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Sustainable Development in Islamic Education: Embedding a Zero-Waste-Based Learning Program for Pre-Service Madrasah Teachers

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ABSTRACT

This study aims to formulate a learning program for the pre-service elementary madrasah teacher IAIN Ponorogo. This study is very important to be able to support sustainable development appropriate for environmental conservation. The program is supported with zero-waste aspect waste management materials which have been included in environment studying approach. Research and Development was used as a design of the study while this model belongs to eight instructional development phases, with or without modification in ADDIE Model. Observation was conducted to examine the implementation and process of the learning activities. Documentation was utilized to collect data from faculty and departmental administration, particularly regarding curriculum and its related components. Questionnaires were administered to students to gather feedback for product improvement during the trial phase. While to assess product effectiveness, data collection was carried out using test techniques. Results in a structured learning framework consisting of Course Learning Outcomes (CPMK), Semester Learning Plans (RPS), and Practical Guidelines. N-gain analysis demonstrates that the program is moderately effective in improving environmental knowledge and attitudes, but lowly effective in behavior changes as a recent activity. This implies that a systematic environmental learning approach is needed which needs to go beyond the boundaries of one course.

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INTRODUCTION

Sustainable development has become a top priority worldwide, and schools are key players in making it happen. A central part of this is promoting environmental literacy for giving people the knowledge, skills, and values to make smart, responsible decisions about environmental issues. As Lanie et al. noted, environmental literacy goes beyond just being aware of environmental problems. It's about having the ability to act in ways that help solve these issues. Educators, especially those teaching environmental subjects, have a strong influence on behaviors like waste management, with knowledge and concern driving students' attitudes and intentions toward environmentally friendly practices.[1] This is where educational systems particularly Islamic schools can really make a difference in promoting environmental literacy and advancing sustainability.

Islamic principles, such as moderation, stewardship (*khalifah*), and the prohibition of wastefulness, are closely aligned with contemporary sustainability goals like resource conservation, pollution control, and biodiversity preservation.[2] Humans, as khalifah (stewards) of the earth, are tasked with maintaining and preserving the environment.[3] The Quran and Hadith provide clear guidance on the importance of protecting nature as an act of obedience to Allah. Islamic schools, based on Islamic principles, advocate a balanced relationship between human development and environmental care. This all-encompassing approach blends traditional Islamic teachings with modern education techniques, aiming for a more sustainable future.[4] By weaving Islamic eco-ethics into their curriculum, these institutions teach not only the importance of protecting the environment but also the moral duty to conserve resources for future generations.[5]

In this context, environmental literacy isn't just about knowing facts; it's also about shaping attitudes, values, and behaviors - critical elements for fostering long-term sustainable practices.[6] Environmental literacy requires transcending discipline-based education to foster holistic understanding, critical thinking, and ethical awareness of environmental issues.[7] It advocates integrating interdisciplinary approaches in education to challenge the limitations of framework thinking and promote a deeper connection between learners and their environment. Students' autonomy and environmental awareness could be fostered by integrating environmental education as a hidden curriculum.[8] Implementing environmental

[1] Lanie Santos dan Cyren Grace Ramirez, "Effect of Environmental Knowledge and Awareness on Green Behavior: Testing Behavioral Intentions, Environmental Attitude, and Green Commitment as Mediators," *The Normal Lights* 16, no. 2 (2022): 1-32.

[2] Labeeb Bsoul dkk., "Islam's Perspective on Environmental Sustainability: A Conceptual Analysis," *Social Sciences* 11, no. 6 (2022): 228.

[3] Muhajirin Ansori Situmorang, "Islamic Perspective and the Public Awareness in Protecting of Environment," *International Journal of Education, Social Studies, and Management (IJESSM)* 4, no. 2 (2024): 768–778.

[4] Sahri Sahri dan Su'udin Aziz, "The Role of Islamic Education Teachers in Increasing Social Awareness and Environmental Awareness in the Young Generation," *Al-Wijdan: Journal of Islamic Education Studies* 8, no. 4 (2023): 490–502.

