Fostering Environmental Ethics: The Role of Integrated Digital and Eco-Literacy in Islamic Education

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Abstract

The accelerating advancement of digital technology and artificial intelligence in the Fourth Industrial Revolution demands Islamic Education (PAI) to develop students' digital competence and critical engagement. Simultaneously, worsening environmental degradation highlights the urgent need for educational models that integrate Islamic theological values with eco-literacy to foster ethical and sustainable behavior. This study examines the effectiveness of integrating digital literacy and eco-literacy into the Islamic Education (PAI) curriculum to transform the values of *tawḥīd* into students' environmental ethics in Madrasah Aliyah across Tegal Regency. The study is grounded in the context of global environmental crises and the dynamics of the Fourth Industrial Revolution, which require Islamic education to produce a generation that is not only faithful but also environmentally responsible and digitally adaptive. The purpose of this research is to measure the effectiveness of the integration model in enhancing students' understanding of *tawḥīd*, environmental attitudes, and environmentally ethical behavior, as well as to assess the role of artificial intelligence (AI) technology in the learning process. A quasi-experimental method using a pretest–posttest control group design was employed with 240 students assigned to experimental and control groups. Instruments included a *tawḥīd* comprehension test, an environmental attitude scale, behavioral observations, and a digital literacy assessment. The findings reveal significant improvements in all three variables in the experimental group compared to the control group, with *tawḥīd* comprehension serving as a partial mediator between digital literacy and environmental behavior. AI-based tools enhanced student engagement and personalized learning, effectively supporting the internalization of Islamic values. These results reinforce the theoretical framework of integrating digital literacy and eco-literacy as an innovative educational approach in Islamic Education and highlight its potential as a pedagogical strategy responsive to technological advancements and contemporary environmental challenges.

INTRODUCTION

The era of the Fourth Industrial Revolution has brought fundamental shifts across various sectors, including Islamic Religious Education (PAI). Advances in digital technology and artificial intelligence (AI) present both significant opportunities and complex challenges for PAI learning. On the one hand, technological progress offers broad access to information and a wide range of innovative learning methods capable of engaging learners more interactively and adaptively (Henriksen et al., 2024). On the other hand, the increasingly urgent global environmental crisis compels educational institutions to move beyond strengthening spirituality alone, toward incorporating ecological awareness as an integral component of religious education (Juanda et al., 2024).

In Islamic thought, the concept of *khalīfah* underlines the role of humans as stewards of the earth who bear moral responsibility to sustain the balance and harmony of the natural world (Albar et al., 2024). Although *tawḥīd* serves as the theological foundation for sustainable environmental stewardship, empirical realities show a significant gap between theoretical understanding and actual practice, particularly among Madrasah Aliyah (MA) students who are in a transitional stage of

cognitive and moral development (Rohmatulloh et al., 2023). This gap indicates the need for an enhanced educational approach that not only conveys religious concepts academically but also promotes the transformation of eco-ethical behavior in real contexts.

The geographical context of Tegal Regency, one of the highly industrialized areas in Central Java, presents complex environmental challenges (Dinas Lingkungan Hidup, 2025). Data from the Tegal Environmental Agency indicate worrying declines in environmental quality, highlighting the urgency for a comprehensive and holistic educational approach. Religious education thus holds a strategic position in integrating ecological consciousness as part of the mitigation and adaptation efforts to environmental issues in this region.

Existing literature suggests that integrating digital literacy into PAI involves developing students' critical abilities to access, evaluate, and utilize religious information through digital media. Juanda emphasizes the need to compare human understanding with AI capabilities to create learning processes that are optimal and relevant in the digital era (Juanda et al., 2024). Further, Shahidi Hamedani develops the concept of Education 5.0 within the framework of Society 5.0, integrating AI as a more adaptive and personalized learning instrument (Shahidi Hamedani et al., 2024). In the PAI context, this implies the use of AI not merely as a supportive tool, but as a mediator that deepens the understanding of Islamic values and their application in contemporary life.

