Journal of Science and Mathematics Education
Vol. 1 No. 4, December 2025, pp. 103-110
E-ISSN 3090-0336

JOSME
Journal of Science and Mathematics Education

Development of Integrated Science Modules with Local Wisdom to Improve Environmental Literacy at State Junior High School 46 Jakarta

Bagus Firmansyah[1*], Reza Aditya Maulana[2]
[1,2] Department of Physics Education, State University of Jakarta, Indonesia.
* Corresponding author : bagusfir321@gmail.com

ARTICLE INFO

Article history
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Received : September 30, 2025
Revised : October 25, 2025
Accepted : December 26, 2025
Published: December 28, 2025

Keywords
Integrated Science
Local Wisdom
Environmental Literacy
Learning Module
Junior High School

ABSTRACT

This study aims to develop an Integrated Science module based on local wisdom to enhance environmental literacy among students at State Junior High School 46 Jakarta. The development process followed the Research and Development (R&D) design using the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation). Local wisdom elements integrated into the module include traditional environmental practices, local flora and fauna knowledge, and cultural values related to sustainability. The module was tested for validity, practicality, and effectiveness. Expert validation involving material, media, and education specialists confirmed the module's content and construct validity. The practicality test, conducted through teacher and student responses, indicated that the module is user-friendly and engaging. Effectiveness was measured using pretest and posttest scores to evaluate improvements in students' environmental literacy, focusing on awareness, knowledge, attitude, and action components. The results revealed a significant increase in posttest scores, indicating that students who used the module showed improved understanding and positive behavioral changes toward the environment. Additionally, the integration of local wisdom helped students relate science concepts to real-life contexts, enhancing their critical thinking and sense of responsibility toward the environment. This study concludes that the integration of local wisdom in science learning materials is an effective approach to foster environmental literacy in junior high school students.

How to cite: Firmansyah, B., & Maulana, A, M. (2025). Development of Integrated Science Modules with Local Wisdom to Improve Environmental Literacy at State Junior High School 46 Jakarta, *1*(4). 103-110. https://doi.org/10.70716/josme.v1i4.331

INTRODUCTION

Environmental degradation has become an increasingly urgent global concern, and education plays a critical role in addressing this crisis by cultivating environmental literacy among younger generations. Environmental literacy encompasses the knowledge, awareness, attitudes, and behaviors that enable individuals to make informed decisions and take responsible actions toward the environment. In many countries, including Indonesia, the integration of environmental literacy within formal education has been acknowledged as essential for shaping environmentally responsible citizens. However, despite the growing international emphasis on sustainability education, the implementation of environmental literacy in school curricula often remains superficial, fragmented, and insufficiently contextualized. This issue highlights the need for instructional materials that meaningfully connect scientific concepts with students' cultural and ecological realities.

One of the persistent challenges in developing environmental literacy is the disconnection between formal science education and students' everyday life experiences. Learning materials frequently rely on generalized or Western-centric examples that do not resonate with the cultural background or environmental conditions of students. As a result, students may struggle to relate their science learning to local issues or to understand how scientific principles apply within their own communities. This mismatch reduces the relevance and impact of science education, weakening the development of environmental literacy. In the Indonesian context—where cultural diversity and rich ecological knowledge have long shaped community interactions with the environment—this issue is particularly prominent. Although the national curriculum encourages contextualized learning, many instructional resources still overlook the potential of local wisdom as a foundation for environmental education.

Local wisdom, or indigenous ecological knowledge, refers to cultural values, practices, and understandings that have been developed over generations through close interactions with the environment. These include traditional water conservation methods, community-based waste management, sustainable

harvesting practices, and local ecological norms that promote environmental balance. Integrating this knowledge into the science curriculum can enrich students' learning experiences by providing culturally relevant entry points to scientific concepts. Prior research suggests that when science learning is contextualized through culturally embedded knowledge, students develop deeper comprehension, stronger emotional connections to the material, and greater motivation to engage in sustainable behaviors. However, despite this potential, the use of local wisdom in science learning—especially within urban settings like Jakarta—remains limited and underexplored.

