

# The Effectiveness ESD-Oriented Learning Strategies with Local-Based Interactive Visual Media to Enhance Environmental sensitivity among Geography Students in Aceh

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## Abstract

This study aims to analyze the effectiveness of Education for Sustainable Development (ESD)-oriented learning supported by local-based interactive visual media in enhancing the environmental sensitivity of geography education students in Aceh. The study employed a quantitative approach using a quasi-experimental non-equivalent control group design involving 122 students from three universities in Aceh. The participants were divided into experimental and control groups. The experimental group received ESD-oriented learning integrated with local environmental issues and interactive visual media, while the control group received conventional learning. The research instrument consisted of an environmental sensitivity questionnaire based on local environmental case studies using a 4-point Likert scale. Data were collected through pretests and posttests and analyzed using descriptive statistics, paired-sample t-tests, independent-sample t-tests, and N-Gain analysis. The results revealed a significant improvement in the environmental sensitivity of students in the experimental group compared to the control group ( $p < 0.05$ ). The experimental group achieved a moderate N-Gain score, while the control group showed a lower improvement. The findings indicate that ESD-oriented learning integrated with local-based interactive visual media is more effective in strengthening students' environmental awareness, empathy, responsibility, and concern toward environmental issues. This study highlights the importance of contextual and interactive learning in promoting sustainable environmental education in higher education.

**Keywords:** Education for Sustainable Development (ESD), Environmental Sensitivity, Visual Learning Media Contextual Learning

## INTRODUCTION

Global environmental problems such as climate change, ecosystem degradation, and environmental pollution have become critical challenges that threaten the sustainability of human life. These issues occur not only on a global scale but also have direct impacts on local contexts, including Aceh, which is highly vulnerable to coastal degradation and marine ecosystem damage. This condition highlights the strategic role of education in fostering environmental awareness and responsibility among younger generations, particularly university students as agents of change within society (Ardoin, Bowers, & Gaillard, 2020; Sukacké et al., 2022; Sulistiyo et al., 2026).

In this context, Education for Sustainable Development (ESD) has emerged as an educational approach aimed at integrating environmental, social, and economic dimensions holistically into the learning process (Salam & Hamdu, 2022). ESD emphasizes not only the enhancement of knowledge but also the development of critical thinking skills, values, and attitudes that support sustainability. The effectiveness of ESD in higher education has been shown to increase student engagement in understanding and responding to environmental issues through contextual and participatory learning approaches (Rahmawati, Roshayanti, Susatyo Nugroho, & Saipul Hayat, 2021; Salsabila, Trisnowati, & Juliyanto, 2026).

However, learning practices in higher education still tend to focus predominantly on cognitive aspects, while the development of affective dimensions, such as environmental sensitivity, has not received optimal attention. Environmental sensitivity is an essential dimension of environmental education that reflects individuals' awareness, empathy, concern, and responsibility toward the environment (Jayadinata, Muqodas, & Ardiyanti, 2024). Low levels of environmental sensitivity may result in limited student involvement in environmental conservation efforts and a lack of pro-environmental behavior (A. A. Arini et al., n.d.).

Furthermore, learning practices that lack contextual relevance and the limited use of local environment-based learning media have made students less able to connect learning materials with the environmental realities surrounding them (Daniel Ady Putra, Gian Fitralisma, & M. Anisul Fata, 2024; Salam & Hamdu, 2022). In fact, learning approaches that integrate local contexts have been proven to be more effective in enhancing students' understanding and emotional engagement. The use of locally based interactive visual media can serve as an alternative for providing more authentic, engaging, and meaningful learning experiences (Firmansyah, Muhria, & Gani, 2026; Nurdianti & Sholikhah, 2024).

Several previous studies have examined the effectiveness of ESD in learning; however, most have primarily focused on improving cognitive aspects, such as environmental knowledge and ecological literacy. Research that specifically integrates ESD-oriented learning strategies with locally based interactive visual media to enhance affective dimensions, particularly environmental sensitivity, remains limited, especially within the context of higher education in coastal regions (Salam & Hamdu, 2022; Salsabila et al., 2026).

