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Developing an Ecoliteracy E-Module through the ADDIE Model to Foster Sustainable Development (SDGs) in Elementary Schools

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Abstrak. This research is motivated by the importance of ecoliteracy education in elementary schools to instill sustainable values. Integrating the Sustainable Development Goals (SDGs) into learning is a strategic step to foster environmental awareness through a digital approach. This study aims to develop an e-module on ecoliteracy integrated with the SDGs for elementary school students, using the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). This research method uses a research and development (R&D) design with a mixed methods approach. The subjects were 50 students, divided into two groups: an experimental group and a control group (25 students each). Quantitative data were collected through pre-tests and post-tests, while qualitative data were obtained through interviews and observations. Findings and analysis showed that the experimental group achieved a post-test score of 85% with an N-gain of 0.6 (moderate), while the control group achieved 70% with an N-gain of 0.2 (low). These data indicate an increase in students' understanding of the ecoliteracy concept after the e-module. In conclusion, the ADDIE-based ecoliteracy e-module has proven effective in strengthening environmental awareness and supporting sustainability-focused education in elementary schools.

Keywords: e-module, ecoliteracy, SDGs, ADDIE model, elementary school

INTRODUCTION

Global environmental issues, such as climate change which is increasingly affecting weather patterns and ecosystem systems across the globe, pollution which is damaging the quality of air, water and soil on a worldwide scale, and the loss of biodiversity which is threatening the balance of nature globally, are increasingly pressing to receive serious attention from all levels of society (Rizkyansyah et al., 2025). These issues not only impact environmental conditions but also human wellbeing and the sustainability of life on earth (Anisa Sofiana Perdani et al., 2025). Therefore, it is crucial to cultivate a deep ecological awareness from an early age, and elementary schools have a very strategic role in this endeavor. Through ecoliteracy education, schools can provide the knowledge and skills young people need to understand, appreciate, and act sustainably towards their environment (Aliyah & Falah, 2025). Ecoliteracy itself refers to the ability to understand environmental problems, recognize the relationship between individual actions and natural conditions, and take steps that support the sustainability of ecosystems and natural resources (Langkanae et al., 2025). However, recent studies show that elementary school students' understanding of environmental issues and their relationship to the Sustainable Development Goals (SDGs) remains very limited, both in terms of knowledge and in the application of sustainability values in their daily lives (Vioreza et al., 2023). This condition highlights the need to develop more innovative, creative, and experiential learning materials that can strengthen students' eco-literacy and encourage them to be more actively involved in urgent environmental conservation efforts in this challenging era. (Wisman & Santoso, 2024).

Over the last decade, numerous studies have focused on developing technology-based learning media to improve students' understanding of the environment. As an example (Tyas

et al., 2022) Creating interactive media based on the 3R concept (Reduce, Reuse, Recycle), which is designed to foster environmentally friendly behavior among students, temporary (Shamla & Eka Wulandari, 2025) Research on the effectiveness of using digital modules in improving scientific literacy and ecological awareness in students. However, many of these studies have not explicitly integrated the principles of. The Sustainable Development Goals (SDGs) are included in ecoliteracy learning materials, which should serve as an essential basis for developing sustainable attitudes and behaviors (Perdani et al., 2025). In addition, although existing teaching materials provide helpful information, many of them are informative but lack sufficient space to develop applicable, sustainable attitudes or behaviors, especially in the context of more context- and action-oriented learning (Ade Muslimat, 2022). Therefore, efforts are needed to design more holistic and comprehensive learning media that not only convey information but also encourage students to internalize sustainability principles and apply them in their daily lives (Muliadi & Pahmi, 2021)