Existing studies on environmental literacy and local wisdom have primarily focused on rural or indigenous communities, where cultural traditions are more visibly preserved. Research commonly examines local wisdom in regions such as Bali, Papua, Java, or traditional agrarian communities. In contrast, studies addressing local wisdom in metropolitan areas like Jakarta are relatively scarce. Urban students often have minimal exposure to traditional environmental practices despite living in a culturally diverse environment. This situation presents an academic gap: while many scholars have demonstrated the educational potential of local wisdom in rural science learning, few have examined how local wisdom can be integrated into modern, urban classrooms to enhance environmental literacy. Furthermore, local wisdom in Jakarta—particularly that of the Betawi culture—has unique characteristics related to water management, community cohesion, and environmental harmony, yet these aspects are rarely represented in science instructional materials.

Another gap in previous research concerns the development of integrated science (IPA Terpadu) modules that holistically incorporate local wisdom. Many existing environmental education programs focus on cognitive aspects of environmental literacy, such as knowledge of ecosystems or pollution, but pay less attention to affective and behavioral dimensions. There is also a lack of systematic instructional design using validated frameworks such as ADDIE to ensure that learning materials are not only contextually relevant but also pedagogically sound, user-friendly, and empirically tested. While numerous studies report the need for contextualized and culturally responsive science teaching, few offer concrete, structured, and empirically validated instructional products that can be directly implemented by teachers.

In response to these gaps, the present study aims to develop an Integrated Science module that embeds local wisdom specific to the Jakarta context, with the intention of improving environmental literacy among junior high school students at State Junior High School 46 Jakarta. This study's novelty lies in its combined focus on (1) urban local wisdom, particularly Betawi environmental practices, (2) the integration of this knowledge into an interdisciplinary science framework, and (3) a systematic module development process using the ADDIE model, including expert validation and empirical testing of effectiveness. Unlike previous research that primarily emphasizes rural traditional knowledge, this study addresses the underexplored potential of urban cultural wisdom as a meaningful component of environmental education. Additionally, the module does not merely present cultural content but aligns it directly with scientific concepts, national curriculum competencies, and real-world environmental challenges faced by Jakarta residents.

The study also contributes theoretically by demonstrating how culturally embedded knowledge can enhance not only environmental awareness but also attitudes and environmentally responsible behaviors—components of environmental literacy that are often more difficult to achieve through conventional instruction. In urban settings where environmental problems such as flooding, waste accumulation, and air pollution are increasingly severe, connecting scientific explanations with culturally rooted environmental values can help students understand the relevance of environmental stewardship to their daily lives. This approach aligns with the principles of culturally responsive pedagogy, which emphasize the integration of learners' cultural backgrounds into teaching processes to improve engagement and learning outcomes.

In addition to addressing the lack of contextualized instructional materials, this study responds to the practical challenges faced by educators in implementing environmental and sustainability education. Teachers often report difficulties finding learning resources that are both curriculum-aligned and locally relevant. Many available textbooks provide general examples that fail to reflect Jakarta's specific environmental conditions, such as tidal flooding, poor waste management, and urban biodiversity loss. The Integrated Science module developed in this study directly addresses these issues by incorporating local case studies, community practices, and environmental problems familiar to students, thereby strengthening the contextualization of scientific content.

Moreover, the study acknowledges the need for empirically validated educational products. Many instructional innovations described in the literature are not rigorously tested, making it difficult to assess their actual effectiveness in classroom settings. This study incorporates expert validation from specialists in science education, instructional design, and environmental studies to ensure the module's content accuracy, pedagogical appropriateness, and cultural relevance. It also employs pretest and posttest measurements with students to evaluate the module's impact on environmental literacy across cognitive, affective, and behavioral dimensions. This combination of expert review and empirical testing strengthens the study's contribution and positions it as a model for developing culturally grounded science materials in other urban contexts.