Moreover, within the context of geography education, learning approaches that integrate local environmental issues play a strategic role in fostering spatial awareness and strengthening the interconnectedness between humans and the environment (Suhartini, Maryam, & Trisnowati, 2025). Students are not only expected to understand geographical concepts but also to critically and contextually interpret environmental phenomena. A place-based education approach has been proven effective in enhancing student engagement and strengthening emotional connections with their surrounding environment (Anggriani, Karyadi, & Ruyani, 2019; Tanjung, Nasution, Lubis, Hasudungan, & Nababan, 2022).

The development of digital technology has also created new opportunities for designing more interactive and immersive learning media. Interactive visual media, including digital simulations and environmental visualizations, enable students to experience representations of environmental conditions more realistically, even within classroom settings (Nurdianti & Sholikhah, 2024). The use of such technologies improves conceptual understanding and contributes to the creation of more meaningful learning experiences that positively influence students' affective dimensions (Khomarudin & Na'imah, 2020; Suhartini et al., 2025).

Nevertheless, the integration of ESD-oriented learning strategies, local context-based approaches, and the utilization of interactive visual media in enhancing environmental sensitivity has not been extensively examined in a comprehensive manner. Most previous studies have tended to treat pedagogical approaches, media utilization, and local contexts as separate variables rather than as interconnected components. Therefore, this study seeks to address this gap by integrating these three aspects into a unified and contextual learning framework (Maryati & Jaya Lahay, 2025; Safitri, 2025; Yusuf Zaelani & Setyo Sansongko, 2025).

Based on the aforementioned issues, this study offers novelty through the integration of ESD-oriented learning strategies with locally based interactive visual media to enhance students' environmental sensitivity. Unlike previous studies that primarily emphasized cognitive aspects, this research focuses on strengthening affective dimensions through contextual learning experiences grounded in the local environmental context of Aceh. Furthermore, the locally based interactive visual media employed in this study function not only as instructional tools but also as a means of fostering students' emotional connectedness with real environmental issues in their surrounding environments.

Accordingly, this study aims to examine the effectiveness of ESD-oriented learning strategies supported by locally based interactive visual media in improving the environmental sensitivity of geography education students in Aceh. The findings of this study are expected to contribute to the development of contextual, innovative, and sustainable learning strategies in higher education.

## METHODS

This study employed a quantitative approach using a quasi-experimental method with a non-equivalent control group design to examine the effectiveness of Education for Sustainable Development (ESD)-oriented learning strategies supported by locally based interactive visual media in enhancing students' environmental sensitivity (Jeremy, Putri, Willyarti, & Jauhari, 2025). The research participants consisted of 122 students from Geography Education Study Programs at three universities in Aceh: Syiah Kuala University (50 students), Universitas Samudra (50 students), and Universitas Al Washliyah (22 students). The sample was selected using purposive sampling techniques and divided into experimental and control groups (Cuandra, Jessen, Kharisma, Anggraini, & Muliati, 2023).

The learning intervention was conducted in the Environmental Geography course over 3–4 class meetings. The experimental group received ESD-oriented learning supported by locally based interactive visual media, while the control group participated in conventional learning activities. The learning stages included the exploration of local environmental issues, problem-based learning, the use of interactive media, group discussions, and reflective learning activities.

The research instrument consisted of an environmental sensitivity questionnaire developed based on the concept of environmental sensitivity proposed by Louise Chawla (2020) and adapted from the connectedness to nature indicators formulated by S. Otto and P. Pensini (2017). The instrument comprised 25 statement items measured using a five-point Likert scale (1–5), covering the dimensions of awareness, concern, empathy, responsibility, and sensitivity toward local environmental contexts. Prior to its implementation, the instrument was tested for validity and reliability.

Data were collected through pretests and posttests administered to both groups and subsequently analyzed using descriptive statistics, paired-sample t-tests, independent-sample t-tests, and N-Gain analysis to determine the level of improvement in students' environmental sensitivity. The interpretation of N-Gain scores followed three categories: low (<0.3), moderate (0.3–0.7), and high (>0.7), with a significance level set at 0.05.