This gap in ecoliteracy learning highlights the urgency to develop ecoliteracy e-modules that not only provide knowledge about environmental issues but also connect that knowledge to the Sustainable Development Goals (SDGs) framework and students' daily lives (Alda Resal et al., 2022). The originality focus of this research lies in the direct integration of students' cognitive, affective, and behavioral dimensions through the ADDIE model: Analysis, Design, Development, Implementation, and Evaluation. (Lulu Jola et al., 2025). This model ensures that the learning design process is carried out systematically and adaptively, while accounting for students' needs and characteristics (Abdul Manab et al., 2025). Furthermore, this study employed a mixed-methods approach, combining quantitative and qualitative methods. This approach was designed to provide a more holistic and comprehensive insight into the effectiveness of e-modules, taking a broader perspective on both measurable outcomes and student experiences within a learning context focused on active engagement and sustainable behavioral change. Thus, this study aims to make a significant contribution to improving ecoliteracy learning practices in elementary schools, while simultaneously creating a stronger foundation for the implementation of SDG principles in environmental education (Sururi et al., 2022).

The main problem addressed in this study is the low level of environmental understanding and awareness among elementary school students, which is further exacerbated by the limited learning materials that can effectively support sustainability education. Although ecological education has begun to be introduced, existing materials still do not comprehensively address the dimensions of sustainability, especially those that integrate the principles of the Sustainable Development Goals (SDGs). Therefore, the main objective of this study is to develop and evaluate the effectiveness of an SDGs-based ecoliteracy e-module that is expected to improve students' understanding of environmental issues while fostering their sense of responsibility for nature conservation. This study aims to produce an e-module that is not only valid in terms of content, but also practical and easy to apply in the context of learning in elementary schools. Through this e-module, it is hoped to support the implementation of sustainability-oriented education and make a significant contribution to improving the quality of environmental learning at the elementary school level, ultimately helping to shape a generation that is more concerned and responsible for environmental sustainability.

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METHODOLOGY

Research Approach

This study adopted a Research and Development (R&D) approach to design and develop an e-module on ecoliteracy integrated with the Sustainable Development Goals (SDGs) for elementary school students. The R&D approach was chosen for its ability to produce a product that is not only relevant to current educational needs but also applicable to elementary school learning (Haq et al., 2023). Through this approach, the research aims to create e-modules that can be used directly by teachers and students in the teaching and learning process, while ensuring the resulting products meet the expected standards of quality and effectiveness. Furthermore, this research also measures the extent to which the developed e-modules can improve students' understanding of environmental issues and the SDGs, and encourage changes in attitudes and behaviors that are more environmentally responsible (Waruwu, 2024). Thus, the R&D approach does not focus solely on product development but also on evaluating its effectiveness in the context of sustainability-oriented learning in elementary schools (Natalia et al., 2023).

Types of Research

The research design applied in this study uses a mixed-methods approach, combining quantitative and qualitative data analysis to provide a more comprehensive picture of the effectiveness of the ecoliteracy e-module. Quantitative research is based on a positivist approach that emphasizes the measurement and analysis of numerical data to test hypotheses. In contrast, qualitative research uses a naturalistic or phenomenological approach that focuses on understanding subjective meanings and experiences in natural contexts (Ultavia et al., 2023). Quantitative data were collected through pre- and post-test administrations to measure changes in students' understanding of environmental issues and sustainability principles integrated into the Sustainable Development Goals (SDGs). Meanwhile, qualitative data were obtained through in-depth interviews and direct observations, providing more detailed insights into students' experiences with the e-module and its impact on their understanding of ecoliteracy. The combination of these two types of data enabled the study not only to measure the extent of improvement in students' understanding quantitatively but also to qualitatively explore how the e-module influenced students' attitudes and behaviors in applying ecoliteracy knowledge in their daily lives. Thus, this mixed-methods approach provides a more holistic understanding of the effectiveness and impact of e-modules in the context of sustainability-based education (Hasan Syahrizal & Syahran Jailani, 2023).

Method of Collecting Data

Pre- and post-tests were administered to assess changes in students' understanding of ecoliteracy concepts, with a focus on environmental issues and the application of sustainability principles. The pre-test was administered before using the e-module to obtain an initial overview of students' knowledge. In contrast, the post-test was administered after using the e-module to assess the extent to which their understanding had developed.

