

Integrating School Environmental Culture into a Problem-Based Science Module to Improve Students' Problem-Solving and Environmental Understanding

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ABSTRACT

Environmental problems require science learning that connects conceptual understanding, problem-solving skills, and school-based environmental action. This study aimed to develop a science teaching module integrating the School Environmental Care and Culture Movement into Problem Based Learning and to examine its validity, practicality, and effectiveness in improving junior high school students' problem-solving skills and environmental understanding. The study used research and development with the ADDIE model, consisting of analysis, design, development, implementation, and evaluation. The subjects involved five expert validators, two science teachers, and 60 seventh-grade students of SMP Negeri 22 Padang divided into experimental and control classes. Data were collected through validation sheets, practicality questionnaires, and tests of problem-solving skills and environmental understanding. Validity and practicality data were analyzed using percentages, while effectiveness was analyzed using gain score, N-Gain, effect size, and the Mann-Whitney test. The module obtained a validity score of 91.40%, teacher practicality of 93.89%, and student practicality of 94.17%, all in the very good category. The experimental class showed higher improvement in problem-solving skills than the control class, with $p < .001$, effect size of 0.75, and N-Gain of 0.48. Environmental understanding also improved significantly, with $p = .003$, effect size of 0.39, and N-Gain of 0.53. Therefore, the developed module is valid, practical, and effective for strengthening GPBLHS-based science learning.

Keywords: Environmental Understanding, GPBLHS, Problem Based Learning, Problem-Solving Skills, Science Module

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INTRODUCTION

Environmental problems are closely related to education, community behavior, and the ability of young people to make responsible decisions in daily life. Pollution, waste management, ecosystem degradation, and low participation in environmental care cannot be solved only through policy or infrastructure. These issues also require learning experiences that help students understand environmental concepts and use such understanding to solve real problems around them. Schools therefore have a strategic role in developing environmental awareness, scientific reasoning, and responsible behavior through classroom instruction and school culture (Danhas & Danhas, 2021; Danhas & Dewata, 2023; Husin et al., 2025).

The School Environmental Care and Culture Movement, known in Indonesia as Gerakan Peduli dan Berbudaya Lingkungan Hidup di Sekolah (GPBLHS), places schools as agents of environmental care and culture. GPBLHS is implemented through several components, including environmentally oriented policy, environment-based curriculum, participatory environmental activities, and the management of environmentally friendly facilities. Among

these components, the environment-based curriculum is closely connected to the role of teachers because it requires environmental values to be integrated into lesson planning, learning activities, assessment, and student participation (BP2SDM, 2020; Peraturan Menteri Lingkungan Hidup dan Kehutanan RI Nomor 52 Tahun 2019 Tentang GPBLH Di Sekolah, 2019).

Initial analysis in this study indicated that the environment-based curriculum component in several junior high schools in Padang was not yet optimal compared with other GPBLHS indicators. Teachers had attempted to discuss environmental issues, but the integration of GPBLHS values into science learning was not yet supported by a systematic teaching module. Learning activities were often limited to explaining concepts, while activities that trained students to identify environmental problems, analyze causes, formulate solutions, and reflect on action were still limited. This situation shows the need for teaching materials that translate GPBLHS values into classroom learning practices.

Science learning at the junior high school level provides a suitable entry point for strengthening GPBLHS because the topic of interactions between living things and their environment is directly related to ecosystems, biotic and abiotic components, food chains, environmental balance, pollution, and conservation. These concepts are not only theoretical but are also visible in students' school environment. Therefore, science lessons can connect conceptual understanding with observations of real environmental problems, such as unmanaged waste, limited green areas, and low student participation in maintaining school cleanliness (Inabuya et al., 2021; Surya et al., 2023).

Problem Based Learning (PBL) is relevant for this purpose because it starts learning from authentic problems and encourages students to investigate, discuss, propose alternatives, and evaluate solutions. PBL does not position students merely as recipients of information but as learners who use evidence and reasoning to solve contextual problems. When combined with GPBLHS values, PBL can guide students to understand environmental concepts while also practicing environmental care through simple, realistic, and observable school-based actions (Hmelo-Silver, 2004; Savery, 2015; Rohmah et al., 2025).

However, PBL implementation requires organized teaching materials. A teaching module should not only provide content but also guide learning syntax, student worksheets, assessment activities, reflection, and contextual tasks. Previous studies have discussed environmental education, Adiwiyata or GPBLHS implementation, PBL, and teaching module development separately (Mutia et al., 2024; Nurwidodo et al., 2020; Winarko et al., 2024). Nevertheless, there is still a need for a science teaching module that specifically integrates GPBLHS values into PBL syntax, activities, assessment, and environmental problem contexts on the topic of interactions between living things and their environment.