From an Islamic eco-literacy perspective, Taisir proposes a framework that integrates environmental sustainability into the PAI curriculum by emphasizing the development of learning objectives, media, and activities rooted in Islamic values (Taisir et al., 2024). This approach aligns with the concept of *khalīfah*, which emphasizes stewardship and ecological responsibility. Albar also introduces ecological *pesantren* models that incorporate organic farming, waste management, and conservation practices as part of the internalization of environmental ethics in Islamic educational settings (Albar et al., 2024).

The transformation of *tawḥīd* values into environmental ethics has also been explored by Mohidem and Hashim, who merge environmental and health perspectives within an Islamic framework (Mohidem & Hashim, 2023). Interpretations of Qur'anic verses and hadith on human responsibility as *khalīfah* and principles of cleanliness offer theological legitimacy for embedding environmental education within the PAI curriculum. A concrete example is Rohmatulloh's "Energy-Saving Triangle" concept, which internalizes *tawḥīd* values in energy-saving behaviors, demonstrating how religious principles can be manifested in environmentally responsible actions (Rohmatulloh et al., 2023).

The role of AI in PAI is increasingly prominent, with Allen and Kendeou (2023) developing the ED-AI Lit framework that highlights the importance of AI literacy—from understanding AI mechanisms to applying AI tools and recognizing the ethical implications of their use (Allen & Kendeou, 2024). Nawi et al. further discuss the opportunities and risks associated with AI development from an Islamic ethical standpoint, affirming that AI guided by Islamic ethics has substantial potential to strengthen religious education (Nawi et al., 2023).

Although previous studies have examined digital literacy and eco-literacy independently, there remains a lack of comprehensive and empirical research on the integration of both literacies within the PAI curriculum, especially in the context of transforming *tawḥīd* values into environmental ethics among MA students with the support of AI technologies. Husamah's study on environmental literacy in *pesantren* using the MSELS/I instrument provides valuable insights, yet it does not link environmental literacy with digital literacy or AI (Husamah et al., 2020). This study aims to bridge these gaps by developing a comprehensive integration model and measuring its effectiveness quantitatively. This study offers several innovative contributions to the field of Islamic Education. Unlike previous research that examines digital literacy and eco-literacy separately, this study develops and empirically tests an integrated instructional model that positions both literacies as complementary pathways for transforming *tawḥīd* values into environmental ethics. The incorporation of AI-based adaptive learning technologies represents another pedagogical

innovation, enabling personalized value internalization and bridging theological understanding with real ecological challenges. Methodologically, the study advances current scholarship by demonstrating, through quasi-experimental analysis, that *tawḥīd* comprehension partially mediates the relationship between digital literacy and pro-environmental behavior—revealing a previously unexplored psychological mechanism. Furthermore, grounding the model within the socio-ecological context of Tegal Regency provides a context-responsive framework that may be adapted by Islamic educational institutions facing similar environmental and technological complexities.

Based on this background and literature review, this research aims to analyze the effectiveness of integrating digital literacy and eco-literacy into the PAI curriculum in enhancing MA students' understanding of *tawḥīd*, to examine its impact on changes in environmental attitudes and ethical behavior, to evaluate the role of AI as a learning medium that strengthens the integration process, and to develop an adaptive and relevant implementation model for MA schools in Tegal Regency. This approach is expected to contribute meaningfully to the development of Islamic education that is responsive to ecological and technological challenges in the 21st century.

METHODS

This study employed a quantitative approach using a quasi-experimental pretest–posttest control group design to measure the effectiveness of integrating digital literacy and eco-literacy into the Islamic Education (PAI) curriculum in Madrasah Aliyah (MA) across Tegal Regency (Rully Indrawan, 2017). This design was chosen to compare changes in *tawḥīd* value comprehension as well as environmental attitudes and ethical behavior between the experimental group receiving the integration model intervention and the control group receiving conventional instruction.

