

Need Analysis for the Developing the SI-ECOFIS E-Worksheet: Integrating Ecotheology and Education for Sustainable Development in Environmental Physics Courses

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Abstract: Environmental Physics instruction in higher education still lacks systematic integration of ecological values with scientific concepts, limiting students' sustainability competencies and environmental ethics. This study identified instructional needs and formulated evidence-based design requirements for developing the SI-ECOFIS (Sustainable Integrated Ecotheological Environmental Physics) e-worksheet integrating Islamic ecotheology and Education for Sustainable Development (ESD). A mixed-methods Research and Development approach based on the ADDIE model was employed, focusing on the Analysis phase. Participants included 75 Physics Education students, three lecturers, and three experts from UIN Raden Intan Lampung. Data were collected through questionnaires, interviews, document analysis, and classroom observations, then analyzed using descriptive statistics and thematic analysis. Findings indicated that existing teaching materials inadequately integrate ecotheological perspectives and ESD competencies. Students showed high digital readiness, while lecturers and experts highlighted the need for structured, value-integrated instructional materials. Six design requirements were identified, providing an empirical foundation for developing the SI-ECOFIS e-worksheet and Environmental Physics learning resources

Keywords: e-worksheet; ecotheology; Education for Sustainable Development; Environmental Physics; needs analysis

Abstrak: Pembelajaran Fisika Lingkungan di perguruan tinggi masih belum mengintegrasikan nilai-nilai ekologis secara sistematis dengan konsep-konsep ilmiah sehingga membatasi pengembangan kompetensi keberlanjutan dan etika lingkungan mahasiswa. Penelitian ini bertujuan mengidentifikasi kebutuhan pembelajaran serta merumuskan persyaratan desain berbasis bukti untuk mengembangkan e-worksheet SI-ECOFIS (Sustainable Integrated Ecotheological Environmental Physics) yang mengintegrasikan ekoteologi Islam dan Education for Sustainable Development (ESD). Penelitian menggunakan pendekatan Research and Development (R&D) metode campuran berdasarkan model ADDIE dengan fokus pada tahap Analisis. Partisipan terdiri atas 75 mahasiswa Pendidikan Fisika, tiga dosen, dan tiga pakar dari UIN Raden Intan Lampung. Data dikumpulkan melalui angket, wawancara, analisis dokumen, dan observasi kelas, kemudian dianalisis menggunakan statistik deskriptif dan analisis tematik. Hasil penelitian menunjukkan bahwa bahan ajar yang ada belum mengintegrasikan perspektif ekoteologi dan kompetensi ESD secara memadai. Mahasiswa memiliki kesiapan digital yang tinggi, sedangkan dosen dan pakar menekankan perlunya bahan ajar terstruktur berbasis nilai. Enam persyaratan desain berhasil diidentifikasi sebagai landasan empiris pengembangan e-worksheet SI-ECOFIS dan sumber belajar Fisika Lingkungan.

Kata Kunci: analisis kebutuhan; e-worksheet; ekoteologi; Fisika Lingkungan; Pendidikan untuk Pembangunan Berkelanjutan

INTRODUCTION

The global environmental crisis of the 21st century has prompted educational institutions to rethink their strategic role in shaping an ecologically responsible generation. Education for

Sustainable Development, as outlined in UNESCO's 2030 Education Agenda and the SDGs, calls for an educational approach that transcends mere knowledge transfer toward the development of values, competencies, and transformative actions (Leicht & Heiss, 2018; UNESCO, 2020). In this context, science education—particularly Environmental Physics—occupies a strategic position in bridging empirical understanding of environmental phenomena with the ethical and civic dimensions of sustainability.

However, the prevailing approach in Environmental Physics courses at universities tends to prioritize cognitive content delivery and has not been optimal in fostering values and sustainability competencies. Most existing textbooks and worksheets focus primarily on the theoretical principles of thermodynamics, fluid dynamics, and radiation physics, with limited contextualization regarding real ecological challenges or the ethical dimensions of the human-environment relationship (Brundiers et al., 2021; Leal Filho et al., 2018). Wijayanti et al. (2021), in their systematic assessment of physics instructional materials, found that materials implementing ESD principles remain extremely scarce, and called for curriculum adjustment aligned with sustainability issues a finding that directly situates the present study within an active and unsolved need in physics education. The younger generation who will inherit this Earth needs more than mathematical proficiency; they must be equipped with a holistic perspective that views nature not as an object of exploitation but as an integral part of life to be protected and preserved.

