematics, Buketamong School Friendship 128, Cho Airong, Narathiwat, Thailand.

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Corresponding Author:

Taufik Hidayat

taufikjurnal67@gmail.com

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Abstract: This study aims to analyze the effect of Problem Based Learning integrated with socio-scientific issues on strengthening students' environmental care character at Ban Buketamong School Friendship 128, Cho Airong, Narathiwat, Thailand. The research employed a pre-experimental one-group pretest-posttest design involving 30 Grade 8 students. Data were collected using a 25-item environmental care character questionnaire and analyzed through descriptive statistics and a paired sample t-test. The results showed that the mean score increased from 67.37 in the pretest to 82.80 in the posttest. The paired sample t-test indicated a significant difference between pretest and posttest scores ($p < 0.05$), with a large effect size (Cohen's $d = 10.28$). These findings demonstrate that Problem Based Learning based on socio-scientific issues significantly enhances students' environmental awareness, responsibility, participation, and sustainable behavior. The integration of authentic environmental problems into learning activities provides meaningful opportunities for students to develop responsible attitudes and moral reflection toward environmental challenges. Therefore, this instructional approach is recommended to promote environmental care character among junior secondary school students.

Keywords: Character education; Environmental care character; Junior secondary school; Problem based learning; Socio-scientific issues

Introduction

Environmental problems such as waste accumulation, deforestation, and water pollution continue to threaten sustainable development globally. Education has an important role in increasing students' environmental understanding and responsibility through meaningful learning knowledge (Baena-Morales et al., 2023; UNESCO, 2017, 2020). Schools are expected not only to develop students' cognitive competencies but also to strengthen character values, including environmental care character. Environmental care character refers to attitudes and behaviors that demonstrate responsibility, awareness, and active

participation in protecting the environment (Napitupulu et al., 2025; Permanasari et al., 2021).

However, learning practices in many schools still emphasize knowledge acquisition rather than character formation. Conventional instruction often limits students' opportunities to analyze real environmental problems critically and reflect on their moral implications (Hodson, 2020). Previous studies indicate that contextual and student-centered approaches are more effective in promoting environmental attitudes and responsible behavior (Gök et al., 2023; Kusdiah et al., 2024; Kuvac et al., 2019; Mutiani, 2017).

Problem Based Learning (PBL) is a student-centered learning model that engages learners in solving authentic and meaningful problems. Through

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investigation, collaboration, and reflection, PBL encourages critical thinking and responsible decision-making (Aripin et al., 2025; Gu et al., 2022; Mahfud & Pamuji, 2025; Muliyadi et al., 2026; Suhartini, 2025). PBL also promotes active engagement in real-world problem-solving situations that enhance collaboration and responsibility (Akçay et al., 2024; Durmaz et al., 2024). When integrated with socio-scientific issues (SSI), learning becomes more relevant because students analyze real-life environmental issues that involve scientific concepts as well as ethical and social considerations (Lesnefsky, 2023; Nolan et al., 2025).

Socio-scientific issues such as plastic waste management, land use changes, and environmental pollution are relevant to students' daily lives in Southern Thailand. Integrating these issues into science learning may provide opportunities for students to develop environmental awareness and moral reasoning simultaneously (Ariza et al., 2021; Noviar et al., 2024). Research shows that SSI-based instruction can enhance students' environmental literacy and character development (Chowdhury et al., 2020; Denzin et al., 2000; Januarti et al., 2024; Lestari et al., 2025).

Furthermore, integrating socio-scientific issues into environmental learning has been shown to significantly improve students' environmental responsibility and pro-environmental behavior (Burrows, 2021; Yamguchi et al., 2020). This approach enables students to connect scientific knowledge with real environmental challenges in their daily lives.

Therefore, this study aims to analyze the effect of Problem Based Learning based on socio-scientific issues on strengthening students' environmental care character at Ban Buketamong School Friendship 128, Cho Airong, Narathiwat, Thailand.

Method

This study employed a pre-experimental research design using a one-group pretest-posttest design to examine the effect of Problem Based Learning (PBL) based on socio-scientific issues (SSI) on students' environmental care character. The pre-experimental design is appropriate for measuring changes before and after treatment within one group (Molina-Azorin et al., 2022).

Research Design

$$O_1 - X - O_2 \quad (1)$$

Where O_1 represents the pretest, X represents the treatment using PBL based on socio-scientific issues, and O_2 represents the posttest.

Participants

The participants were 30 Grade 8 students at Ban Buketamong School Friendship 128, Cho Airong District, Narathiwat, Thailand. The sampling technique used was total sampling, since all students in the class were involved as research subjects.