The study population included all MA students in Tegal Regency, Central Java, totaling approximately 5,200 students across 18 schools (Ministry of Religious Affairs, Tegal Regency, 2024). The sample was selected using a cluster random sampling technique with MA schools as the sampling units. Based on Cochran's formula with a 95% confidence level and a 5% margin of error, a minimum sample of 240 students was required. These students were then divided into two groups: 120 students in the experimental group from three MA schools and 120 students in the control group from three other MA schools.

Inclusion criteria consisted of Grade XI MA students in Tegal Regency who had attended PAI classes for at least one year, had access to digital devices (smartphones, tablets, or laptops), and obtained parental or guardian consent to participate. Students were excluded if they had cognitive limitations, were absent for more than 20% of the intervention period, or transferred to another school during the study.

The independent variable was the integration of digital literacy and eco-literacy into the PAI curriculum supported by AI technology. This intervention included the use of integrated PAI learning modules, AI-based digital learning platforms, eco-literacy practical activities, and assessments implemented digitally and conventionally.

The dependent variables consisted of *tawḥīd* value comprehension, environmental attitudes, and environmental ethical behavior. *Tawḥīd* comprehension was measured using the *Tawḥīd* Values Comprehension Test (TVCT), which consisted of multiple-choice and essay items with high reliability. Environmental attitudes were measured using the Islamic version of the Environmental Attitude Scale (EAS-IV), while environmental behavior was assessed through observations and self-reports using the Environmental Behavior Assessment (EBA). Control variables included age, gender, socioeconomic background, prior academic performance, and access to technology at home.

All research instruments used in this study were standardized and demonstrated adequate reliability, including the TVCT, EAS-IV, EBA, and Digital Literacy Assessment (DLA). The research procedure began with a two-week preparation phase involving obtaining permission from the Ministry of Religious Affairs in Tegal Regency, providing orientation sessions for school principals and PAI teachers, training teachers to implement the integration model, and preparing the AI-based digital learning platform. A one-week pretest was then administered to both groups to

assess baseline conditions. The 12-week intervention was implemented in the experimental group through integrated PAI instruction combining digital literacy, eco-literacy, AI-supported learning, environmental practice activities, and reflective discussions. The control group received conventional PAI instruction without AI and without literacy integration. A posttest was administered one week after the intervention to measure changes, and a follow-up test four weeks later assessed retention and sustainability of improvements.

Data analysis included descriptive statistics to describe respondent characteristics and variables, tests of normality and homogeneity of variance (J. Supranto, 2016), and hypothesis testing using Analysis of Covariance (ANCOVA) with pretest scores as covariates to control for baseline differences. Effect sizes were calculated using Cohen's d, and robustness tests were conducted using Yuen's test when normality assumptions were violated (Erceg-Hurn & Mirosevich, 2008). Additional analyses, including correlation, regression, and mediation testing, were performed to explore relationships among digital literacy, *tawḥīd* comprehension, and environmental behavior.

RESULTS AND DISCUSSION
Mediation and AI-Supported Learning Outcomes

This study involved 240 Madrasah Aliyah (MA) students in Tegal Regency, evenly distributed between the experimental group (n = 120) and the control group (n = 120). The demographic characteristics of both groups demonstrated substantial equivalence at baseline, as presented in Table 1. Detailed analysis of demographic variables confirmed that age, gender, socioeconomic background, and access to technological devices such as smartphones, laptops/PCs, and stable internet connections did not differ significantly between groups. These findings establish that both groups were comparable prior to the intervention.