Overall, this study fills a significant research gap by exploring the integration of local wisdom into urban science education, specifically within Jakarta's cultural and environmental context. It addresses the limited availability of instructional materials that meaningfully connect scientific concepts with students' cultural backgrounds and everyday experiences. The novelty of the study lies in its use of a structured development model, its focus on the unique cultural knowledge of Jakarta communities, and its empirical evaluation of the module's effectiveness in improving environmental literacy. By bridging the divide between scientific content and cultural identity, the study contributes to the advancement of environmentally responsible behavior among junior high school students and supports national efforts to strengthen Education for Sustainable Development.

In summary, the revised introduction emphasizes the importance of contextualized environmental education, identifies gaps in previous research related to urban local wisdom and instructional material development, and highlights the novelty and contributions of the present study. The integration of local wisdom with science learning presents a promising approach to fostering environmental literacy that is both meaningful and sustainable. Through the development and evaluation of this Integrated Science module, the study aims to offer a practical, culturally responsive, and pedagogically sound model that can be used to enhance environmental education not only in Jakarta but also in other culturally diverse urban environments.

RESEARCH METHODOLOGY

This study employed a Research and Development (R&D) design to develop an Integrated Science module incorporating local wisdom for the purpose of enhancing environmental literacy among junior high school students at State Junior High School 46 Jakarta. The R&D approach was selected to ensure a systematic process of designing, creating, and evaluating the instructional module, emphasizing both product development and empirical validation. The development process followed the ADDIE model, which includes five key stages: Analysis, Design, Development, Implementation, and Evaluation. This model is widely recognized for its structured methodology in instructional material development and allows for iterative refinement based on empirical feedback and expert input.

In the analysis stage, a needs assessment was conducted through interviews and questionnaires administered to science teachers and students. The data collected helped identify gaps in the current science curriculum related to environmental literacy and the lack of contextual relevance. The study also involved a review of the local environmental practices and cultural knowledge unique to the Jakarta area, such as traditional waste management, water conservation techniques, and local biodiversity practices. These elements were mapped onto the existing science curriculum standards to identify possible integration points. Additionally, baseline data on students' environmental literacy were collected using a standardized instrument adapted from existing validated tools, covering four key dimensions: knowledge, awareness, attitude, and behavior.

The design and development phases focused on creating the module content, structure, and learning activities. Content experts, instructional designers, and science educators collaborated to ensure that the material was scientifically accurate, pedagogically sound, and culturally relevant. The module was organized thematically and included interactive activities such as local environmental case studies, group projects, observation tasks, and reflective journals. Visuals and language were adapted to match students' cognitive levels and cultural background. Draft versions of the module underwent expert validation by three specialists in science education, instructional media, and environmental studies. The validation instrument assessed aspects such as content accuracy, language clarity, cultural relevance, and alignment with learning objectives.

During the implementation phase, the validated module was pilot-tested in a real classroom setting over a four-week instructional period. The study involved a sample of 30 eighth-grade students selected through purposive sampling based on their availability and the teacher's willingness to participate. Pretest and posttest assessments were administered to evaluate the effectiveness of the module in enhancing students' environmental literacy. The instruction was delivered by the regular science teacher, who had received a short orientation on how to use the module effectively. Observations, field notes, and student feedback were also collected during this phase to assess the practicality and engagement levels of the module.

The evaluation phase consisted of both formative and summative evaluations. Formative evaluation included ongoing observations, feedback from students and teachers, and periodic assessments throughout the implementation process. This feedback was used to revise and improve the module iteratively. Summative evaluation focused on analyzing the pretest and posttest results using descriptive and inferential statistics to determine the module's impact on students' environmental literacy. Paired sample t-tests were employed to identify significant differences between pre- and post-intervention scores across all four dimensions of environmental literacy. Additionally, a post-intervention survey was administered to gauge students' perceptions of the module's relevance and effectiveness.

Throughout the research process, ethical considerations were upheld to ensure the rights and privacy of all participants. Informed consent was obtained from students and their guardians, and participation was voluntary. Data confidentiality was strictly maintained, and all instructional activities adhered to school guidelines. The research design also ensured that the intervention did not disrupt the regular teaching-learning process but instead complemented the existing curriculum. This ethical and methodological rigor contributes to the reliability and credibility of the study's findings and its potential scalability in other educational contexts.