Research Instruments

The instruments used in this study were:

Environmental Care Character Questionnaire

The questionnaire consisted of 25 Likert-scale items (1–5 scale) adapted from environmental character education indicators (Ratnasari et al., 2024). The indicators included environmental awareness, responsibility, participation, and sustainable behavior.

Observation Sheet

Used to observe students' environmental care behavior during PBL activities.

Documentation

Included lesson plans and student worksheets designed according to the PBL stages (Syahfitri et al., 2023). The validity of the questionnaire was tested using Pearson Product-Moment correlation, while reliability was measured using Cronbach's Alpha. An instrument is considered reliable if $\alpha \geq 0.70$ (Taber, 2018).

Research Procedure

The study was conducted in three stages:

Pretest Stage

Students completed the environmental care character questionnaire to measure their initial condition.

Treatment Stage

The treatment was conducted over four meetings using PBL integrated with socio-scientific issues. The PBL stages followed standard procedures: (1) problem orientation, (2) organizing students, (3) guided investigation, (4) developing and presenting solutions, and (5) evaluation and reflection (Yew et al., 2016).

The socio-scientific issues discussed included plastic waste management, environmental pollution, and land use changes in Southern Thailand. SSI-based instruction encourages students to analyze scientific concepts alongside ethical and social implications (Benek et al., 2022; Noris et al., 2024).

Posttest Stage

After the treatment, students completed the same questionnaire to measure changes in environmental care character.

Data Analysis

Data were analyzed using descriptive and inferential statistics. Descriptive statistics included mean and standard deviation. Prior to hypothesis testing, data were tested for normality using the Shapiro-Wilk test (Yuan et al., 2022).

To determine whether there was a significant difference between pretest and posttest scores, a paired sample t-test was conducted at a significance level of $\alpha = 0.05$. Additionally, the effect size was calculated using Cohen's *d* to measure the magnitude of the treatment effect (Felt et al., 2017).

Result and Discussion

Results

The results of the study are presented in the following tables.

Table 1. Descriptive Statistics of Environmental Care Character Scores

Test	N	Mean	Std. Deviation
Pretest	30	67.37	4.94
Posttest	30	82.80	3.65

Table 1 shows that the mean score increased from 67.37 in the pretest to 82.80 in the posttest, indicating an improvement in students' environmental care character after the implementation of PBL based on socio-scientific issues.

Table 2. Normality Test (Shapiro-Wilk)

Test	Statistic	Sig. (p)
Pretest	0.977	0.742
Posttest	0.979	0.795

Table 2 indicates that both pretest and posttest data are normally distributed because the significance values are greater than 0.05 ($p > 0.05$). Therefore, parametric testing using a paired sample t-test was appropriate.

Table 3. Paired Sample t-Test Results

Variable	T	df	Sig. (2-tailed)	Cohen's <i>d</i>
Pretest-Posttest Scores	-56.304	29	0.000	10.28

Table 3 shows that there is a significant difference between pretest and posttest scores ($p < 0.05$). The Cohen's *d* value of 10.28 indicates a large effect size, meaning that the treatment had a strong practical impact on students' environmental care character.

Discussion

The findings demonstrate that Problem Based Learning integrated with socio-scientific issues significantly improves students' environmental care character. The substantial increase in the mean score

confirms that contextual and problem-oriented learning experiences influence students' environmental awareness, responsibility, and participation. This result is consistent with previous studies showing that active and problem-based learning approaches contribute significantly to the development of students' environmental literacy and pro-environmental behavior (Ardoin et al., 2020; Gök et al., 2023).

The learning process during the implementation of Problem Based Learning is illustrated in Figure 1. Students were actively engaged in group discussions, analyzing real environmental issues, and collaboratively proposing solutions. These activities encouraged students to think critically and take responsibility for environmental problems in their surroundings. This supports the view that participatory and student-centered learning environments enhance students' engagement and environmental responsibility (Liu et al., 2024; Monroe et al., 2019).



Figure 1. Students' activities during group discussion in Problem Based Learning

The large effect size further indicates that the intervention was not only statistically significant but also educationally meaningful. The use of real environmental problems encouraged students to reflect critically on environmental issues and to develop responsible attitudes toward their surroundings. Integrating real-world contexts into science learning has been shown to strengthen students' ability to evaluate complex environmental problems and make informed decisions (Gu et al., 2022; Redman et al., 2021).