Based on this gap, the present study developed a science teaching module integrating GPBLHS into PBL activities. The module was designed to support the implementation of environment-based curriculum and improve students' problem-solving skills and environmental understanding. The research questions addressed in this study were: how is the GPBLHS-integrated science module developed, how valid and practical is the module, and how effective is the module in improving students' problem-solving skills and environmental understanding?

METHOD

This research used a research and development design with the ADDIE model. ADDIE was selected because it provides a systematic framework for producing and testing educational products through five stages: analysis, design, development, implementation, and evaluation (Branch, 2009). The study was conducted at SMP Negeri 22 Padang with the involvement of expert validators, science teachers, and seventh-grade students. The validity test involved five validators who assessed content, language, presentation, and graphic aspects. The practicality test involved two science teachers and 30 students, while the effectiveness test involved 60 students divided into an experimental class and a control class.

The product developed in this study was a printed science teaching module for the topic of interactions between living things and their environment. The module contained general information, learning outcomes, learning objectives, problem contexts, learning materials, PBL-

based activity steps, handouts, student worksheets, assessment rubrics, and reflection activities. GPBLHS values were integrated through the use of school environmental problems, waste management activities, environmental observation, planting activities, discussion of conservation actions, and habituation of environmentally responsible behavior.

The analysis stage consisted of needs analysis, problem analysis, learner analysis, literature analysis, and goal analysis. Needs analysis was carried out to identify teacher and student expectations for a GPBLHS-integrated module. Problem analysis identified obstacles in implementing environment-based curriculum. Learner analysis described students' readiness and learning preferences. Literature analysis examined GPBLHS, PBL, science learning, problem-solving skills, and environmental understanding. Goal analysis was used to formulate learning objectives and assessment indicators.

The design stage produced the module framework, learning flow, worksheets, assessment indicators, and integration map between PBL syntax and GPBLHS values. The development stage involved preparing Prototype I, validating the module, revising it according to expert suggestions, and producing a revised prototype. The implementation stage consisted of practicality testing and a quasi-experimental trial. The evaluation stage was carried out throughout all stages through expert feedback, teacher and student responses, and the analysis of learning outcome data. Product quality was interpreted through validity, practicality, and effectiveness criteria as suggested in educational design research (Nieveen, 1999).

Table 1. ADDIE-Based Development Procedure of the GPBLHS-Integrated Science Module

Stage	Activity	Output
Analysis	Needs, problem, learner, literature, and goal analyses	Module specifications
Design	Learning flow, PBL tasks, worksheets, and assessment design	Prototype map
Development	Drafting, expert validation, and revision	Revised module
Implementation	Practicality test and quasi-experimental trial	Response and outcome data
Evaluation	Revision and interpretation of product quality	Final module and findings

Data collection instruments consisted of validation sheets, teacher practicality questionnaires, student practicality questionnaires, problem-solving tests, and environmental understanding tests. The validation sheet assessed content, language, presentation, and graphics. Practicality questionnaires measured ease of use, clarity, attractiveness, usefulness, and classroom applicability. The problem-solving test measured students' ability to identify problems, analyze causes, propose solutions, select appropriate solutions, and evaluate problem-solving processes. The environmental understanding test measured students' understanding of environmental concepts, human-environment relationships, and environmental protection efforts.

The validity and practicality scores were analyzed using percentages and interpreted using predetermined criteria. Effectiveness was examined through gain score and normalized gain (N-Gain). Before hypothesis testing, normality and homogeneity assumptions were examined. Because the gain score data did not fully meet the parametric assumptions, the Mann-Whitney test was used to compare the improvement between the experimental and control classes. Effect size was calculated to identify the magnitude of the module's effect on each learning outcome.

Table 2. Integration of PBL Syntax and GPBLHS Values in the Developed Module

PBL Stage	GPBLHS Activity
Problem orientation	Students observe school environmental problems such as waste, limited green areas, and cleanliness issues.
Student organization	Students define environmental issues, form groups, and distribute investigation tasks.
Investigation	Students collect data, discuss findings, and relate the problem to ecosystem concepts.
Product development	Students design solutions and conduct simple environmental care actions.