The ESD framework offers a viable solution by encouraging students not only to understand environmental issues but to actively engage in sustainable problem-solving through critical thinking, collaboration, and concrete action (Rieckmann, 2018; Wiek et al., 2011). Advances in digital technology have simultaneously opened new opportunities for instructional innovation. The electronic student worksheet (e-LKM, or Lembar Kerja Mahasiswa Elektronik) represents one such innovation, capable of incorporating videos, animations, simulations, and interactive reflection tools to provide a multidimensional learning experience beyond what conventional paper-based worksheets can offer (Ayusni et al., 2023; Suryani, 2024). Islamiyah & Lestari (2025) demonstrated this potential by developing an ESD-based e-worksheet for global warming topics via the ADDIE model, with validation confirming high feasibility and flexible learning promotion. Similarly, Pratiwi et al. (2023), developing an SDGs-integrated electronic physics module through an R&D approach, showed that digitally delivered ESD materials can optimize environmental literacy. These precedents confirm technical feasibility, while simultaneously revealing that neither study incorporated ecotheological values or focused on Environmental Physics within an Islamic higher education context.

Indonesia, as a country with a predominantly Muslim population, possesses rich spiritual perspectives that have not yet been widely integrated into science education. Ecotheology—theological reflection on the relationship between faith traditions and ecological responsibility—has emerged as a key framework for integrating spiritual values into environmental education (Foltz, 2003; Gerten & Bergmann, 2012; White Jr, 1967). Hidayat (2023) argues that Islamic ecotheological narratives constitute a practical framework capable of responding to Indonesia's climate crisis through normative value-based approaches positioning ecotheology as an actionable pedagogical resource rather than an abstract theological concern. Mufida et al. (2023) demonstrated through qualitative investigation that the application of tawhid, amanah, and khilafah values through Quran-based education can meaningfully increase ecological awareness. (Puspita & Rakhmawati (2023) further showed that systematic integration of Islamic and environmental values into science teaching materials through an I-SETS worksheet approach is both feasible and educationally appropriate. In the Islamic tradition, concepts such as khalifah (stewardship of the earth), mizan (cosmic balance), and amanah (trust and responsibility) offer theologically grounded motivations for environmental stewardship that resonate deeply with students in Indonesia Islamic higher education institutions ('Izz al-Dīn, 2000; Muda, 2020; Nasr, 1996). Integrating these perspectives into physics education does not conflate religion with science; rather, it enriches the value dimension of the students' learning experience.

Despite this convergent body of evidence, demonstrating the feasibility of ESD-integrated digital materials on the one hand, and the educational potential of Islamic ecotheological frameworks on the other, the availability of instructional materials that simultaneously integrate both perspectives within Environmental Physics courses remains extremely limited. Existing teaching materials are generally conventional, text-heavy, and fail to encourage critical or spiritual reflection. This situation poses a significant challenge for educators who seek more meaningful and transformative learning experiences (Ayushandra & Wuryastuti, 2022; Azizah & Astuti, 2020). It is precisely this meaningfulness, connecting physics content to students' ecological responsibilities as Muslim stewards of the earth that determines whether learning can leave a tangible impact on students' environmental attitudes and behaviors.

Although a growing body of prior studies has developed ESD-based instructional materials, integrated spiritual values into science learning, or advanced ecotheological frameworks in Indonesian education (see Table 1), research that specifically develops an Environmental Physics e-LKM integrating an ecotheological perspective and ESD competencies within the context of Islamic higher education and grounded in systematic needs analysis remains absent from the literature. A structured comparison of the most closely related prior studies reveals the multi-dimensional gap that the present study addresses:

Table 1. Comparison of Previous Studies and Identification of Research Gap

Previous Studies	ESD	Ecotheology / Islamic Values	Environmental Physics	e-LKM / Digital	Islamic HEI Context	Needs Analysis	Research Gap
Wijayanti et al. (2021)	✓	✗	✓	✗	✗	✓	Assessment only; no material development or ecotheology
Hidayat (2023)	✗	✓	✗	✗	✓	✗	Theoretical discourse; no instructional material
Mufida et al. (2023)	✗	✓	✗	✗	✓	✗	Qualitative study; no physics content or digital format
Pratiwi et al. (2023)	✓	✗	✓	✓	✗	✗	SDGs e-module; no ecotheology or Islamic HEI context
Puspita & Rakhmawati (2023)	✓	✓	✗	✗	✗	✗	I-SETS worksheet for general science; not physics-specific, no e-format
Suryani (2024)	✓	✗	✓	✓	✗	✗	No ecotheology; limited Islamic HEI context
Islamiyah & Lestari (2025)	✓	✗	✗	✓	✗	✓	ESD e-worksheet via ADDIE; not Environmental Physics, no ecotheology
Utami et al. (2025)	✓	✓	✗	✗	✗	✗	No digital worksheet; not Environmental Physics
Azizah & Astuti (2020)	✓	✗	✗	✓	✓	✗	No ecotheology; not physics-specific
SI-ECOFIS (This Study)	✓	✓	✓	✓	✓	✓	First integrated e-LKM combining all six dimensions in Environmental Physics within Islamic HEI

Note. ✓ = dimension addressed; ✗ = not addressed. ESD = Education for Sustainable Development; e-LKM = Lembar Kerja Mahasiswa Elektronik (electronic student worksheet); HEI = Higher Education Institution. Studies are ordered chronologically within thematic clusters.

As Table 1 demonstrates, no prior study has simultaneously addressed all six dimensions: (1) ESD competency development, (2) ecotheological or Islamic value integration, (3) Environmental Physics as the specific subject domain, (4) an e-LKM digital format, (5) the context of Islamic higher education in Indonesia, and (6) grounding in systematic needs analysis. Studies by Islamiyah & Lestari (2025) dan Pratiwi et al. (2023) confirm the pedagogical effectiveness of ESD-integrated digital physics materials but contain no ecotheological dimension. Studies by Hidayat (2023),

Mufida et al. (2023), and Puspita & Rakhmawati (2023) establish the educational potential of Islamic ecotheological integration but do not operate within Environmental Physics or employ a digital worksheet format. Wijayanti et al. (2021) document the scarcity of ESD-based physics materials but offer no development solution. This convergence of documented needs, demonstrated feasibility in adjacent domains, and absence of an integrated solution constitutes the specific research niche that SI-ECOFIS is designed to fill.

SI-ECOFIS (Sustainable Integrated Ecotheological Environmental Physics) e-worksheet is conceptualized as a digitally developed e-LKM that systematically integrates an ecotheological perspective with ESD competency development following Wiek et al.'s (2011) five-competency framework within Environmental Physics instruction. Unlike conventional worksheets, SI-ECOFIS is designed as an interactive, reflective, and value-rich learning medium, positioning students not merely as physics learners but as ecologically conscious agents of sustainable change. The development of this innovative instructional material must begin with a rigorous needs analysis that maps current learning practices, identifies gaps, and outlines the requirements the proposed innovation must satisfy (Branch & Varank, 2009; Dick, Walter, Carey, Lou, Carey, 2015). This study therefore reports the needs analysis phase of the SI-ECOFIS e-worksheet development project, conducted within the ADDIE Research and Development framework, providing an empirically grounded conceptual basis for the subsequent design and development stages.

The main research questions guiding this needs analysis are: (1) What are the gaps and limitations in current Environmental Physics teaching materials regarding ecotheology and ESD? (2) What are the learning needs and digital readiness profiles of students enrolled in the Environmental Physics course? (3) What are the perceptions and expectations of faculty members and environmental education experts regarding ESD-oriented e-worksheets in Environmental Physics? and (4) What framework components are needed for the development of the SI-ECOFIS e-worksheet?