[5] Najma Mohamed, "Islamic Education, Eco-ethics and Community," *Studies in Philosophy and Education* 33 (2014): 315–328.

[6] John F. Disinger dan Charles E. Roth, "Environmental Education Research News," *Environmentalist* 12, no. 3 (1992): 165–168.

[7] Andrew Brennan, "Environmental Literacy and Educational Ideal," *Environmental Values* 3, no. 1 (1994): 3–16.

[8] Erni Dewi Riyanti, "The Earth Day Every Day Project: Environmental Education as Hidden

education through hidden curricula also an effective approach to instill sustainable values, promoting autonomy, and encourage proactive attitudes among students. Higher education institutions, particularly those aligned with Islamic values, have a vital role in preparing future generations to take on environmental challenges through informed, ethical, and sustainable actions. Integrating real-world environmental contexts can foster critical thinking and sustainability awareness among university students, making it a valuable pedagogical strategy for developing holistic, impactful learning experiences in higher education settings.[9]

Indonesia, with its serious environmental issues, underscores the need for stronger environmental literacy. Data from the Indonesian Central Statistics Agency (BPS) shows that many regions, especially Sumatra and Java, have low public awareness of environmental concerns.[10] Take waste management as an example: protests from residents in Ponorogo Regency have highlighted fears about water contamination from poor waste disposal. This issue points to the broader challenge of waste management and the need for better environmental literacy to tackle these problems. Solutions like Zero Waste are being suggested to reduce environmental risks,[11] but these strategies will only succeed if people understand the entire waste cycle, from generation to disposal.

In education, low environmental literacy among students is another challenge. Studies reveal that while students' environmental knowledge is generally moderate, their attitudes toward environmental issues tend to be more positive.[12] However, this good attitude doesn't always translate into responsible actions, especially in areas like waste management. From the research result, students demonstrate basic awareness and moderate sensitivity to environmental issues, there is a gap in higher-level skills and proactive behaviors.[13] Another study implied that developing environmental literacy among pre-service teachers not only equips them with the skills to teach environmental issues effectively but also positions them as role models for fostering sustainable practices within communities.[14]

At IAIN Ponorogo, initial observations show a similar gap between students' attitudes and their actual environmental practices. While students are generally supportive of waste management, they lack sufficient knowledge and engagement in sustainable waste practices. Closing this gap between what students know, how they feel, and how they act is crucial for preparing them to address environmental issues in their future careers.

This environmental literacy gap is likely to be due in part, at least this increased with the rare involvement of students extracurricular activities clusters and companies which

Curriculum in Language Learning," *Cendekia: Jurnal Kependidikan dan Kemasyarakatan* 15, no. 1 (2017): 1–20.

[9] Hasan Baharun, "Pengembangan Media Pembelajaran PAI Berbasis Lingkungan melalui Model Assure," *Cendekia: Jurnal Kependidikan dan Kemasyarakatan* 14, no. 2 (2016): 231–246.

[10] Badan Pusat Statistik, *Laporan Indeks Perilaku Ketidakpedulian Lingkungan Hidup Indonesia 2018* (Jakarta: Badan Pusat Statistik, 2018), 20.

[11] Muhammad Nizar dkk., "Manajemen Pengelolaan Sampah Kota Berdasarkan Konsep Zero Waste: Studi Literatur," *Jurnal Serambi Engineering* 1, no. 2 (2017): 93–102.

[12] Ratna Farwati dkk., "Potret Literasi Lingkungan Mahasiswa Calon Guru Kimia di Universitas Sriwijaya," *Journal of Science Education and Practice* 1, no. 1 (2017): 1–8.

[13] Ruqoyyah Nasution, "Analisis Tingkat Literasi Lingkungan Mahasiswa FKIP Universitas Mulawarman dengan Transformasi Skor NELA (National Environmental Literacy Assessment)," *Jurnal Ilmiah BioSmart (JIBS)* 7, no. 1 (2021): 38–51.