**Table 1. Environmental Awareness toward Real Environmental Issues in Aceh**

No.	Statement	1	2	3	4
1	I still use single-use plastics even though I am aware that much of the waste along the Aceh coastline has not been properly managed. (R)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2	I have littered, despite knowing that it can worsen river pollution that eventually flows into the sea in Aceh. (R)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

No.	Statement	1	2	3	4
3	I pay attention to the increasingly polluted condition of beaches in Aceh caused by waste accumulation.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4	I rarely contemplate how my daily habits contribute to waste problems in Aceh. (R)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5	I continue to use private vehicles even though I am aware that air pollution has been increasing in several areas of Aceh. (R)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Table 2 Environmental Concern toward Current Environmental Situations**

No.	Statement	1	2	3	4
6	I feel disturbed when seeing waste accumulating on beaches or rivers in Aceh, yet I do not take any action. (R)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7	I have reminded or advised others not to litter carelessly.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8	I choose to remain silent even when I witness environmental pollution around me. (R)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9	I participate in environmental clean-up activities organized by the campus or community.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10	I only care about environmental issues when there are official regulations or organized activities. (R)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Table 3 Environmental Empathy toward Environmental Cases in Aceh**

No.	Statement	1	2	3	4
11	I feel sad when witnessing the degradation of coastal and marine ecosystems in Aceh.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12	I do not experience any emotional impact when seeing news about floods or environmental damage in Aceh. (R)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
13	I feel that environmental degradation in Aceh does not significantly affect my life. (R)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
14	I can imagine the impact of environmental degradation in Aceh on future generations.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
15	I consider environmental issues in Aceh to be non-urgent problems. (R)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Table 4 Environmental Responsibility in Real-Life Behavior**

No.	Statement	1	2	3	4
16	I try to reduce the use of plastic after seeing the waste conditions in Aceh.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
17	I still choose cheaper products even though they may potentially harm the environment. (R)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
18	I dispose of waste properly even when there is no supervision.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
19	I rarely think about the environmental impacts of my daily habits. (R)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

No.	Statement	1	2	3	4
20	I make efforts to reduce habits that may worsen environmental degradation.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Table 5 Local Aceh-Based Environmental Sensitivity (CORE NOVELTY)**

No.	Statement	1	2	3	4
21	I often neglect coastal abrasion and environmental degradation along the coastal areas of Aceh. (R)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
22	I have searched for information about environmental conditions in Aceh, such as marine waste, floods, or coastal abrasion.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
23	I feel that environmental conditions in Aceh are unrelated to my life. (R)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
24	I am interested in participating in environmental conservation activities in Aceh.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
25	I do not feel that I have a role in protecting the environment in Aceh. (R)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
26	I have changed some of my daily habits after observing environmental conditions in Aceh.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

## RESULTS AND DISCUSSION

### Results

The findings of this study indicate that the implementation of Education for Sustainable Development (ESD)-oriented learning strategies supported by locally based interactive visual media had a positive effect on improving students' environmental sensitivity. Descriptively, the mean posttest score of the experimental group showed a significant increase compared to the pretest score. The average environmental sensitivity score of students in the experimental group increased from a moderate category during the pretest ( $M = 62$ ,  $SD = 7.10$ ) to a high category during the posttest ( $M = 82$ ,  $SD = 6.21$ ).

In contrast, the control group demonstrated a relatively lower improvement, with scores increasing from ( $M = 61$ ,  $SD = 6.85$ ) to ( $M = 68$ ,  $SD = 6.40$ ), which remained within the moderate category.

**Table 6. Pretest and Posttest Results of Students' Environmental Sensitivity**

Group	Pretest Mean (SD)	Category	Posttest Mean (SD)	Category
Experimental Group	62 (7,10)	Moderate	82 (6,21)	High
Control Group	61 (6,85)	Moderate	68 (6,40)	Moderate

Based on the results of the paired sample  $t$ -test, a significant difference was found between the pretest and posttest scores in the experimental group ( $t^* = 12.45$ ;  $p^* < 0.001$ ). Although the control group also showed improvement, the increase was relatively lower ( $t^* = 3.12$ ;  $p^* < 0.05$ ). Furthermore, the results of the independent sample  $t$ -test revealed a significant difference between the experimental and control groups in the posttest scores ( $t^* = 9.37$ ;  $p^* < 0.001$ ). Students who participated in ESD-oriented learning

supported by locally based interactive visual media demonstrated higher levels of environmental sensitivity compared to those who participated in conventional learning.