METHOD

Research Design

This study constitutes the Analysis phase of a larger Research and Development (R&D) project employing the ADDIE model (Branch & Varank, 2009; Dick, Walter, Carey, Lou, Carey, 2015). The analysis phase is specifically concerned with identifying instructional needs, learner characteristics, environmental constraints, and content specifications that must inform the subsequent Design phase, it does not produce or evaluate the product itself. A convergent mixed-methods design was adopted (Creswell, J. W., & Poth, 2018), in which quantitative data from student questionnaires and qualitative data from interviews, document analysis, and classroom observations were collected concurrently and subsequently merged at the interpretation stage. The needs analysis framework follows Tessmer (1993) front-end analysis model, encompassing four interrelated analyses: needs analysis, learner analysis, task analysis, and context analysis.

Research Subjects and Location

This study was conducted at the Physics Education Study Program, UIN Raden Intan Lampung. Research subjects were selected through purposive sampling based on direct relevance to the research objectives. Three participant groups were involved: (1) 75 students currently enrolled in or who had completed the Environmental Physics course; (2) 3 lecturers responsible for teaching the course; and (3) 3 subject-matter experts comprising an instructional designer, an environmental education specialist, and an ecotheology scholar.

Data Collection Methods

Four complementary data collection methods were employed. A student needs questionnaire was administered online to all 75 student participants, capturing quantitative data on perceptions of existing materials across five dimensions: content adequacy, visual appearance, readability, value relevance, and ESD competency integration, operationalized using items adapted

from Wiek et al. (2011) five-competency framework. Semi-structured interviews were conducted individually with the three lecturers and three experts (approximately 45–60 minutes each, audio-recorded). Document analysis systematically reviewed all Environmental Physics instructional materials in active use ($n = 24$ documents) using a structured checklist across five dimensions. Classroom observation covered five Environmental Physics sessions using a structured rating sheet and narrative field notes, focusing on pedagogical approach, media use, student engagement, and sustainability-oriented discourse.

Data Analysis Techniques

Survey data were analyzed descriptively using mean values and percentages, classified by a five-level need scale (mean ≥ 4.20 = very high need; 3.40–4.19 = high; 2.60–3.39 = moderate; 1.80–2.59 = low; < 1.80 = very low. Interview data were analyzed using thematic analysis (Braun & Clarke, 2006): verbatim transcription, open coding, axial coding, theme identification, and member-checking with two participants. Document analysis employed structured content analysis, with each criterion rated on a 0–2 scale and results aggregated into dimension gap indices. Observation data were analyzed through rating aggregation and descriptive narrative synthesis across five sessions, with inter-observer reliability applied. Triangulation of sources and methods (Creswell, J. W., & Poth, 2018) integrated all four data streams into a convergence matrix identifying the design requirements for SI-ECOFIS.

RESULT AND DISCUSSION

The needs analysis generated convergent findings across four data sources: document analysis ($n = 24$ materials), classroom observations ($n = 5$ sessions), student questionnaires ($n = 75$), and faculty and expert interviews ($n = 6$ informants). The results are organized into four subsections, progressing from the curriculum level to the student level, faculty and expert level, and culminating in the synthesis of evidence-based design requirements.

Curriculum and Existing Instructional Material Analysis

Document analysis of 24 Environmental Physics instructional materials in active use at the study site, combined with systematic classroom observation of five learning sessions, revealed pervasive and multi-dimensional instructional gaps. Table 2 presents the findings by analysis dimension.

Table 2. Document Analysis and Classroom Observation Findings

No.	Analysis Dimension	Findings	Instructional Implications
1	Physics Concepts & Mathematical Exercises	Consistently present across all materials	Strong disciplinary foundation exists; ESD and values dimensions can be layered onto this base
2	Environmental Contextualization	Present only as incidental examples, not as analytical focus	Contextual Indonesian environmental case studies must be structurally embedded, not peripheral
3	Digital Interactivity	Static printed format dominates; minimal digital affordance	SI-ECOFIS e-worksheet must leverage digital affordances as a structural feature, not a decorative add-on
4	ESD Competency Integration	Largely absent; only isolated sustainability references found	All five Wiek et al. (2011) ESD competencies must be explicitly scaffolded through dedicated activities
5	Islamic Ecotheological Values	Completely absent from all reviewed materials	Khalifah, amanah, and mizan must be structurally integrated throughout the e-worksheet, grounded in Quranic sources
6	Reflective & Values-Oriented Tasks	Virtually absent; post-task reflection questions non-existent	A dedicated ecological values reflection component is required after each content unit