[14] Febrianawati Yusup, "Profil Literasi Lingkungan Mahasiswa Calon Guru IPA," *Quantum: Jurnal Inovasi Pendidikan Sains* 12, no. 1 (2021): 128.

when used as known help enhance critical skills, pro-environmental behaviors.[15] Furthermore, students participating in these activities become more confident and environmentally aware.[16] To address this gap, universities around the world, including in Indonesia, have started initiatives to improve environmental literacy among students. Activity-based and project-driven teaching methods should be implemented to enhance EL and foster practical engagement with environmental issues.[17] Emphasizing waste segregation, the use of eco-friendly products, and active participation in sustainability campaigns are critical to fostering environmentally conscious lifestyles among students.[18]

While programs like recycling and waste reduction are common, they often fail to produce lasting changes in behavior without a solid understanding of environmental issues. The absence of hands-on, experiential learning opportunities in university courses exacerbates this problem. Educational strategies that incorporate environmental stewardship content within the curriculum, such as the 'greening of outdoor curricula' and partnerships with relevant organizations like companies or NGOs, could significantly enhance students' environmental literacy.[19] Programs that connect classroom knowledge to practical experiences help students internalize environmental literacy and gain the skills needed to tackle real-world environmental challenges. Hands-on activities and challenge tests enhanced student's interest, motivation, and ability to think critically about contemporary agriculture and environmental issues in the region.[20] Such experiences not only enhance understanding but also prepare students for future roles in environmental stewardship and policy-making.[21] Thus, an approach that combines theoretical education with real-world campus projects could bridge the gap, connecting classroom knowledge to practical experiences and enabling students to internalize environmental literacy while gaining the skills needed to tackle real-world environmental challenges.

To meet these challenges, this study suggests creating an educational program focused on independent waste management to boost students' environmental literacy. The plan is to integrate environmental education into the Basic Biology Practicum course at IAIN Ponorogo using the Zero Waste model. This would help future teachers develop the knowledge and practical skills they need to manage waste effectively, both on campus and in their future careers. By combining theory with practice, the program would encourage hands-on learning that builds students' environmental literacy and prepares them to implement

[15] P Wesley Schultz dan Lynnette Zelezny, "Values as Predictors of Environmental Attitudes: Evidence for Consistency across 14 Countries," *Journal of environmental psychology* 19, no. 3 (1999): 255–265.

[16] Irida Tsevreni, "Towards an Environmental Education without Scientific Knowledge: An Attempt to Create an Action Model Based on Children's Experiences, Emotions and Perceptions about Their Environment," *Environmental Education Research* 17, no. 1 (2011): 53–67.

[17] Janaka Kuruppuarachchi, Palaniappan Hemadila, dan Buddhika Madurapperuma, "Comparison of the Literacy Level on Major Environmental Issues of the GCE (A/L) Students of Different Disciplines in Kandy District, Sri Lanka," *Sustainability* 15, no. 5 (2023): 3968.

[18] Eun-Hi Choi dkk., "Factors Affecting Zero-waste Behaviours of College Students," *International Journal of Environmental Research and Public Health* 19, no. 15 (2022): 9697.

[19] Isoken T Aighewi dan Ulamen A. Osaigbovo, "Students' Perspectives on Worldwide 'Greening' of Tertiary Education Curricula," *Research in Science Education* 40 (2010): 625–637.

[20] DD Poudel dkk., "Hands-on Activities and Challenge Tests in Agricultural and Environmental Education," *The Journal of Environmental Education* 36, no. 4 (2005): 10–22.

[21] Rosina Bierbaum dan Marissa Lazaroff, "From Theory to Practice: The Student Experience Evaluating Development Projects Focused on Nature-Based Solutions," *Sustainability* 14, no. 9 (2022): 5722.

sustainable practices in their communities.[22]

The study has two goals: 1) to develop a waste management program for the Basic Biology Practicum course, based on the Zero Waste model, for prospective Madrasah Ibtidaiyah teachers; and 2) to assess how effective this program is at boosting students' environmental literacy using statistical analysis. The expected result is to create a model that other institutions, especially Islamic ones, can use to develop similar programs that promote environmental literacy and sustainability. If successful, this program could serve as a foundation for broader initiatives focused on building environmental responsibility and sustainability within the academic world and beyond.