Interviews and observations were conducted to gather in-depth qualitative data on students' and teachers' experiences during the learning process using e-modules. An interview is a question-and-answer communication process between an interviewer and a

source that aims to obtain in-depth information about a topic, facts, beliefs, or feelings (Rahmawati et al., 2024). Interviews provided direct insight into students' and teachers' perspectives on the effectiveness of e-modules. At the same Time, observations allowed direct observation of students' interactions with the learning materials and any changes in attitudes or behaviors that emerged from e-module use. Observation is the activity of carefully and directly observing an object or phenomenon to collect data and information. The goal is to gain a deeper understanding of the observed object, such as a specific behavior, condition, or process, which can then be used as a basis for research, analysis, or work program planning (Rahmawati et al., 2024). With this approach, the study not only measured academic understanding but also assessed the emotional and practical impacts students experienced as they increased their environmental awareness.

Data Collection Procedures

Researchers will implement an e-module on the Sustainable Development Goals (SDGs) for ecoliteracy with two groups of students: an experimental group and a control group. The experimental group will be given the developed e-module. In contrast, the control group will not receive the same treatment, serving as a comparison to observe differences in the resulting impact. The research process begins with a pre-test given to both groups to measure students' initial knowledge regarding the concept of ecoliteracy and environmental issues. After the pre-test, the e-module will be implemented on the experimental group for a predetermined period to improve their understanding of ecoliteracy and sustainability. After the e-module is implemented, a post-test will be conducted to evaluate the extent to which students' understanding, particularly in the experimental group, has improved compared to the control group (Asyiah Siregar et al., 2023). Thus, this research design aims to measure the direct impact of the e-module on students' understanding of ecoliteracy and to compare results between the treatment and non-treatment groups.

Data Analysis

Quantitative data from the pre-test and post-test will be analyzed using descriptive statistics. We will use [specific software or tool] to calculate the mean score and N-gain, which will help us assess the learning effectiveness.

The qualitative data from interviews and observations will undergo a rigorous thematic analysis. This method will identify key themes related to the e-module's impact on students' environmental awareness and their experiences during module use, ensuring the thoroughness and reliability of our findings.

Location Description

This research was conducted at SDN Bojongkacor 02, an elementary school located in an urban area. The school's commitment to global sustainability is evident in its implementation of an ecoliteracy e-module that is aligned with the Sustainable Development Goals (SDGs). With good access to digital devices and internet connections, the school's infrastructure supports the effective implementation of technology-based learning for elementary school students. This alignment with the SDGs inspires stakeholders with the school's contribution to global sustainability.

Location Context

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This study involved approximately 50 fifth-grade students, divided into two groups: an experimental group and a control group, each consisting of 25 students. This location was chosen for its relevance to the research topic, which focuses on environmental education and the use of digital technology in elementary school learning. SDN Bojongkacor 02 is considered an ideal location to implement the ecoliteracy e-module, given the school's readiness to use technology to support learning and its focus on developing sustainability-based education.

Research Subjects

Participants in this study were 50 5th-grade students, divided into two groups: the experimental group (25 students) will use the SDGs-based ecoliteracy e-module. The control group (25 students) will not use the e-module. Participant Criteria Students: Aged between 10 and 12 years, who attend elementary school and have access to digital devices that support the use of e-modules 5.

Research Procedures

A pre-test was given to students before using the e-module to gauge their initial understanding of ecoliteracy concepts and environmental issues. The purpose of this pre-test was to obtain a clear picture of students' baseline knowledge before they received digital-based learning.

An ecoliteracy e-module designed to increase environmental awareness and understanding of the Sustainable Development Goals (SDGs) will be provided to the experimental group. This module will be implemented over Time to allow students to understand the material. The control group, on the other hand, will not receive this e-module and will instead follow conventional learning without any special treatment related to digital media.