The pattern revealed by document analysis is not merely a content gap but a structural one: the pedagogical logic of all reviewed materials is organized around disciplinary knowledge transmission

covering concepts, demonstrating formulas, and assessing procedural accuracy. There is no structural provision for sustainability-oriented inquiry, reflective engagement, or value-based reasoning. Classroom observations corroborated this pattern: across all five observed sessions, instruction was lecturer-centered and confined to content delivery, with no instances of collaborative reflection, sustainability-oriented discourse, or student-initiated environmental questioning. As one lecturer noted when asked about this pattern during interview:

"We have attempted to introduce sustainability concepts, but there are no structured instructional materials that systematically integrate them into Environmental Physics." (Lecturer 2, Interview, 2026)

The complete absence of ecotheological content (0 of 24 materials) is particularly significant in the Indonesian Islamic HEI context, where students' educational identities are shaped by the intersection of scientific and Islamic scholarly traditions. This absence suggests that the separation of science content from values education is not a deliberate pedagogical choice but a structural default a point to which the Discussion returns.

Student Needs, Digital Readiness, and Motivational Orientation

The student questionnaire revealed key patterns in learning needs, ESD competency levels, and digital readiness. Regarding ESD competencies, students demonstrated the highest proficiency in interpersonal competencies (mean = 67.2/100) and normative competencies (mean = 63.8/100), while systems thinking (mean = 58.4/100) and anticipatory competencies (mean = 55.1/100) showed the greatest decline. These findings align with the broader literature indicating that high-level sustainability competencies require explicit pedagogical guidance rather than emerging organically from standard science instruction.

Students' low achievement in systems thinking and anticipatory competencies suggests that sustainability competencies have not developed optimally through current Environmental Physics instruction. The low systems thinking competency may be attributed to the predominantly content-centered nature of Environmental Physics instruction, which rarely exposes students to complex socio-ecological systems and sustainability-oriented problem solving. This finding is consistent with the research by Wiek et al. (2011), which confirms that sustainability competencies particularly systems thinking and anticipatory competency do not develop automatically through conventional science instruction but require instructional designs that explicitly target their development. The results of this study are also consistent with the findings of Brundiers et al. (2021), which show that higher education students often have difficulty understanding the interconnections between environmental systems and predicting the long-term impacts of sustainability issues. Therefore, the development of learning activities focused on ESD competencies is an urgent need in the development of SI-ECOFIS e-worksheet.

The high digital readiness profile 100% smartphone ownership, 92% internet access, 87% smartphone use for academic learning establishes the technical feasibility of a digital e-worksheet format for this population. Student interview data provided important motivational context for these quantitative patterns:

"Current Environmental Physics worksheets mostly contain formulas and theoretical explanations. We rarely discuss real environmental issues or reflect on our responsibility toward nature." (Student 18, Interview, 2026)

"Learning would be more meaningful if physics concepts were connected to Islamic values and real environmental problems." (Student 41, Interview, 2026)

These quotations indicate that students' motivational deficit with existing materials is not about format but about content orientation: the absence of real-world relevance and values-based reflection. When asked specifically about ecotheological integration, 82% of students reported it

would increase their motivation to engage with environmental issues, and 76% believed it would deepen their sense of responsibility toward the environment.

Figure 1 summarizes the five digital readiness and preference indicators collected from the student questionnaire.