RESEARCH METHOD

This study used the research and Development (R&D) approach to design, develop, and evaluate a learning program aimed at integrating environmental education with zero-waste management strategies in the Basic Biology Practicum course at FTIK PGMI IAIN Ponorogo. The goal was to create an innovative educational program that meets the needs of students and enhances their environmental literacy, particularly about sustainable waste management. The development followed the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation) ensuring a structured approach to planning, creating, and refining the program. This model helped organize all course elements, including curriculum, lesson plans, laboratory activities, and assessment tools. By following this process, the program adhered to best practices in instructional design and allowed for continuous improvement throughout its creation. The course was specifically designed to incorporate hands-on zero-waste strategies, aiming to increase students' environmental awareness through practical learning experiences.

To assess the program's effectiveness, a one-group pretest – post test design was used. This method compares students' environmental literacy before and after the intervention.[23] Thirty-three PGMI students, primarily female and aged 19 to 23, participated in the study. The pretest measured their initial environmental literacy, and the post test measured any improvements after completing the course. By comparing the results, the study aimed to gauge the impact of the program on students' knowledge and behaviors related to zero-waste practices.

Data were collected using both qualitative and quantitative methods. Observations tracked students' engagement with the course materials and their involvement in zero-waste activities. Semi-structured interviews with students and instructors provided deeper insights into the program's effectiveness, challenges, and areas for improvement. These interviews were crucial for refining the program and better understanding students' experiences with environmental literacy.

The program's validity was ensured through a multi-stage validation process. First, the Course Learning Outcomes (CPL), Course Learning Objectives (CPMK), syllabus (RPS), and practical guide were reviewed by two experts—one in curriculum development and the

[22] Teresa Monte and Pedro Reis, "Design of a Pedagogical Model of Education for Environmental Citizenship in Primary Education," *Sustainability* 13, no. 11 (2021): 6000.

[23] Endang Mulyatiningsih, *Riset Terapan Bidang Pendidikan dan Teknik* (Yogyakarta: UNY Press, 2011), 34.

other in media development. Their feedback was used to refine the course materials, ensuring they met academic standards and were easy to use. The validation process was iterative, with revisions made after each round of feedback.

For data analysis, both qualitative and quantitative techniques were used. Qualitative analysis focused on expert feedback and observational data to refine the course design and ensure alignment with zero-waste goals. Quantitative analysis used N-Gain scores to measure changes in environmental literacy, comparing pretest and post test results. These scores were categorized into three levels: low, medium, and high - indicating the effectiveness of the program in improving students' environmental knowledge and behaviors.

RESULT AND DISCUSSION

Program Development

The development of an educational program aimed at enhancing environmental literacy, particularly in the context of waste management, was undertaken to integrate zero-waste management principles into the Basic Biology Practicum Course at PGMI FTIK IAIN Ponorogo. This endeavor was designed to address the pressing need for environmental education among students, especially considering the increasing environmental challenges faced by communities, such as those seen at the Mrican Landfill in Ponorogo. The program aimed to develope a comprehensive framework that included a curriculum structure (CPMK/*Capaian Pembelajaran Mata kuliah* and Course Descriptions), and educational instruments (RPS/Lesson plan, Laboratorium Guidelines, and Assessment).

This research developed a Basic Biology Practicum program based on environmental education, integrating zero-waste methods into learning activities. The development steps used the ADDIE model, which includes the phases of analysis, design, development, implementation, and evaluation. The analysis phase involved an in-depth study of the teaching and learning process, graduate profiles, and learning tools. This was carried out through collaboration with course instructors and the PGMI department team. The design phase included the creation of the program framework and learning tools such as the Semester Learning Plan/lesson plan (RPS), practicum guidelines, and assessment sheets/instrument. The main focus was on practicum activities involving zero waste management through anaerobic composting, biopores, and the use of BSF (Black Soldier Fly) maggots.