Furthermore, students also presented the results of their discussions in front of the class, as shown in Figure 2. This activity strengthened students' confidence, communication skills, and participation in learning. Discussion-based and argumentation-oriented instruction has been shown to improve students' reasoning and communication skills in science learning (Lesnefsky et al., 2025; Nolan et al., 2025).



Figure 2. Students presenting solutions to environmental problems

Thus, integrating socio-scientific issues within PBL can be considered an effective instructional strategy to strengthen environmental care character among junior secondary school students.

Conclusion

Based on the results of the study, it can be concluded that the implementation of Problem Based Learning (PBL) integrated with socio-scientific issues (SSI) significantly strengthens students' environmental care character. The statistical analysis showed a meaningful increase in students' environmental care character scores from pretest to posttest, supported by a significant paired sample t-test result and a large effect size. These findings indicate that learning activities centered on authentic environmental problems provide effective opportunities for students to develop environmental awareness, responsibility, participation, and sustainable behavior. The integration of socio-scientific issues into PBL not only enhances cognitive understanding but also fosters moral reflection and responsible decision-making related to environmental challenges. Therefore, PBL based on socio-scientific issues can be recommended as an effective instructional strategy to promote environmental care character among junior secondary school students, particularly in contexts where environmental issues are closely related to students' daily lives.

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Author Contributions

Conceptualization, T.H. and A.M.L.; methodology, T.H.; software, T.H.; validation, T.H., A.M.L., and S.A.; formal analysis, T.H.; investigation, T.H. and M.B.; resources, T.H.; data curation, T.H.; writing—original draft preparation, T.H.; writing—review and editing, T.H., A.M.L., S.A., M.B., and D.L. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

References

- Akcay, B., & Benek, İ. (2024). Problem-Based Learning in Türkiye: A Systematic Literature Review of Research in Science Education. *Education Sciences*, 14(3), 330. <https://doi.org/10.3390/educsci14030330>
- Ardoin, N. M., Bowers, A. W., & Gaillard, E. (2020). Environmental education outcomes for conservation: A systematic review. *Biological Conservation*, 241, 108224. <https://doi.org/10.1016/j.biocon.2019.108224>
- Aripin, N., Alberida, H., Ahda, Y., & Mufit, F. (2025). The Impact of Problem-Based Learning on Science Learning to Improve Students' Critical Thinking and Problem-Solving Skills: A Meta-Analysis. *Jurnal Penelitian Pendidikan IPA*, 11(6), 45–57. <https://doi.org/10.29303/jppipa.v11i6.10051>
- Ariza, M. R., Christodoulou, A., van Harskamp, M., Knippels, M. C. P. J., Kyza, E. A., Levinson, R., & Agesilaou, A. (2021). Socio-Scientific Inquiry-Based Learning as a Means Toward Environmental Citizenship. *Sustainability (Switzerland)*, 13(20), 11509. <https://doi.org/10.3390/su132011509>
- Baena-Morales, S., Merma-Molina, G., & Ferriz-Valero, A. (2023). Integrating education for sustainable development in physical education: fostering critical and systemic thinking. *International Journal of Sustainability in Higher Education*, 24(8), 1916–1932. <https://doi.org/10.1108/IJSHE-10-2022-0343>
- Benek, I., & Akcay, B. (2022). The effects of socio-scientific STEM activities on 21st century skills of middle school students. *Participatory Educational Research*, 9(2), 25–52. <https://doi.org/10.17275/PER.22.27.9.2>
- Burrows, M. S. (2021). *Socioscientific Issues in School-Based Agricultural Education: Describing and Exploring Factors of Integration*. DigitalCommons@USU.