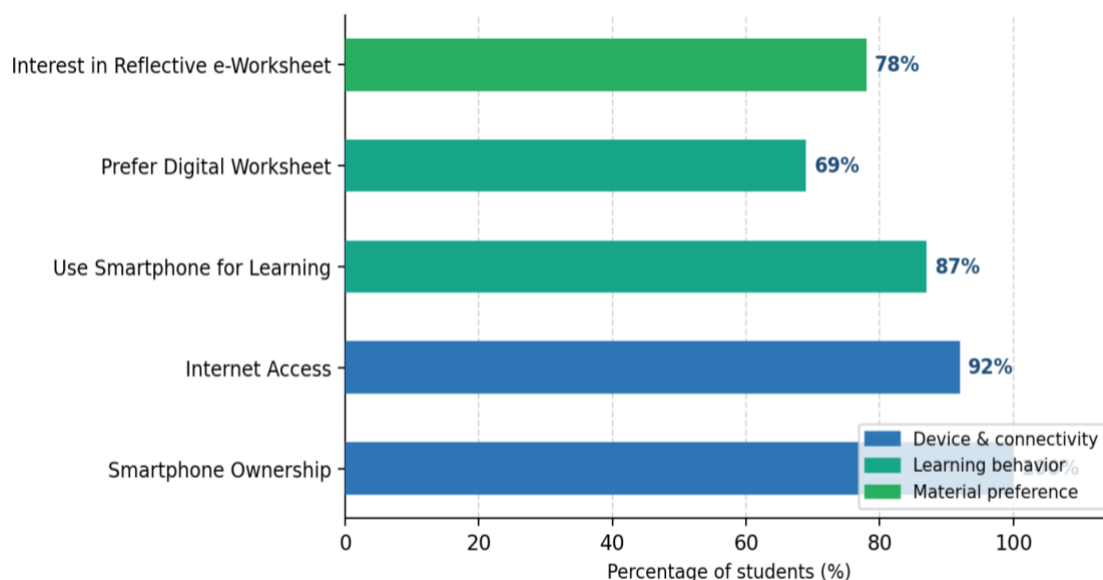


Figure 1. Students' Digital Readiness and e-Worksheet Preference (n = 75). Bars show the percentage of students affirming each indicator, grouped by category: device/connectivity (blue), learning behavior (teal), and material preference (green).

Lecturer and Expert Needs Analysis

Table 3 summarizes the key findings from Lecturer and expert interviews, with their direct design implications.

Table 3. Lecturer and Expert Interview Findings and Design Implications

Source	Key Finding	Design Implication
Lecturers (n = 3)	All three affirm importance of ESD-oriented materials but none have developed them; primary barrier = lack of ready-to-use templates; secondary barriers = insufficient ESD framework knowledge and uncertainty about science–religion epistemological boundary	SI-ECOFIS e-worksheet must function as a faculty-facing capacity-building tool: modular, adaptable, with built-in epistemological guidance for combining physics content with Islamic ecological values
Experts (n = 3)	Unanimous agreement on feasibility and strategic importance; ecotheology must be reflectively embedded throughout learning activities, not appended as religious footnotes; structured replicability is essential for cross-institutional uptake	Each SI-ECOFIS e-worksheet component must include an explicit ecotheological reflection linked to physics content; framework must be structured and documented to enable instructor adaptation

Synthesis of Design Requirements

The synthesis of findings from questionnaires, interviews, classroom observations, and document analysis resulted in eight evidence-based design requirements that will guide the subsequent development of the SI-ECOFIS e-worksheet. These requirements do not represent the final product design but rather constitute empirical specifications derived from stakeholders' instructional needs, as presented in Table 4.