The curriculum was developed with a clear focus on the cognitive, affective, and behavioral domains of environmental literacy. The design process began with the formulation of specific learning outcomes (CPMK) that aligned with the broader course learning outcomes (CPL) relevant to environmental action. The curriculum was enriched with content that emphasized the importance of zero-waste principles and waste management processes, ensuring that students gained not only theoretical knowledge but also practical skills applicable to real-life scenarios. To achieve this, the curriculum framework was revised to include a detailed description of the course that clarified the learning outcomes related to environmental action. The RPS was significantly modified by removing activities related to Borax testing and replacing them with activities focused on waste management, such as composting with anaerobic composters, biopores, and

assistance-based composting. These changes were made to better align the curriculum with the zero-waste philosophy.

The practical guide for the Basic Biology Practicum was developed in line with the revised RPS. The guide provided step-by-step instructions for conducting waste management practices, encouraging students to engage in activities like waste audits and composting both on campus and at home. The guide was designed to be user-friendly, with clear language and visuals to ensure accessibility for all students. The assessment instruments for the course were also developed with a dual focus on the execution and reporting of practical activities. These instruments were designed to evaluate students' performance in carrying out ~~the~~ practical activities as well as their ability to document and report their findings accurately.

The product validation process was carried out in several stages, involving both experts and field testing. The initial draft of the curriculum and learning tools was reviewed by experts in curriculum development and educational media. Feedback from these experts was used to make the first round of revisions, ensuring that the product met the required educational standards. Results of Expert Assesement in Table 1.

Table 1. Results of Science Expert Assessment of Learning Tools (Lesson Plan, Basic Biology Practicum Guide, and Practicum Assessment Instrument)

Learning Instrument	Aspect	Indicator	Assessment Criteria
Lesson Plan	Format	Compliance with applicable regulations	Very Good
		Clarity and ease of understanding	Good
	Content	Clearly defines the final competencies	Good
		Clear and measurable learning indicators	Good
		Study materials are aligned with indicators and up-to-date	Good
		Clarity and ease of understanding teaching approach/method/model/strategy	Good
		Relevance of learning resources/media to study materials	Good
		Alignment of time with credit hours (SKS)	Good
		Relevance of learning experiences with study materials and final competencies	
	Language and Writing	Clarity and ease of understanding	Fair
		Communicative	Good
Practicum Guide	Format	Compliance with guidelines	Very Good
		Clarity and ease of understanding	Good
	Content	Explains practicum title	Very Good
		Explains practicum objectives	Very Good
		Explains theoretical basis for practicum	Good
		Explains tools and materials for practicum	Fair
		Explains practicum procedures	Fair
		Explains practicum observation methods	Fair
		Provides questions and discussion points	Good
	Language	Kejelasan dan kemudahan dipahami	Fair
		Komunikatif	Fair
Practicum Assessment Instrument	Presentation	Compliance with guidelines	Good
		Clarity and ease of understanding	Good
	Content	Describes practicum execution components	Very Good
		Describes assessment components for practicum report	Very Good
	Language	Clarity and ease of understanding	Good
		Communicative	Good

The learning program, validated by PGMI curriculum experts, underwent revisions by the researcher before the trial. Then, the trial of the Practicum Guide was conducted as part of a learning program with students, who were then asked to provide feedback for its improvement. Trial results focused on the implementation of the learning program and students' environmental literacy. During the trial, the implementation of the developed product (Lesson Plan, Practicum Guide, practicum Assessment Instrument), was evaluated by observing how the practicum guide facilitated the learning process and the students' observations and feedback. The trial resulted in: 1) the practicum guide is highly suitable for promoting student creativity, specifically in waste management through composting; 2) the guide is generally suitable in terms of ease of use, encouraging interest and enjoyment among students, its reusability, and as a resource for acquiring information; 3) regarding time suitability, the guide was rated fairly adequate, suggesting it could better support the practicum process. As for language, image usage, and structure, these received a "fairly adequate" rating across all indicators. From student observation, suggested the following improvements: 1) use simpler language; 2) provide clearer, more detailed instructions for composting and biopore procedures; 3) divide the content by sub-practical; 4) add more images to illustrate composting steps; 5) correct typos; 6) clarify the tools and materials for the biopore practicum; 7) improve the clarity of the observation results table; and 8) include an explanation of the benefits of compost in the introduction.