- Chowdhury, T. B. M., Holbrook, J., & Rannikmäe, M. (2020). Socioscientific Issues within Science Education and their Role in Promoting the Desired Citizenry. *Science Education International*, 31(2), 203–208. <https://doi.org/10.33828/sei.v31.i2.10>
- Denzin, N. K., & Lincoln, Y. S. (2000). *Handbook of research qualitative*. Pustaka Pelajar.
- Durmaz, H., & Çelik Keser, H. (2024). The Effect of STEM Education Practices on the Awareness towards STEM Education and Opinions of Preservice Science Teachers. *Necatibey Eğitim Fakültesi Elektronik Fen ve Matematik Eğitimi Dergisi*, 18(1), 1–30. <https://doi.org/10.17522/balikesirnef.1402084>
- Felt, J. M., Castaneda, R., Tiemensma, J., & Depaoli, S. (2017). Using person fit statistics to detect outliers in survey research. *Frontiers in Psychology*, 8(MAY), 1–9. <https://doi.org/10.3389/fpsyg.2017.00863>
- Gök, G., & Boncukçu, G. (2023). The Effect Of Problem-Based Learning on Middle School Students' Environmental Literacy and Problem-Solving Skills. *Journal of Science Learning*, 6(4), 414–423. <https://doi.org/10.17509/jsl.v6i4.62781>
- Gu, S., Chen, C., Jiang, B., Ding, K., & Xiao, H. (2022). Study on the Pressure Relief Mechanism and Engineering Application of Segmented Enlarged-Diameter Boreholes. *Sustainability (Switzerland)*, 14(9), 1–22. <https://doi.org/10.3390/su14095234>
- Hodson, D. (2020). Going Beyond STS Education: Building a Curriculum for Sociopolitical Activism. *Canadian Journal of Science, Mathematics and Technology Education*, 20(4), 592–622. <https://doi.org/10.1007/s42330-020-00114-6>
- Januarti, I. M., & Muliyadi, L. (2024). Development of Ethnoscience-Based Student Worksheet Using the Guided Inquiry Learning Model to Increase Students' Learning Motivation and Scientific Literacy: A Review. *International Journal of Science Education and Science*, 1(1), 13–18. <https://doi.org/10.56566/ijses.v1i1.109>
- Kusdiah, Y., Sriwati, M., Kasnawati, K., & Sampe, R. (2024). Peran Pendidikan Lingkungan Dalam Meningkatkan Kesadaran Masyarakat Tentang Pengelolaan Sampah. *Jurnal Review Pendidikan Dan Pengajaran*, 7(3), 7415–7421. <https://doi.org/10.31004/jrpp.v7i3.29635>
- Kuvac, M., & Koc, I. (2019). The effect of problem-based learning on the environmental attitudes of preservice science teachers. *Educational Studies*, 45(1), 72–94. <https://doi.org/10.1080/03055698.2018.1443795>
- Lesnefsky, R. R. (2023). Instructional Pathways to Considering Social Dimensions Within Socioscientific Issues. *Innovations in Science Teacher Education*, 8(2), 1–16. Retrieved from <https://innovations.theaste.org/index.php/iste/article/view/391>
- Lesnefsky, R. R., Elsner, J., Kirk, E. A., Yeldell, J., Ke, L., & Sadler, T. D. (2025). Exploring Resources and Reasoning Practices in Socioscientific System Modeling for Justice-Centered Science Education. *CBE – Life Sciences Education*, 24(1), 1–17. <https://doi.org/10.1187/cbe.24-01-0017>
- Lestari, A. D., Suwono, H., & Prabaningtyas, S. (2025). By-Clime: Development of PBL-SSI-based e-module on climate change to enhance SA and ITS of upper secondary students. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, 11(3), 1075–1085. <https://doi.org/10.22219/jpbi.v11i3.41934>
- Liu, J., & Green, R. J. (2024). Children's pro-environmental behaviour: A systematic review of the literature. *Resources, Conservation and Recycling*, 205(March), 107524. <https://doi.org/10.1016/j.resconrec.2024.107524>
- Mahfud & Pamuji. (2025). The effectiveness of Problem-Based Learning Method in Enhancing Students' Critical Thinking Skills in Junior High Schools. *Journal of Entomological Research*, 49(2), 557–559. <https://doi.org/10.5958/0974-4576.2025.00094.0>
- Molina-Azorin, J. F., & Fettes, M. D. (2022). Books on Mixed Methods Research: A Window on the Growth in Number and Diversity. *Journal of Mixed Methods Research*, 16(1), 8–16. <https://doi.org/10.1177/15586898211068208>
- Monroe, M. C., Plate, R. R., Oxarart, A., Bowers, A., & Chaves, W. A. (2019). Identifying effective climate change education strategies: a systematic review of the research. *Environmental Education Research*, 25(6), 791–812. <https://doi.org/10.1080/13504622.2017.1360842>
- Muliyadi, L., Hamidi, H., Islami, A. V., Rizaldi, D. R., Hasanah, R., Yadaeni, A., Hariadi, M. H., Hanafi, M., & Wathoni, H. (2026). Analysis Validation of Physics Learning Devices Based on Problem Based Learning Assisted by PhET Simulation to Improve Students' Creativity and Critical Thinking. *Indonesian Journal of Science Education and Applied Research*, 1(1), 27–31. Retrieved from <https://journals.balaipublikasi.id/index.php/ijos ear/article/view/743>
- Mutiani, M. (2017). Ips Dan Pendidikan Lingkungan: Urgensi Pengembangan Sikap Kesadaran Lingkungan Peserta Didik. *Sosio-Didaktika: Social Science Education Journal*, 4(1), 45–53. <https://doi.org/10.15408/sd.v4i1.5718>
- Napitupulu, N. D., Novianti, I., Iduard, I., Rutmiyanti, R., Ibrahim, I., & Embatau, K. S. (2025). Environmental Literacy in Middle School: Ecological Knowledge, Cognitive Skills, Environmental Affect, and Pro-Environmental