Table 1. Demographic Characteristics of Respondents

Characteristic	Experimental Group (n = 120)	Control Group (n = 120)	p-value
Age (years)	16.5 ± 0.9	16.4 ± 0.8	0.358
Gender			0.612
— Male	60 (50.0%)	58 (48.3%)	
— Female	60 (50.0%)	62 (51.7%)	
Socioeconomic Status			0.689
— Low	32 (26.7%)	35 (29.2%)	
— Middle	57 (47.5%)	59 (49.2%)	
— High	31 (25.8%)	26 (21.7%)	
Technology Access			
— Smartphone	119 (99.2%)	117 (97.5%)	0.423
— Laptop/PC	46 (38.3%)	44 (36.7%)	0.741
— Stable Internet	90 (75.0%)	88 (73.3%)	0.766

Baseline analysis using independent samples t-tests indicated no significant differences between the experimental and control groups across all dependent variables, including *tawḥīd* value comprehension, environmental attitudes, environmental ethical behavior, and digital literacy (p > 0.05). This confirms that both groups started from comparable positions before the intervention was implemented (Table 2).

Table 2. Baseline Comparison of Scores Between Groups

Variable	Experimental Group (M ± SD)	Control Group (M ± SD)	t	df	p-value
Tawḥīd Comprehension	68.7 ± 11.5	68.2 ± 12.1	0.291	238	0.772
Environmental Attitudes	80.1 ± 14.3	79.5 ± 13.9	0.353	238	0.724
Environmental Behavior	55.3 ± 17.9	54.8 ± 18.2	0.209	238	0.834
Digital Literacy	70.8 ± 15.5	69.9 ± 16.0	0.393	238	0.695

ANCOVA results for *tawḥīd* value comprehension revealed a highly significant difference between the experimental and control groups following the intervention ($F(1,237) = 48.21$, $p < 0.001$, $\eta^2 = 0.169$). Students in the experimental group, who received PAI instruction integrating digital literacy and eco-literacy supported by AI technology, demonstrated significantly higher comprehension scores (M = 86.2, SD = 9.8) compared to the control group (M = 72.7, SD = 13.1). The intervention yielded a large effect size (Cohen's d = 0.85; Table 3).

Table 3. ANCOVA Results for *Tawḥīd* Value Comprehension

Source of Variation	SS	df	MS	F	p-value	η^2
Covariate (Pretest)	9,132.4	1	9,132.4	82.54	< 0.001	0.258
Group	5,230.7	1	5,230.7	48.21	< 0.001	0.169
Error	25,683.1	237	108.33	—	—	—
Total	39,046.2	239	—	—	—	—

Changes in environmental attitudes also indicated significant improvement among students in the experimental group. ANCOVA results showed a clear difference between groups ($F(1,237) = 38.94$, $p < 0.001$, $\eta^2 = 0.141$). The experimental group achieved a mean score of 95.8 (SD = 11.4), substantially higher than the control group (M = 82.7, SD = 13.9). The effect size (Cohen's d = 0.76) indicates a large effect, demonstrating that the integrated instructional model positively shaped students' pro-environmental attitudes.

Analysis of environmental ethical behavior, assessed through structured observations and self-report measures, also yielded significant results ($F(1,237) = 32.15$, $p < 0.001$, $\eta^2 = 0.119$). Students in the experimental group demonstrated markedly higher levels of pro-environmental behavior (M = 78.4, SD = 14.6) compared to those in the control group (M = 61.2, SD = 16.8). The effect size (Cohen's d = 0.68) reflects a moderate-to-large effect, strengthening the conclusion that the integrated model promoted meaningful behavioral changes.