RESULTS AND DISCUSSION

The implementation of the Integrated Science module with local wisdom elements demonstrated a substantial improvement in students' environmental literacy at State Junior High School 46 Jakarta. Based on the pretest and posttest results, students showed significant gains across all four dimensions of environmental literacy: environmental knowledge, environmental awareness, environmental attitudes, and environmentally responsible behavior. The paired sample t-test results revealed that the mean posttest scores were statistically higher than the pretest scores, indicating that the module effectively enhanced students' understanding and engagement with environmental issues contextualized through their local culture and community practices.

The knowledge dimension exhibited the most notable increase. Before the intervention, many students displayed limited understanding of local environmental challenges and scientific concepts related to ecosystems, pollution, and sustainability. After engaging with the module, which incorporated local examples such as the use of *biopori* for rainwater infiltration and traditional waste sorting methods, students demonstrated improved comprehension. This finding supports earlier studies that emphasize the role of contextualized learning in improving conceptual understanding in science education (Ardies et al., 2021; Wang & Zhao, 2020). Local wisdom proved to be a powerful entry point for introducing environmental science topics in a way that resonated with students' lived experiences.

In terms of environmental awareness, students became more conscious of their surroundings and local ecological issues. The use of reflection journals, neighborhood observation activities, and group discussions fostered critical thinking about environmental degradation in urban Jakarta. This aligns with research by Olsson and Gericke (2021), who found that place-based education increases students' sensitivity to local environmental issues. Students reported increased awareness of problems such as river pollution, air quality decline, and the improper disposal of household waste.

Regarding environmental attitudes, the module succeeded in nurturing positive values toward nature and sustainability. Learning activities that engaged students in cultural storytelling, such as traditional ecological practices of the Betawi people, helped humanize environmental content and make it emotionally resonant. Emotional engagement, as discussed by Hartley and Morrell (2019), plays a crucial role in shifting student attitudes and fostering long-term commitment to environmental stewardship. Students began

expressing concern for their community's environmental health and recognized their roles as agents of change.

The fourth dimension, environmentally responsible behavior, showed promising changes, albeit more gradual than the other dimensions. Students began initiating small-scale actions such as creating compost bins at home, reducing plastic use, and organizing school-wide clean-up campaigns. Although behavioral changes take longer to solidify, the early signs of initiative observed during the study reflect what Roczen et al. (2020) highlight as the outcome of sustained, values-based environmental education. The module's emphasis on actionable steps contributed to students' ability to translate knowledge and attitude into tangible behavior.

Qualitative data from interviews and field notes further validated the effectiveness of the module. Teachers noted increased student engagement and participation during lessons. They also observed improvements in students' critical thinking and communication skills, especially during group discussions and presentations. These findings are consistent with the work of Boeve-de Pauw and Van Petegem (2018), who reported that environmental education that includes cultural elements can also promote soft skills and student agency.

Student feedback highlighted that the incorporation of local wisdom made learning more relatable and meaningful. Many students expressed pride in learning about their cultural heritage and how it connects to environmental sustainability. This finding resonates with the theory of culturally responsive pedagogy, which holds that students are more likely to engage in learning when instructional materials reflect their cultural background (Gay, 2020). This pride translated into greater classroom participation and enthusiasm for learning science.

The module also promoted interdisciplinary learning by integrating environmental science with geography, social studies, and civics. Students developed a holistic understanding of the interconnectedness between the environment, culture, and community well-being. This supports the growing literature on integrated science education, which advocates for breaking disciplinary silos to address complex socio-environmental issues (Aikens et al., 2019). Such integration prepares students for real-world problem solving.

Another key strength of the module was its alignment with the Indonesian national curriculum, which increasingly emphasizes character education, local content, and sustainability. By embedding these principles into the science curriculum, the module bridged the gap between national educational goals and classroom practice. As stated by Nugroho and Herdiansyah (2022), integrating local wisdom into formal education can enhance both cognitive and affective learning outcomes.