**Table 7 Statistical Test Results of Students' Environmental Sensitivity**

Statistical Test	Group/Comparison	t-value	Sig. (p)	Interpretation
Paired Sample t-test	Experimental Group	12,45	<0,001	Significant Improvement
Paired Sample t-test	Control Group	3,12	<0,05	Moderate Improvement
Independent Sample t-test	Experimental vs. Control Group	9,37	<0,001	Significant Difference

In addition, the results of the N-Gain analysis indicated that the experimental group achieved an average score of 0.55, which falls into the moderate category, whereas the control group obtained an average score of 0.18, categorized as low. These findings indicate that the improvement in students' environmental sensitivity in the experimental group was higher than that of the control group.

**Table 8 N-Gain Analysis Results of Students' Environmental Sensitivity**

Group	Mean N-Gain Score	Category
Eksperimen	12,45	Moderate
Kontrol	3,12	Low

When analyzed based on each indicator, the highest improvement was observed in the dimensions of environmental concern and environmental responsibility, while the dimensions of awareness and empathy also demonstrated positive trends. Students in the experimental group showed increased ability not only to understand environmental problems but also to demonstrate greater concern for the environmental conditions surrounding them.

**Table 9 Improvement of Environmental Sensitivity Based on Indicators**

Indicator	Level of Improvement	Description
Environmental Awareness	Moderate	Demonstrated a positive trend
Environmental Concern	High	Showed the most dominant improvement
Environmental Empathy	Moderate	Increased emotionally
Environmental Responsibility	High	Students became more active in protecting the environment

Therefore, the findings of this study indicate that ESD-oriented learning strategies supported by locally based interactive visual media are effective in enhancing students' environmental sensitivity, both statistically and in terms of improvements across each measured indicator.

## Discussions

The findings of this study demonstrate that the effectiveness of Education for Sustainable Development (ESD)-oriented learning strategies combined with locally based interactive visual media contributed significantly to improving students' environmental sensitivity (Widiyastuti et al., 2024). This improvement was reflected in the differences between pretest and posttest scores and further supported by the higher N-Gain values obtained by the experimental group compared to the control group. These findings indicate that learning designed integratively by combining cognitive, affective, and contextual aspects has greater effectiveness in fostering students' environmental awareness and concern. The results of this study are consistent with previous research suggesting that the development of sustainability competencies requires holistic and transformative learning approaches (Darmayanti et al., 2025; Fubani et al., 2024; Salsabila et al., 2026; Zakki et al., 2026).

The improvement in environmental sensitivity identified in this study was influenced by the interaction between learning strategies, instructional media, and the local context employed in the learning process (Rizkiani & Suasti, 2025). ESD-oriented learning strategies not only focused on knowledge transfer but also provided meaningful learning experiences through the exploration of real environmental issues in Aceh. Concrete phenomena such as coastal pollution, marine waste accumulation, and coastal abrasion occurring within their own region exposed students to these environmental realities. Exposure to these environmental realities enabled students to establish connections between the knowledge they learned and actual environmental conditions, thereby fostering stronger emotional engagement (Maharani & Indriyani, 2024). This finding supports the view that direct and contextual experiences are key factors in shaping environmental attitudes (Rasyid et al., 2023).

The interactive visual media utilized in this study also played an important role in enhancing the quality of the learning process. The media functioned not only as tools for delivering information but also as a means of presenting environmental conditions in a more concrete and immersive manner. Visualizations of marine pollution and the degradation of coastal ecosystems in Aceh strengthened students' perceptions of the urgency of environmental issues. Consequently, students not only understood environmental issues cognitively but also experienced them emotionally. Previous studies have indicated that the use of visual media and immersive technologies can enhance emotional engagement and strengthen experience-based learning (Hakim & Syawaludin, 2025; Rahmani et al., 2026).