Table 4. Evidence-Based Design Requirements for SI-ECOFIS

Evidence from Needs Analysis	Design Requirement	SI-ECOFIS Component Implied
Existing worksheets emphasize physics concepts and mathematical problem-solving only; 0% ecotheology, 8.3% ESD content (document analysis)	Contextual environmental problem-solving tasks	Core Physics Content + Contextual Problem-Solving Assignments using real Indonesian environmental data
87% of students use smartphones for academic learning; 69% prefer digital over print resources; 92% have internet access (questionnaire)	Smartphone-accessible interactive e-worksheet format	Web-based or interactive PDF format with mobile-first design and low-bandwidth compatibility
Systems thinking competency (mean = 58.4/100) and anticipatory competency (mean = 55.1/100) are the furthest below the proficiency threshold of 70 (questionnaire)	Explicit systems thinking and anticipatory competency scaffolding activities	ESD Competency Activities: scenario analysis, systems mapping, futures thinking tasks
Reflective tasks virtually absent from all reviewed materials (12.5% partial presence); students describe worksheets as spiritually uninspiring (interview)	Embedded ecological value reflection section after each content unit	Ecological Values Reflection: post-task questions linking physics findings to khalifah, amanah, and mizan
All five ESD competencies below proficiency threshold; no existing material explicitly targets ESD competency development (questionnaire + document analysis)	Five explicitly targeted ESD competency development tasks per topic unit	ESD Competency Activities mapped to Wiek et al. (2011) framework with explicit learning objectives and assessment criteria
All three lecturers cite lack of ready-to-use templates as the primary barrier; two lack ESD framework familiarity (interview)	Modular, ready-to-use learning scenarios with built-in instructor guidance	Six modular components with facilitator notes and adaptation guidelines enabling selective integration into existing courses
Expert interviews unanimously recommend structured, reflectively embedded Islamic ecological values; 82% student receptivity to ecotheological integration; 0% existing materials include ecotheology (interview + questionnaire)	Structured ecotheological integration grounded in Quranic sources and recognized Islamic scholarship	Introduction to Ecotheology component per unit, drawing on khalifah, amanah, and mizan embedded as reflective dimension, not decorative footnote
Collaboration competency closest to proficiency (mean = 67.2); experts recommend community-level action projects; 76% of students see potential in connecting physics to their environmental responsibility (interview + questionnaire)	Collaborative environmental action project as capstone per topic unit	Collaborative Action Task: group-based project designing community-level sustainability solutions using Environmental Physics principles

The finding that all five ESD competencies fall below the proficiency threshold of 75 with systems thinking and anticipatory competency showing the most severe deficits is not a random outcome of this particular student population. It reflects a predictable structural consequence of the instructional environment documented in the curriculum analysis. Wiek et al. (2011) explicitly argue that higher-order sustainability competencies, particularly systems thinking and anticipatory competency, do not develop automatically through standard science instruction; they require purposefully designed learning experiences that expose students to complex socio-ecological systems, multi-causal environmental dynamics, and scenario-based future reasoning. The content-delivery model that dominates Environmental Physics instruction at the study site confirmed by both document analysis and classroom observation is structurally incapable of cultivating these competencies, regardless of students' intrinsic motivation.

This interpretation is corroborated by Brundiers et al. (2021), who conducted a multi-institution study across higher education programs and found that systems thinking and anticipatory

competency consistently represent the most significant development challenges, even among students in explicitly ESD-oriented programs. Leal Filho et al. (2018) similarly identified that the transformation of science learning toward sustainability orientation requires not merely adding sustainability content but fundamentally restructuring the pedagogical mode from knowledge transmission to inquiry-based, competency-developing engagement. The current study extends these findings to the Indonesian Islamic HEI context, where an additional layer of opportunity exists: students' existing normative competency the highest of the five, at 63.8/100 suggests a values-oriented foundation attributable in part to their Islamic educational background. This finding implies that the normative gap is smaller than a secular ESD model would predict, and that this strength can be strategically leveraged as an entry point for ecotheological integration in SI-ECOFIS e-worksheet.

The complete absence of ecotheological content in all 24 reviewed Environmental Physics materials and the epistemological anxiety expressed by lecturer informants about integrating religious perspectives without compromising scientific credibility points to a systemic structural barrier that goes beyond individual faculty capacity. This barrier operates at multiple levels simultaneously. At the curriculum level, the absence of ecotheology reflects the inherited separation of science and values education in the Indonesian higher education curriculum, a separation that Nasr (1996) traces to the broader modern crisis of divorcing scientific knowledge from spiritual and ethical responsibility. At the faculty level, the barrier is epistemological: lecturers lack not motivation but a structured framework that shows how Islamic ecological values can enrich physics learning without conflating theological claims with scientific ones. This finding aligns with Lozano et al. (2013), who documented that faculty support for sustainability integration rarely translates into practice when structural tools and pedagogical frameworks are absent. At the institutional level, the absence of ready-to-use, validated ecotheological physics materials leaves even motivated instructors without a starting point.