Table 4. Summary of the Effectiveness of Digital Literacy and Eco-Literacy Integration Across All Variables

Variable	Experimental Group M (SD)	Control Group M (SD)	F	p-value	Cohen's d	Interpretation
Tawḥīd Comprehension	84.6 (10.2)	71.3 (12.8)	45.68	< 0.001	0.82	Large Effect
Environmental Attitudes	95.8 (11.4)	82.7 (13.9)	38.94	< 0.001	0.76	Large Effect

| Environmental Behavior | 78.4 (14.6) | 61.2 (16.8) | 32.15 | < 0.001 | 0.68 | Medium–Large Effect |

Mediation and AI-Supported Learning Outcomes

Analysis of the role of AI in instruction indicated substantial increases in student engagement within the experimental group. Average active learning time per session increased by 47%, from 28.5 minutes to 41.9 minutes, compared to the control group's 12% increase. The AI platform enabled adaptive personalization based on learning pace, modality preferences (visual, auditory, kinesthetic), real-time comprehension evaluation through automated feedback, and content recommendations aligned with students' interests—collectively contributing to enhanced instructional effectiveness.

Pearson correlation analysis showed a significant positive relationship between digital literacy and eco-literacy ($r = 0.642$, $p < 0.001$), indicating that students with higher levels of digital literacy tended to exhibit stronger eco-literacy. This supports the synergistic nature of both literacies within the integrated learning model.

Table 5. Correlation Matrix Among Variables

Variable	1	2	3	4
1. Digital Literacy	1	—	—	—
2. Eco-Literacy	0.642**	1	—	—
3. *Tawḥīd* Comprehension	0.578**	0.691**	1	—
4. Environmental Behavior	0.523**	0.734**	0.685**	1
Note: p < 0.001				

Mediation analysis using PROCESS macro revealed that *tawḥīd* value comprehension functioned as a partial mediator in the relationship between digital literacy and environmental ethical behavior. The direct effect of digital literacy on environmental behavior was $\beta = 0.234$ ($p = 0.008$), while the indirect effect mediated through *tawḥīd* comprehension was $\beta = 0.189$, with a 95% confidence interval [0.102, 0.281]. The total effect was $\beta = 0.423$ ($p < 0.001$). These findings suggest that approximately 44.7% of the influence of digital literacy on environmental behavior was mediated by *tawḥīd* comprehension, underscoring the central role of spiritual-value transformation in this integration model.

Qualitative observations during the intervention period reinforced the quantitative results, revealing observable behavioral improvements both at school and at home. At school, 89% of students in the experimental group consistently practiced organic–inorganic waste separation, 76% adopted water conservation behaviors, and 82% actively turned off unused electronic devices to save energy. At home, parent follow-up reports indicated that 68% of students initiated environmentally friendly practices, 54% served as "change agents" encouraging their families, and 71% demonstrated increased concern for local environmental issues.

Collectively, these findings provide strong evidence for the effectiveness of integrating digital literacy and eco-literacy supported by AI technology into PAI instruction. The model successfully transformed students' *tawḥīd* value comprehension into tangible, sustainable environmental attitudes and behaviors among Madrasah Aliyah students in Tegal Regency.

Effectiveness of the Integration Model

The findings of this study confirm the hypothesis that integrating digital literacy and eco-literacy into the Islamic Education (PAI) curriculum is effective in transforming *tawḥīd* values into environmental ethics among Madrasah Aliyah students in Tegal Regency. These findings align with the theoretical framework proposed by Taisir et al. (2024), which emphasizes the importance of incorporating environmental sustainability into the PAI curriculum in an integrated and coherent manner. The large effect sizes for *tawḥīd* comprehension (d = 0.82) and environmental attitudes (d

= 0.76) indicate that this integrative approach not only strengthens students' cognitive understanding but also significantly reshapes their affective orientations toward the environment. This suggests that connecting spiritual values with concrete actions enhances the effectiveness of PAI instruction when compared to conventional approaches that tend to separate theological domains from environmental practices.