Analysis and evaluation	Students evaluate the feasibility of solutions and reflect on responsible environmental behavior.
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RESULT AND DISCUSSION

The analysis stage showed that science teachers needed a teaching module that could help them integrate GPBLHS values into classroom learning. The existing learning process had discussed environmental topics, but the learning activities were not yet systematically connected with school environmental problems. Students also needed learning activities that were more contextual and action-oriented. The topic of interactions between living things and their environment was considered suitable because it provides opportunities to connect science concepts with problems that students can directly observe at school.

The developed module followed PBL syntax and embedded GPBLHS values in each learning activity. Students were guided to observe environmental conditions, identify problems, discuss possible causes, search for information, propose solutions, and evaluate the solution process. The module consisted of learning identity, learning outcomes, learning objectives, learning materials, PBL-based activity steps, handouts, worksheets, assessment rubrics, and reflection. These components were designed to ensure alignment between objectives, learning activities, assessment, and GPBLHS values.

Expert validation showed that the developed module met the feasibility criteria. The average validity score was 91.40%, which was categorized as very valid. The content aspect obtained a score of 93.50%, language 93.75%, presentation 90.00%, and graphics 88.33%. These results indicate that the module was relevant to learning objectives, appropriate for junior high school students, understandable in language, organized in presentation, and visually feasible for classroom use.

Table 3. Validity and Practicality of the Developed GPBLHS-Integrated Module

Component	Score (%)	Category
Content validity	93.50	Very valid
Language validity	93.75	Very valid
Presentation validity	90.00	Very valid
Graphic validity	88.33	Very valid
Average validity	91.40	Very valid
Teacher practicality	93.89	Very practical
Student practicality	94.17	Very practical

The high validity score indicates that the module had a strong theoretical and instructional basis. A valid teaching module must show consistency between objectives, materials, activities, and assessment (Brown & Green, 2016; Nieveen, 1999). In this study, the module did not only present environmental concepts but also provided learning scenarios that supported students in analyzing real environmental problems. This strengthens the position of the module as a learning tool that connects science content, environmental education, and problem-based pedagogy.

Teacher practicality reached 93.89%, indicating that teachers considered the module easy to use and relevant to classroom conditions. Teachers could follow the learning flow, use the worksheets, and connect the activities with GPBLHS implementation. Student practicality reached 94.17%, showing that students responded positively to the module. Students could understand the instructions, follow group activities, and use the worksheets to guide their investigation. These findings show that the module is not only theoretically appropriate but also usable in real classroom contexts.

The practicality findings also confirm that the module functions as a bridge between curriculum demands and GPBLHS implementation. Instead of separating environmental programs from classroom learning, the module integrates environmental care into ordinary science lessons. This integration is important because GPBLHS will be more meaningful when students experience it as part of learning, not only as a school program outside the classroom (BP2SDM, 2020; Mutia et al., 2024).

The effectiveness test showed that students in the experimental class experienced greater improvement in problem-solving skills than students in the control class. The experimental class obtained a pretest mean of 47.47 and a posttest mean of 72.87, with a gain score of 25.40.

The control class obtained a pretest mean of 45.27 and a posttest mean of 60.40, with a gain score of 15.13. The N-Gain score of the experimental class was 0.48, while the control class was 0.28.

Table 4. Students' Pretest, Posttest, Gain Score, and N-Gain Results

Outcome	Class	Pretest	Posttest	Gain	N-Gain
Problem-solving	Experimental	47.47	72.87	25.40	0.48
Problem-solving	Control	45.27	60.40	15.13	0.28
Environmental understanding	Experimental	35.47	69.73	34.27	0.53
Environmental understanding	Control	49.47	70.13	20.67	0.41

The Mann-Whitney test on the gain score of problem-solving skills produced $U = 63.500$, $Z = -5.779$, and $p < .001$. This means that the difference in improvement between the experimental and control classes was statistically significant. The effect size was 0.75, which indicates a large effect. These results show that the GPBLHS-integrated module provided stronger support for developing problem-solving skills than conventional learning.

The improvement in problem-solving skills can be explained by the learning characteristics of the module. Students were not directly given answers to environmental problems; instead, they were guided to understand the problem context, identify causes, discuss evidence, and formulate possible solutions. This process trained students to move from recognizing a problem to evaluating the feasibility of solutions. The action component of GPBLHS also supported problem-solving skills because students experienced the relationship between ideas and simple environmental practices. These findings are consistent with studies showing that PBL can strengthen students' higher-order thinking and problem-solving abilities through authentic investigation (Amala & Yushardi, 2022; Hmelo-Silver, 2004; Savery, 2015).