Following the e-module implementation period, a post-test was administered to measure the extent to which students' understanding of ecoliteracy had developed. This post-test aimed to assess differences in students' understanding levels between the pre-test and post-test, to evaluate the effectiveness of the learning intervention.

Interviews with teachers and students were conducted to delve deeper into their experiences with e-modules during the learning process. These interviews aimed to understand the impact of e-module use on students' attitudes, understanding, and environmental awareness, and to obtain feedback on their experiences learning with digital technology.

Observations during the learning process were also conducted to assess student interactions in e-module-based learning activities. These observations focused on how students participated in discussions, interacted with the learning materials, and applied the ecoliteracy concepts they had learned in their daily lives.

RESULTS AND DISCUSSION

Research Result

The purpose of this study is to create and assess an ecoliteracy e-module based on the Sustainable Development Goals (SDGs) in order to raise elementary school pupils' knowledge and comprehension of the environment. The ADDIE paradigm (Analysis, Design, creation, Implementation, Evaluation) is used in the e-module creation process to make sure the content is appropriate for learning goals and can be implemented successfully. In this study, fifty

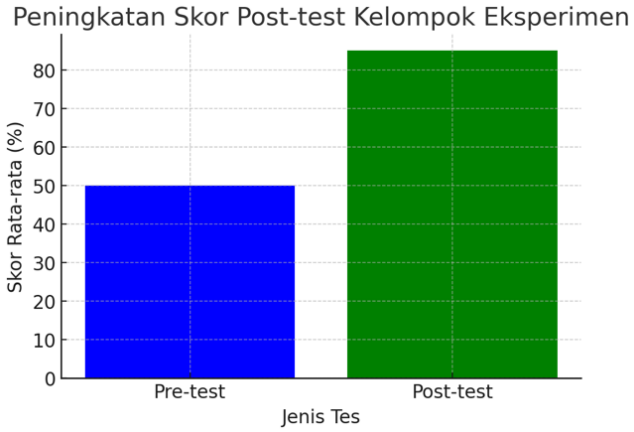
students were split into two groups: a control group that did not get therapy through an ecoliteracy e-module and an experimental group that did. This study's primary goal was to determine how much the SDGS-based e-module enhanced students' comprehension of sustainability concepts and environmental challenges in comparison to traditional teaching techniques in the control group.

Table 1. Students' Pre-test and Post-test Scores

Kelompok	Pre-test (%)	Post-test (%)	N-gain (%)
Kelompok Eksperimen	50	85	0.6 (Sedang)
Kelompok Kontrol	48	70	0.2 (Rendah)

Results from Table 1 shows an increase in learning outcome scores in both the experimental and control groups. The experimental group's higher gains, with an N-gain of 0.70 categorized as medium/high, should reassure educators of the approach's effectiveness. Meanwhile, the control group increased from 48% to 70%, with an N-gain of 0.42 (medium). The experimental group using the SDGS-based ecoliteracy e-module experienced a significant increase in post-test scores, with an N-gain of 0.6, indicating moderate growth. Meanwhile, the control group only showed a lower increase, with an N-gain of 0.2. These results suggest that using the SDGS-based ecoliteracy e-module can improve students' understanding of ecoliteracy and the SDGS.

Figure 1. Increase in Post-test Score of Experimental Group



The objective of this research is to create and assess the impact of an e-module focused on ecoliteracy, aligned with the Sustainable Development Goals (SDGs), in enhancing elementary school students' comprehension and consciousness of environmental matters. The e-module's creation follows the ADDIE model, encompassing Analysis, Design, Development, Implementation, and Evaluation. The graph illustrates the rise in average scores for the experimental group, from the pre-test to the post-test, after using the SDGs-based ecoliteracy e-module. Initially, the experimental group's pre-test average stood at 50%, demonstrating their baseline grasp of ecoliteracy prior to e-module