Furthermore, the findings indicate a shift from mere knowledge transmission toward transformative learning. According to Mezirow's transformative learning theory, learning becomes transformative when individuals revise their frames of reference through critical reflection (as cited in Fleming (2018). In this context, the integration model not only teaches students about *tawḥīd* and the environment but also facilitates critical reflection on the relationship between the two. This aligns with arguments that environmental education within the Islamic context must evoke "ecological–spiritual consciousness," prompting learners to reconcile their theological beliefs with real environmental crises (Athoillah, 2024; Fitriana et al., 2025). The strong influence on the affective domain (d = 0.76) reinforces the notion that this model successfully bridges the cognitive–affective gap commonly observed in conventional PAI. The findings also support research showing that the internalization of ethical values—including environmental ethics—is significantly strengthened when learning involves simulation, personal reflection, and emotional engagement rather than doctrinal memorization alone (Tiara Ramadhani et al., 2024). Thus, the effectiveness of the model lies not in the addition of content but in its capacity to weave spiritual values, modern literacies, and ecological awareness into a holistic and transformative learning experience.

The Role of AI as a Catalyst

The increase in student engagement facilitated by artificial intelligence (AI) can be understood through two major theoretical frameworks: Cognitive Load Theory and Self-Determination Theory. This aligns with Allen and Kendeou's (2023) argument that AI literacy plays a crucial role in modern education, where cognitive and psychological mechanisms guide the effective use of AI tools.

Within the context of PAI—where students must integrate abstract theological concepts such as *tawḥīd* with concrete environmental issues—the adaptive learning features of AI significantly reduce extraneous cognitive load. For visual learners, AI can present interactive simulations illustrating how littering a single plastic item in a river (a violation of *khalīfah* stewardship) affects broader marine ecosystems, visually demonstrating interconnectedness in *tawḥīd*. For advanced learners, AI can present complex global environmental policy case studies from an Islamic stewardship perspective, while for students requiring more support, AI offers simplified explanations and formative quizzes to reinforce foundational understanding. By tailoring instructional content to individual learners' comprehension levels, AI enables more efficient cognitive resource allocation for deeper processing (Oyebola Olusola Ayeni et al., 2024; Sweller et al., 2019). This is particularly important to prevent cognitive overload and ensure optimal comprehension of core concepts.

Moreover, gamification elements and immediate feedback in AI platforms directly fulfill the three basic psychological needs outlined in Self-Determination Theory: competence, autonomy, and relatedness (Ryan & Deci, 2020). Instant feedback strengthens perceptions of competence by validating learning progress in real time, while customization and adaptive learning paths support students' autonomy in navigating learning in ways that align with their preferences. These interactions also foster emotional and social connectedness within the learning environment, enhancing intrinsic motivation and sustained engagement (Liu et al., 2024). In this sense, AI does not replace the spiritual dimension of PAI, but instead amplifies value internalization through adaptive, responsive, and personally meaningful learning mechanisms.

Transforming *Tawḥīd* Values into Environmental Action

The mediation analysis shows that *tawḥīd* value comprehension functions as a partial mediator between digital literacy and environmental ethical behavior, reinforcing the Islamic concept of humans as *khalīfah*—responsible stewards of the earth. This transformation process involves three interrelated stages: (1) cognitive restructuring, in which students reinterpret *tawḥīd* within an ecological framework; (2) affective engagement, where emotional and empathetic connections to environmental issues are formed; and (3) behavioral implementation, where these internalized values materialize into environmentally responsible actions.

Mapping these stages onto the updated Value–Belief–Norm (VBN) Theory (Ibtissem, 2010; Santos da Cruz et al., 2022) provides stronger theoretical grounding. The intervention activated values (biospheric and altruistic) embedded in Islamic teachings—particularly *tawḥīd* as the foundation of stewardship. It then shaped beliefs by enhancing students' digital literacy and eco-literacy, strengthening their awareness of environmental consequences (AC) and perceived ability to contribute solutions (AR). These activated values and beliefs culminated in personal norms, generating a moral sense of responsibility to act (affective engagement), which ultimately drove environmentally responsible behavior. This contributes to earlier research (e.g., Pastwa-Wojciechowska et al., 2021) by empirically demonstrating how theological values operate as active psychological variables that shape behavior. It underscores that effective environmental programs in religious communities must not rely solely on textual injunctions but must actively build cognitive and affective bridges between core theological values and everyday actions (Ma'rufah, 2025; Parker, 2017).