Prior studies that have begun to address this gap provide important context. Johan et al. (2024) and Utami et al. (2025) demonstrated that integrating spiritual values into science learning increases student motivation and ecological awareness, but neither operationalized a systematic, physics-specific framework for doing so. Hidayat (2023) and Mufida et al. (2023) established the theoretical and empirical basis for Islamic ecotheological integration in education, but without producing instructional materials. These findings indicate that the path toward ecotheological integration in physics education requires not advocacy but operationalization: a structured, replicable, and epistemologically transparent instructional framework that guides both students and lecturers. These findings indicate that the proposed SI-ECOFIS e-worksheet should be designed to address this implementation gap during the subsequent Development phase.

The high digital readiness profile documented in this study 87% smartphone use for academic learning, 92% internet access, 78% interest in a reflective e-worksheet is consistent with post-pandemic higher education trends documented by Bond et al. (2021), who found that digital device integration into daily learning has accelerated substantially across higher education globally. UNESCO (2020) similarly notes that digital literacy has become a foundational competency for ESD, recognizing that digital tools can facilitate the kinds of collaborative, scenario-based, and reflective learning experiences that sustainability competency development requires. However, the student interview data reveal an important qualification: students' motivational deficits with existing materials are not about format but about substance. Students do not simply want worksheets on a screen, they want learning experiences that connect physics content to real environmental problems and their own values. Crompton & Burke (2018) found in their systematic review that mobile learning in higher education improves access and flexibility but does not independently improve engagement or learning depth the pedagogical design of the content remains the determinant factor.

This distinction has a direct and critical implication for SI-ECOFIS development: digital format is a necessary but not sufficient condition for achieving the learning outcomes the needs analysis identifies. The e-worksheet must leverage specific digital affordances embedded reflection

tools, interactive scenario simulations, multimedia environmental case studies, collaborative action planning features that could not be replicated in a paper format. Simply migrating existing physics content to an interactive PDF would reproduce the structural deficiencies of current materials in a new medium. The design requirements derived from this needs analysis are therefore specifically calibrated to use digital affordances instrumentally, in service of ESD competency development and ecotheological reflection.

Implications for Developing SI-ECOFIS e-Worksheet

The convergent findings of this needs analysis suggest that SI-ECOFIS should provide learning experiences that simultaneously develop scientific understanding, sustainability competencies, ecological ethics, and reflective thinking rather than simply digitizing conventional worksheets or adding Islamic content as an appendix to standard physics problems. The evidence implies that the most strategically significant design decisions for SI-ECOFIS will involve: (1) how systems thinking and anticipatory competency activities are scaffolded within the physics content so that they build gradually and coherently across topic units; (2) how ecotheological content is positioned epistemologically as a reflective lens on physics findings, not as a competing knowledge claim to address both the epistemological anxiety of lecturers and the motivational need of students; and (3) how the modular structure balances adaptation flexibility for lecturers with sufficient structural coherence to ensure that all eight design requirements are meaningfully addressed in any given implementation.

The finding that normative competency is highest among students suggests an important developmental sequence: ecotheological reflection activities can begin with normative competency connecting physics findings to Islamic stewardship ethics before progressively scaffolding toward the more cognitively demanding systems thinking and anticipatory competency tasks. This sequence would capitalize on existing strengths before addressing identified deficits, following a pedagogical scaffolding logic consistent with Vygotsky's (1978) zone of proximal development applied to competency-based learning design.

CONCLUSION

This study reported the findings of the Analysis phase of the ADDIE model and identified the instructional needs that should guide the development of the SI-ECOFIS e-worksheet for Environmental Physics courses. The findings indicate that existing instructional materials have not systematically integrated Education for Sustainable Development (ESD) competencies or Islamic ecotheological values. At the same time, students demonstrated high digital readiness, while lecturers and experts expressed strong support for developing structured, value-integrated digital learning resources.

The needs analysis generated evidence-based design requirements that provide an empirical foundation for the subsequent Development phase of the ADDIE model. These findings contribute to sustainability-oriented science education by illustrating how instructional needs analysis can inform the design of Environmental Physics learning resources that integrate scientific concepts, ESD competencies, and Islamic ecological values within Indonesian Islamic higher education institutions. Since this study was limited to the Analysis phase, future research should focus on developing, validating, implementing, and evaluating the SI-ECOFIS e-worksheet in broader educational settings.

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