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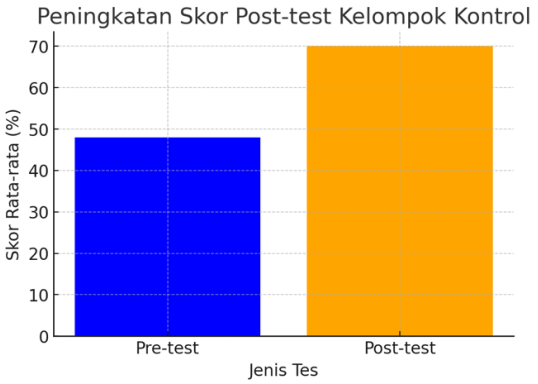
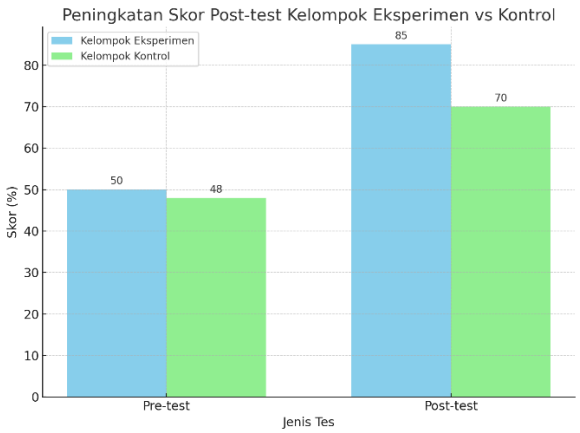
application. Following a period of implementation, their post-test average rose to 85%, signifying a substantial enhancement in their comprehension of ecoliteracy and sustainability principles. This improvement indicates that the e-module proves effective in boosting students' awareness of environmental challenges.

Figure 2. Increase in Post-test Scores of the Control Group



The graph displays the average scores of students from the pre-test to the post-test for the control group, which did not utilize the SDGs-based ecoliteracy e-module. In the pre-test, the control group's average score was 48%, closely matching that of the experimental group. Following a phase of traditional instruction without the e-module, the control group's average score rose to 70% on the post-test. Although this improvement was less pronounced than that observed in the experimental group, it indicates that the control group's advancement was neither as swift nor as substantial in the absence of the e-module intervention. This growth also underscores the comparatively restricted effectiveness of standard teaching approaches relative to the swift and marked gains achieved by the experimental group through the e-module.

Figure 3. Comparison of experimental and control groups



Comparison between the experimental group that used the Sustainable Development Goals (SDGs)-based ecoliteracy e-module and the control group that was not given this treatment. Experiment group Pre-test: Average score of 50%, indicating students' initial

understanding of ecoliteracy before using the e-module. Post-test: Average score of 85%, indicating a significant improvement. This 35% increase suggests that the SDGS-based e-module has substantially improved students' understanding of environmental and sustainability issues.

Control Group Pre-test: Average score of 48%, nearly equivalent to the experimental group's baseline, indicating similar basic understanding.
Post-test: Average score of 70%, a 22% increase. While there was an increase, it was not as significant as in the experimental group, indicating that without the e-module, students' understanding of ecoliteracy developed more slowly.

Impact of Using E-modules Experimental Group: The implementation of SDGS-based ecoliteracy e-modules significantly improved students' environmental understanding and awareness. Based on interviews and observations, students in the experimental group reported greater interest in environmental issues and were more active in class discussions on sustainability. They also began applying ecoliteracy concepts in their daily lives, such as reducing waste and conserving energy. Control Group: Although students in the control group showed increased understanding, interviews and observations indicated that the impact was more limited. Despite increased theoretical knowledge, students did not show significant changes in their attitudes or behaviors toward environmental issues. Students in the control group tended to be less active in discussions and did not apply the concepts they learned in their daily lives.