Research has supported the effectiveness of environmental education and literacy including works by Farwati et al.[24] It is also in line with the research by Ha and Dong, shows that outdoor activities and volunteer participation correlate positively with higher ecological literacy levels, suggesting that hands-on experiences are crucial for developing environmental awareness.[25] The curriculum sought to give a holistic appreciation of environmental challenges, especially on waste. It took a cognitive approach to environmental literacy, focusing on waste management processes and the principle of zero-waste as well as information about what happens with our wastes (cognitive domain). This research also incorporated affective features to create green attitudes and behavioral characteristics in our students that can be applied directly to the practical levels of handling waste at home. Ecological curriculum is crucial for addressing environmental crises.[26]

Creating hands-on guides was a vital part of the program because it took us through a step-by-step process in the principles of zero waste management which helped students have field experience. They provided guides for students to try out waste-reduction, recycling, and composting activities both individually and in groups. Other activities of the course were aimed to take place both within the university and more specifically students' homes or communities and spaces, motivating them for reflections on "what they learn in theory" and in real contexts. An example is a primary activity that required students to perform waste audits, analyzing the various types and amounts of trash produced according to different scenarios, in addition to making suggestions for waste reduction. The practical activities not

[24] Farwati dkk., "Potret Literasi Lingkungan Mahasiswa Calon Guru Kimia Di Universitas Sriwijaya."

[25] Changchen Ha dkk., "The Effectiveness of Lifestyle Interventions on Ecological Literacy: A Contribution to the Underlying Mechanism in Linguistic Ecology," *PLoS One* 18, no. 6 (2023): 287286.

[26] Audrey M Dentith, Peaches E Hash, dan Courtney P Baines, *The Ecological Curriculum: Ecoliteracy, Ecojustice, Ecopedagogy and Sustainability Education* (London: Taylor & Francis Group, 2022), 16.

only highlighted the theoretical lessons delivered in class but also encouraged and empowered students to create an impact on environmental issues.

Using the iterative nature of the ADDIE model, continuous feedback from students and instructors were used to inform each phase of program development. This enabled the development of learning resources and standards, making them responsive to the students' requirements within this program. The aim was to develop an all-encompassing learning program that would be a lot more contextual, making education far-reaching enough for students interested in the new and efficient knowledge and motivation oriented toward waste management practices.

This has implications for teaching students by offering hands-on experiential learning, instead of mere book knowledge; unless this information is applied it means nothing. Unlike any traditional teaching methods, the practical aspects of learning through conducting a waste audit and compost making in this program played an essential role for students to relate zero-waste management with their personal lives. In line with the research conducted by Hekmah et al., which offers integrated science worksheets using a web environment.[27] Laboratory activities provide students with the flexibility to connect learning to real-world contexts, although they may face challenges such as unexpected results.[28]