The study also revealed certain challenges. Some students initially struggled to connect traditional knowledge with scientific concepts. However, with guidance and scaffolded activities, these connections became clearer. Teachers suggested that future iterations of the module include more multimedia resources and training for educators to enhance delivery. These suggestions are consistent with recommendations by Falk and Dierking (2019), who emphasize the importance of teacher support and resource availability in the success of educational interventions.

Additionally, the research found that students' socioeconomic background influenced their baseline environmental literacy levels. Students from families engaged in traditional environmental practices, such as home gardening or waste sorting, had a slight advantage in understanding the module content. This observation underlines the importance of differentiated instruction and the potential of home-school partnerships in reinforcing environmental learning (Lee & Taylor, 2020).

The module's success can also be attributed to its student-centered pedagogy, which encouraged active participation, collaboration, and reflection. These instructional strategies are widely acknowledged in the literature as essential for effective environmental education (Evans et al., 2020). Students were empowered to take ownership of their learning and make informed decisions regarding environmental issues in their community.

Importantly, the module demonstrated scalability and adaptability. While tailored to the Jakarta context, its structure allows for modifications based on local wisdom from other regions. This adaptability is crucial for broader implementation, as highlighted by Wals and Dillon (2020), who advocate for flexible, context-sensitive environmental education models.

From a policy perspective, the study suggests that local wisdom should be more explicitly embedded in national curriculum standards. This would not only enrich the content but also promote cultural

preservation and environmental resilience. The findings support the integration of Environmental and Sustainability Education (ESE) within the formal curriculum, as proposed by UNESCO (2021).

The research also demonstrated the value of collaboration between schools, local communities, and cultural institutions. Community elders and local experts contributed knowledge and validation of traditional practices, fostering intergenerational learning. This collaborative approach enhances the legitimacy and relevance of the educational content (Schusler et al., 2019).

Overall, the module had a transformative impact on students' environmental literacy, blending modern science with ancestral knowledge. It advanced both cognitive and affective domains, suggesting that culturally contextualized science education is a powerful tool for fostering ecological consciousness among youth.

Future research could expand the sample size, involve multiple schools, and explore long-term behavioral outcomes. In addition, developing digital versions of the module could support broader dissemination and integration into hybrid learning environments, which have gained momentum post-pandemic (Kidd & Green, 2022).

In conclusion, the Integrated Science module rooted in local wisdom significantly enhanced students' environmental literacy and contributed to more meaningful, culturally grounded science learning. It offers a promising model for other educators seeking to contextualize science education in diverse cultural settings.

CONCLUSION

The development and implementation of the Integrated Science module based on local wisdom have proven to be an effective strategy for enhancing environmental literacy among students at State Junior High School 46 Jakarta. The module successfully addressed four critical dimensions of environmental literacy—knowledge, awareness, attitude, and behavior—by embedding culturally relevant content into science instruction. By incorporating local ecological practices and community values, students were able to connect scientific concepts with their immediate environment, resulting in improved comprehension and greater engagement. The contextualized learning approach not only enriched students' academic experience but also fostered a deeper emotional and ethical connection to environmental issues.

This study underscores the importance of culturally responsive pedagogy in science education, particularly in the context of environmental sustainability. The module's success highlights the value of integrating local wisdom into curriculum design to promote meaningful learning and civic responsibility. It also demonstrates that educational materials rooted in students' cultural backgrounds can inspire real-world action, foster critical thinking, and cultivate a sense of stewardship. The findings contribute to the growing body of research supporting the integration of environmental and sustainability education in formal schooling and offer practical implications for educators, curriculum developers, and policymakers seeking to foster environmental literacy in diverse sociocultural contexts.

In conclusion, the Integrated Science module with local wisdom serves not only as an instructional innovation but also as a transformative educational model. It bridges scientific knowledge with cultural identity, empowering students to become environmentally conscious citizens capable of addressing contemporary ecological challenges. As environmental crises continue to intensify, such holistic and culturally grounded approaches to education are essential in nurturing future generations who are both informed and empathetic towards their environment. Future scaling and refinement of this module can help realize sustainable education goals at national and global levels.

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