Discussion

The findings of this research reveal that applying the SDGs-based ecoliteracy e-module in the experimental group resulted in a notable enhancement in students' comprehension of ecoliteracy concepts and environmental consciousness relative to the control group. The rise in post-test scores for the experimental group, attaining 85% with an N-gain of 0.6, confirms the e-module's efficacy in fostering students' grasp of ecoliteracy and SDGs content. This research aligns with the findings of several previous studies showing that educational technology, particularly digital-based learning modules, can improve students' understanding of the material being taught. For example, research by (Tri Atmaja et al., 2021) which states that the use of technology-based learning media, such as e-modules, can improve conceptual understanding in elementary school students. However, in contrast to previous research, this study does not focus solely on improving understanding of the material but also integrates the SDGS concept, an innovation in ecoliteracy learning at the elementary school level. (Ekawati et al., 2025).

Theoretically, these findings support the Constructivist theory, which suggests that learning with technology can facilitate the construction of more profound knowledge, with students being more active in processing information (Rahmaniar et al., 2021). In this case, SDGS-based e-modules encourage students not only to memorize information but also to understand and apply sustainability values in their daily lives (Arifah, 2024).

Practically, the results of this study have important implications for the development of technology-based learning in elementary schools. The SDGS-based e-module on ecoliteracy can be used to introduce students to sustainability and environmental awareness from an early age (Taufik et al., 2024). This is important in achieving the Sustainable Development Goals (SDGs), which emphasize the role of education in fostering sustainability and environmental

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awareness among the younger generation (Saifuddin, 2023). However, this study also found that the control group, despite not using e-modules, still showed an increase in understanding, albeit to a lesser extent. This suggests that while traditional learning can improve students' experience, the application of technology, such as e-modules, has a greater impact. Therefore, integrating e-modules into elementary school learning should be considered as an alternative to increasing students' environmental awareness.

This research is in line with research by (Auliya Nurul & Nursiwi, 2024) A study found that technology-based learning can improve students' understanding of material related to moral and environmental values. However, this study further introduces the SDGS into the context of environmental education at the elementary school level, making a new contribution to the literature on ecoliteracy-based education.

CONCLUSION

The objective of this research is to create, build, and assess the impact of an e-module focused on ecoliteracy, grounded in the Sustainable Development Goals (SDGs), aimed at enhancing elementary school students' comprehension, employing the ADDIE (Analysis, Design, Development, Implementation, Evaluation) framework. Drawing from the data examination, the research outcomes show that the crafted e-module has proven successful in markedly advancing students' grasp of ecoliteracy ideas and SDG principles. The implementation of this e-module not only increases students' knowledge of environmental issues but also strengthens their awareness of the importance of sustainability and how they can contribute to environmental conservation efforts. The results showed that the experimental group using the e-module obtained a higher post-test score (85%) than the control group (70%), with a greater N-gain in the experimental group (0.6) than in the control group (0.2). This increase demonstrates the effectiveness of the e-module in improving students' understanding and environmental awareness, in line with learning objectives that focus on sustainability and ecological awareness. The primary contribution of this research lies in the development and implementation of an e-module that integrates the Sustainable Development Goals (SDGs) into ecoliteracy learning at the elementary school level. This research provides empirical evidence that technology-based learning, particularly through e-modules, can significantly support the achievement of sustainability-focused educational goals. The practical implication of these findings is that an SDG-based ecoliteracy e-module can be a highly effective tool in enhancing students' environmental awareness from an early age. This module enables students to gain a deeper understanding of the importance of sustainability. It encourages them to implement ecoliteracy principles in their daily lives, thereby strengthening the foundation of an education oriented toward environmental conservation and a more sustainable future.

Overall, this research significantly advances technology-based learning that supports sustainability education goals and enhances students' understanding of pressing environmental issues. These findings suggest that e-modules integrating sustainability concepts can play a key role in equipping students with the knowledge and skills needed to address global environmental challenges. Furthermore, the findings of this study open the door to the development of additional learning modules focused on student empowerment in both local and global sustainability contexts. Thus, these findings not only enrich existing educational practices but also provide a strong foundation for developing broader educational

initiatives that support the formation of a generation that cares about and is responsible for the sustainability of the planet.

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