Implications for the Tegal Regency Context

The successful implementation of the integration model in Madrasah Aliyah across Tegal Regency demonstrates its potential applicability in semi-urban regions with significant industrialization. Key enabling factors included adequate digital infrastructure—with more than 70% of students having stable internet access—strong institutional support from school leaders and PAI teachers, and the high relevance of local environmental issues to students' daily experiences. The flexibility of the local curriculum also facilitated smooth integration of the intervention.

This success should be interpreted beyond technical factors such as digital infrastructure. Fundamentally, it highlights the strength of Place-Based Education (PBE), which posits that learning is most effective when authentically connected to local ecological, social, and cultural contexts (Harcourt, 2015; Ontong & Grange, 2014). The model succeeded not merely because it was innovative, but because the innovation addressed real, observable environmental impacts that students encounter daily in Tegal. This aligns with findings from Santoso et al. (2022), who observed that climate adaptation programs in coastal Indonesia were more effective when using local mangrove case studies than when using abstract global examples. Thus, replication of this model in other regions should not rely on rigid duplication but on adaptive localization, tailoring content and implementation to the specific ecological and cultural contexts of each region. Institutional support and curriculum flexibility, identified as key facilitators in this study, are essential prerequisites—not merely supplementary conditions—for enabling effective place-based education.

Based on the study findings, several strategic recommendations are offered for broader implementation. First, intensive training for PAI teachers is essential to enable effective integration of digital literacy and eco-literacy supported by AI. Second, the development of digital learning content tailored to local contexts is necessary to enhance relevance and engagement. Third, strategic partnerships with environmental and technological institutions should be established to enrich available resources and learning experiences. Fourth, continuous monitoring and evaluation systems must be implemented to ensure program quality and sustainability. Finally, policy advocacy at both regional and national levels is needed to secure systematic and long-term support for integrating

this model within Islamic education, ensuring its responsiveness to environmental and digital-era challenges.

CONCLUSION

This study demonstrates the effectiveness of integrating digital literacy and eco-literacy into the Islamic Education (PAI) curriculum in transforming *tawḥīd* values into environmental ethics among Madrasah Aliyah students in Tegal Regency. The integration model produced significant improvements in *tawḥīd* comprehension, environmental attitudes, and pro-environmental behavior with large effect sizes, while *tawḥīd* comprehension acted as a partial mediator linking digital literacy to environmental behavior, confirming that spiritual values can be translated into concrete ecological actions. AI-supported learning significantly enhanced student engagement and personalized instruction, reinforcing the internalization of Islamic values within environmental contexts, while the strong positive correlation between digital literacy and eco-literacy illustrates their synergistic role in shaping holistic learning aligned with the Fourth Industrial Revolution. Theoretically, the study advances a new integrative framework connecting spirituality with environmental action, and practically it highlights the need for PAI curriculum reform, teacher training in digital and ecological competencies, and policy support for AI-based Islamic education. Although limited by a short follow-up period, reliance on self-report measures, and a single regional context, the findings offer substantial evidence that the integration of digital literacy and eco-literacy is not merely possible but essential for shaping environmentally responsible Muslim youth. With robust institutional support and adaptive policy implementation, this model has the potential to become a modern, holistic, and sustainable paradigm for Islamic education, positioning Islamic teachings—particularly *raḥmatan lil ʿālamīn*—as a transformative force in addressing global environmental challenges in the era of rapid technological advancement. This study has several limitations. The four-week follow-up period may not be sufficient to evaluate the long-term sustainability of behavioral changes. Generalizability should also be approached cautiously, as the research context is limited to Madrasah Aliyah in Tegal Regency with unique characteristics. Self-report data may contain social desirability bias, and external influences such as media exposure or environmental campaigns during the study period cannot be fully controlled.

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