- Behavior. *Jurnal Eduscience*, 12(2), 281–296. <https://doi.org/10.36987/jes.v12i2.6691>
- Nolan, E., & Zeidler, D. (2025). Transformational Learning for Complex Socioscientific Issues. *Research in Science Education*, 55(4), 771–791. <https://doi.org/10.1007/s11165-025-10264-y>
- Noris, M., Sajidan, S., Saputro, S., & Yamtinah, S. (2024). Trends and Issues of Inquiry and Socio-Scientific Issue (SSI) Research in the Last 20 Years: A Bibliometric Analysis. *International Journal of Education in Mathematics, Science and Technology*, 12(3), 773–792. <https://doi.org/10.46328/ijemst.3767>
- Noviar, D., & Suyanto, S. (2024). A Systematic Literature Review of Socioscientific Issues in Science Education: Integration and Instructional Effect in Science Learning. *Annual International Conference on Education Research*, 01. Retrieved from <https://conference.uin-suka.ac.id/index.php/Pic/article/view/1499>
- Permanasari, G. H., Suherman, S., & Budiati, L. (2021). The Implementation of Environmental Education to Achieve Sustainable Development: Literature Review. *E3S Web of Conferences*, 317. <https://doi.org/10.1051/e3sconf/202131701069>
- Ratnasari, J., Hakam, K. A., Hidayat, M., & Kosasih, A. (2024). Strengthening Environmental Care Character through Contextual Approach in Science Learning. *Jurnal Penelitian Pendidikan IPA*, 10(11), 9234–9241. <https://doi.org/10.29303/jppipa.v10i11.9024>
- Redman, A., & Wiek, A. (2021). Competencies for Advancing Transformations Towards Sustainability. *Frontiers in Education*, 6(November), 1–11. <https://doi.org/10.3389/feduc.2021.785163>
- Suhartini, D. (2025). Efforts to Improve Students' Problem-Solving Skills in Science Learning by Implementing the Problem-Based Learning Model in MIS Ni' matul Aziz. *Deep Learning: Journal of Educational Research*, 1(4), 22–40. <https://doi.org/10.62945/deeplearning.v1i4.276>
- Syahfitri, J., & Endang. (2023). Implementation of Student Worksheets Based on Problem Based Learning to Improve Students' Critical Thinking Skills. *Quagga: Jurnal Pendidikan Dan Biologi*, 15(2), 188–192. <https://doi.org/10.25134/quagga.v15i2.43>
- Taber, K. S. (2018). The Use of Cronbach's Alpha When Developing and Reporting Research Instruments in Science Education. *Research in Science Education*, 48(6), 1273–1296. <https://doi.org/10.1007/s11165-016-9602-2>
- UNESCO. (2017). A Review of education for sustainable development and global citizenship education in teacher education. *Global Education Monitoring Report*, 1–66. Retrieved from <http://unesdoc.unesco.org/images/0025/002595/259566e.pdf>
- UNESCO. (2020). Education for sustainable development: a roadmap. In *Education for sustainable development: a roadmap*. <https://doi.org/10.54675/yfre1448>
- Yamguchi, Z., & Quetelet, G. (2020). A Comparative Study of Post-Marriage Nationality of Women in Legal Systems of Different Countries. *International Journal of Social Science Research and Review*, 3(3), 1–8. <https://doi.org/10.47814/ijssrr.v3i3.41>
- Yew, E. H. J., & Goh, K. (2016). Problem-Based Learning: An Overview of its Process and Impact on Learning. *Health Professions Education*, 2(2), 75–79. <https://doi.org/10.1016/j.hpe.2016.01.004>
- Yuan, X., Wang, J., Yang, S., Gao, M., Cao, L., Li, X., Hong, D., Tian, S., & Sun, C. (2022). Effect of Intermittent Fasting Diet on Glucose and Lipid Metabolism and Insulin Resistance in Patients with Impaired Glucose and Lipid Metabolism: A Systematic Review and Meta-Analysis. *International Journal of Endocrinology*, 2022. <https://doi.org/10.1155/2022/6999907>