Effectiveness of the Program

To determine the effectiveness of the developed instructional program on students' environmental literacy, a one-group pretest-posttest design was employed. By comparing the pretest and post test scores of the students' environmental literacy, the following conclusions were drawn. To assess the program's effectiveness, the N-gain analysis was performed. The N-gain formula was used to assess the students learning gains from pretests and posttest s quantitatively. The intervention effectiveness levels were defined with respect to two cut-points that separated the N-gain in three categories: low (N-gain < 0.3), medium (0.3 ≤ N-gain ≥ 0,7) and high identity-values of about or greater than. The N-gain calculation for the environmental knowledge aspect yielded an average N-Gain score of 0.35, or 34.98%. Based on the N-gain criteria, an N-gain value of 0.35 is classified as moderate. Thus, it can be concluded that the implementation of the developed instructional program had a moderate effectiveness in improving students' environmental literacy in terms of knowledge. For the attitude toward the environment aspect, there was also an increase in the students' environmental literacy scores. The N-Gain calculation for this aspect resulted in an average N-Gain score of 0.55, or 55.34%. According to the N-Gain criteria, this value falls into the moderate category. For the behavior toward the environment aspect, the students' literacy scores showed a smaller increase. The N-Gain calculation for this aspect resulted in an average N-Gain score of 0.12, or 11.92%. Based on the N-Gain criteria, this value is categorized as low. Table 2 shows that result.

[27] Nurul Hekmah, Insih Wilujeng, dan I Suryadarma, "Web-Lembar Kerja Siswa IPA Terintegrasi Lingkungan untuk Meningkatkan Literasi Lingkungan Siswa," *Jurnal Inovasi Pendidikan IPA* 5, no. 2 (2019): 129–138.

[28] Dan Ye, Svoboda Pennisi, dan Leynar Leyton Naranjo, "Incorporating Hands-on Experiments into an Online Science Course," *Journal of Computer Assisted Learning*, (2024): 1400-1412.

Tabel 2. N-Gain in Students' Environmental Literacy

Environmental Literacy Aspect	Average Pretest Score	Average Posttest Score	Ideal Score	N-Gain	N-Gain (%)
Knowledge	7,62	9,67	13	0,35	34,98
Attitude	57,92	69,77	80	0,55	55,34
Behavior	57,92	69,77	80	0,55	55,34

Lessons learned are imperative for improvement and application, as they highlight pivotal determinants of behavior change among youth; the result indicates that efforts to build knowledge & influence attitudes were successful in affecting student's intentions but not yet are entirely reflected in behaviors. These results are consistent with other reported studies, such as Yusup who showed that environmental literacy programs could improve knowledge and attitudes effectively but behaviors remain a more difficult practice to achieve over time.[29]

Results showed that the idea of structured educational interventions can effectively improve students' knowledge and attitude about environmental issues as seen in moderate N-gain scores achieved for this domain. This is consistent with the results obtained the research which similarly found that educational programs were able to enhance students' environmental literacy.[30] Nevertheless, the low N-gain in behaviors noted from this study further demonstrates how difficult it is to translate knowledge and attitudes into steady long-term behavioral change.

Hands-on activities like waste audits and compost exercises were extremely impactful according to many students in converting theoretical knowledge into something more concrete. The activities strengthened their understanding and they were also happy that something concrete could be done for them/with them at the community. A few of the students mentioned difficulties in attempting to zero-waste their lives, specifically calling out infrastructure, norms and habits that get developed over time. These results indicate that although the program was successful in informing and fostering positive attitudes, extra assistance as well as esources may be required to bring about enduring modification at all experience levels.

A significant finding of the current study is that environmental attitudes have a direct effect on students' behavior. The mean N-gain of attitudinal scores indicated that as a program, it was above average in comparison to existing studies related specifically to the environmental issue behavior programs to promote goal behaviors. However, the discrepancy between attitudes and behaviors in this study indicates that we will first need additional programs interrupting structural conditions impeding behavior change (eval) with initiatives such as improvements to recycling and composting facilities on campuses, it may be possible to overcome this barrier by creating a more conducive social environment that encourages the development of zero-waste habits over time.

The role of the zero-waste concept in Islamic education is immense. Islamic universities can incorporate sustainability concepts into their educational programs,

[29] Yusup, "Profil Literasi Lingkungan Mahasiswa Calon Guru IPA."