The module also improved students' environmental understanding. The experimental class obtained a pretest mean of 35.47 and a posttest mean of 69.73, with a gain score of 34.27. The control class obtained a pretest mean of 49.47 and a posttest mean of 70.13, with a gain score of 20.67. The N-Gain score of the experimental class was 0.53, while the control class was 0.41. Although both groups improved, the increase in the experimental class was higher. The Mann-Whitney test produced $U = 250.000$, $Z = -2.990$, and $p = .003$, indicating a significant difference. The effect size was 0.39, which indicates a moderate effect.

Table 5. Mann-Whitney Test Results and Effect Size

Outcome	U	Z	p	Effect Size
Problem-solving skills	63.500	-5.779	< .001	0.75
Environmental understanding	250.000	-2.990	.003	0.39

The increase in environmental understanding occurred because the module connected abstract science concepts with real experiences. Students did not only learn about biotic and abiotic components, food chains, environmental balance, pollution, and conservation as isolated concepts. They used these concepts to interpret actual problems in the school environment. This contextual connection helped students see that science knowledge is useful for explaining and improving their surroundings, which is consistent with environmental literacy frameworks emphasizing knowledge, human-environment relationships, and responsible action (Danhas & Danhas, 2021; Hollweg et al., 2011; Nurwido et al., 2020).

The findings also show that the module had different strengths for the two learning outcomes. The effect size for problem-solving skills was larger than the effect size for environmental understanding. This may occur because the module was strongly oriented toward PBL activities, which directly trained problem identification, analysis, solution planning, and evaluation. Environmental understanding also improved, but part of this understanding may be influenced by students' prior knowledge and learning experiences outside the module. Therefore, future implementation may add more concept reinforcement activities to produce stronger gains in environmental understanding.

Overall, the module contributes to science education by integrating three important elements: environmental education policy, problem-based pedagogy, and teaching material

development. The product translates GPBLHS values into learning activities that are practical for teachers and meaningful for students. The module also supports schools that need documentation and classroom evidence for the environment-based curriculum component of GPBLHS, because student worksheets, observation reports, and action plans can become evidence of environmental learning activities (BP2SDM, 2020; Mutia et al., 2025; Rahman et al., 2024).

For teachers, the module provides an example of how to transform environmental issues into learning problems. In conventional learning, environmental content is often presented as factual information, while in this module the same content becomes a starting point for investigation and action. For students, the integration of PBL and GPBLHS offers a learning experience that combines cognitive and participatory dimensions. Students build environmental understanding through handouts and discussions while also developing problem-solving skills through investigation and solution design.

The module also supports reflective learning. At the end of the activity, students are encouraged to reconsider whether their proposed solution is realistic, what limitations may occur, and what actions can be continued by individuals or groups. Reflection is important in environmental education because environmental care is not only about knowing the problem but also about building awareness and commitment to act responsibly.

These findings have practical implications for schools that are preparing evidence for GPBLHS implementation. The developed module translates the environment-based curriculum indicator into teachable classroom activities rather than treating it only as an administrative document. Through the module, teachers can document learning objectives, learning steps, student worksheets, assessment instruments, and student products related to environmental protection and management. Thus, the module can support science learning and the development of school environmental culture simultaneously (BP2SDM, 2020; Peraturan Menteri Lingkungan Hidup dan Kehutanan RI Nomor 52 Tahun 2019 Tentang GPBLH Di Sekolah, 2019).

Despite these positive findings, the study has limitations. The module was developed only for the topic of interactions between living things and their environment, so its use for other science topics still requires adaptation. The implementation was also conducted in one school and involved a limited number of participants. Future studies may test the module in different schools, develop a digital version, integrate more long-term environmental projects, and examine its effect on environmental attitudes and behavior.

CONCLUSION

The science teaching module integrating GPBLHS into Problem Based Learning was successfully developed using the ADDIE model. The module contains learning objectives, environmental problem contexts, handouts, worksheets, assessment rubrics, and reflection activities that connect science concepts with school environmental issues. The module was categorized as very valid with an average validity score of 91.40%. It was also very practical based on teacher responses of 93.89% and student responses of 94.17%. The effectiveness test showed that the module significantly improved students' problem-solving skills, with $p < .001$, effect size of 0.75, and N-Gain of 0.48 in the experimental class. The module also significantly improved environmental understanding, with $p = .003$, effect size of 0.39, and N-Gain of 0.53 in the experimental class. These findings indicate that integrating GPBLHS values into a problem-based science module can be a feasible strategy for strengthening environment-based curriculum implementation and improving students' ability to understand and solve environmental problems.

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