In addition, the problem-based learning approach integrated into the ESD-oriented learning strategy also contributed to the improvement of environmental sensitivity. During the learning process, students not only received information but were also actively involved in identifying, analyzing, and formulating solutions to environmental problems (Arini et al., 2025). Such active involvement encouraged students to think critically and reflectively, thereby strengthening their environmental awareness and responsibility (Muhibbi et al., 2025). These findings support previous studies stating that problem-based learning within sustainability contexts can significantly enhance pro-environmental attitudes and behaviors (Herdiani & Dewi, 2026; Sudarto et al., 2025; Sumarni & Palennari, 2025).

The significant difference between the experimental and control groups indicates that conventional learning approaches have limitations in developing students' affective dimensions. Learning practices that are lecturer-centered and primarily focused on content delivery tend to provide limited opportunities for students to experience and reflect deeply on environmental issues (Jannah & Rahmi, 2024). Consequently, changes in environmental attitudes and behaviors do not always accompany students' cognitive understanding. In contrast, ESD-oriented learning, which is participatory and contextual in nature, is capable of encouraging both intellectual and emotional engagement among students. This finding is supported by previous studies

suggesting that active and reflective learning approaches have a greater impact on attitude change compared to passive learning methods (Rizki & Daniamiseno, 2019; Sumarni & Palennari, 2025).

The integration of Aceh's local context into the learning process also emerged as an important factor in enhancing environmental sensitivity. When students were exposed to environmental problems closely related to their daily lives, such as marine waste, floods, and coastal abrasion, they tended to demonstrate stronger emotional responses compared to when they studied abstract global environmental issues (Rizkiani et al., 2023). This approach made the learning process more relevant and meaningful, enabling students to perceive environmental issues not merely as theoretical concepts but as realities that directly affect their lives (Rizkiani & Wilis 2025). This finding aligns with the concept of place-based education, which emphasizes the importance of local contexts in improving learning effectiveness (Ardiansyah et al, 2025; Fitriyah et al, 2024).

From the measurement perspective, the use of a case study-based instrument in this research also strengthened the validity of the findings. The questionnaire statements were developed based on actual environmental conditions in Aceh, thereby reducing respondents' tendencies to provide normative or socially desirable answers. Consequently, the data obtained more accurately reflected students' actual conditions and attitudes. This approach is particularly important in environmental attitude research, as context-based instruments are considered more effective in authentically measuring environmental attitudes and behaviors (Awaluddin & Firmansyah, 2025; Dharma et al., 2024).

Overall, this study confirms that improving students' environmental sensitivity requires learning approaches that not only emphasize cognitive aspects but also integrate affective and contextual dimensions. The combination of ESD-oriented learning strategies, the use of interactive visual media, and the integration of Aceh's local context has been proven to create more meaningful and transformative learning experiences. Therefore, this approach has strong potential to be further developed in higher education, particularly in geography education and environmental education, to support the achievement of sustainable development goals.

## CONCLUSION

The results of this study show that using locally based interactive visual media to teach Education for Sustainable Development (ESD) is a good way to make geography education students more aware of the environment. This effectiveness was evidenced by the significant increase in posttest scores in the experimental group compared to the control group, as confirmed by statistical test results and N-Gain analysis. Students who participated in the ESD-based learning demonstrated improvements in the dimensions of environmental awareness, concern, empathy, and responsibility.

This study also addresses the research problem by showing that the integration of ESD-oriented learning strategies with locally based interactive visual media can create learning experiences that are more contextual, engaging, and meaningful. The visualization of local environmental issues in Aceh, such as coastal pollution, marine waste, and coastal abrasion, helped students understand environmental problems more concretely while fostering stronger emotional connections with their surrounding environment. Therefore, ESD-based learning supported by locally based interactive visual media can serve as an innovative alternative learning strategy for strengthening environmental education in higher education.

Furthermore, this study confirms that ESD-oriented learning strategies combined with locally based interactive visual media have strong potential for further development in higher education, particularly in geography education and environmental education. This approach may serve as an innovative learning alternative that supports the strengthening of sustainability competencies as well as the deeper and more sustainable development of students' environmental attitudes and behaviors.

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