[30] Febrianawati Yusup, Istiqamah Istiqamah, dan Khairunnisa Khairunnisa, "Learning Methods on Environmental Education to Improve Pre-Service Teachers Environmental Literacy," *Journal Of Biology Education Research (JBER)* 2, no. 2 (2021): 50–55.

emphasizing the importance of environmental care as part of religious teachings.[31] As environmental issues, especially those with regard to waste management become more formidable; educational institutions have a responsibility to play in fostering sustainable development among students. A study also stated that student' attitudes towards food waste and environmental concerns can be influenced by their religiosity and pro-social behaviors, highlighting the potential for Islamic teachings to shape sustainable practices.[32] We argue that embedding these principles in the curriculum can increase environmental sustainability awareness and promote positive attitudes. But it also underscores the need for ongoing interventions to promote behavior change within an educational environment and beyond.

The results of this study recommend that educational programs on zero waste should be integrated into the curriculum at all levels based on policy. Incorporating environmental literacy throughout the main scope of education would mean preparing students to do more than simply learn some facts and get motivated, they will gain at least the knowledge necessary for sustainability as well develop skills or behaviors involved in who has an impact on the training program. This is in accordance with the national and international movement towards environmental education for sustainable development, which Indonesia has made it explicit through its Waste Management Law of 2008 as well as National Waste Management Strategy 2017 underlining that the provision of information and education is paramount to achieve waste reduction targets.[33]

Overall, this study has important implications for the implementation and efficacy of a developed learning program targeting environmental literacy and zero-waste management. Our results confirm the need to incorporate hands-on experiences in environmental education and make concerted efforts for long-term support of behavior change. Although the program had positive effects on aspects linked to environmental sustainability, more research needs to be done on how these changes can transition into sustainable behaviors and transform lives. In the future, schools should consider multiple novel directions for environmental literacy that can both educate students and encourage them to become drivers of cultural change in their own communities.

CONCLUSION

Designing the program of education through the framework of the Basic Biology Practicum Course at PGMI FTIK IAIN Ponorogo addressed to zero waste, and it was a promising result. The program easily integrated the environmental literacy into its normal course, using zero waste principles of management in an orderly framework with revised learning objectives, practical guides, and assessment tools. The effectiveness of the program is derived from the moderate N-gain in knowledge and attitudes, indicating significant growth in students' knowledge and attitude regarding matters of the environment. However,

[31] Masturin Masturin, Mhd Rasid Ritonga, dan Siti Amaroh, "Tawhid-based Green Learning in Islamic Higher Education: An Insan Kamil Character Building," *Qijis (Qudus International Journal of Islamic Studies)* 10, no. 1 (2022): 215–252.

[32] Asyari Asyari dkk., "Food Waste Behavioral Intention in Islamic Universities: The Role of Religiosity and Pro-Social Behavior," *International Journal of Ethics and Systems*, (2024): 5.

[33] Eka Jatnika Sundana, "Zero Waste Management Index–Sebuah Tinjauan," *Creative Research Journal* 5, no. 02 (2019): 55–62.

the lower N-gain of behavioral changes also indicates the difficulty in transforming educational gain into practice gain and then sustaining it. This study makes major contributions to the field of environmental education by providing a model to embed zero-waste principles in school programs. This indicates that the practical experiences, including waste audits and composting exercises, are paramount in translating theoretical knowledge into practical skills. The need for continued support as well as infrastructure improvement cannot be overemphasized.

The findings of this study represent a milestone towards a campus-wide zero-waste management system at IAIN Ponorogo and contribute to the real estate Sustainable Development Goals. By embedding the principles within the curriculum, it would enhance students' environmental literacy and put the university on a base from which it could lead in sustainable waste management practices. In this sense, this is a first but very crucial step toward the creation of a more sustainable and ecologically friendly campus that could help reach greater environmental sustainability and community impact. Consequently, it also could prevent long-term changes that otherwise would take place and could be measured later on. Furthermore, the research was done in one specific cultural-educational context and therefore might not reflect another region. Very important are longitudinal studies on the impact that behavior change can have due to programs in zero waste, and recommendations for future research can be done to investigate possible solutions to barriers towards desirable practices. The research could have an even better impact if there were academic settings in other countries or universities.

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