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ENHANCING ENVIRONMENTAL LITERACY THROUGH THE IMPLEMENTATION OF EXPERIENTIAL AND JOYFUL LEARNING MARINE EDUTOURISM WITHIN THE BAROS MANGROVE ECOSYSTEM OF BANTUL

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Abstract*: Low environmental literacy among Indonesian students, necessitates innovative pedagogical models such as Experiential and Joyful Learning Marine Edutourism (EJoy-ME). This study evaluates the effectiveness of the EJoy-ME model, based on the local potential of the Baros Mangrove, in enhancing students' environmental literacy. A quasi-experimental pretest-posttest design was implemented in December 2026 with 42 junior high school students from SMP IT Ar Rahmah and SMP Muhammadiyah Kretek. The results show that average literacy scores increased from 46.55 to 52.33 (N-Gain = 0.11, Low category). However, significant improvements were achieved in the issue-analysis domain, where students' ability to identify environmental problems rose from 21% to 74% (N-Gain = 0.67, Moderate category) and formulating solutions increased from 31% to 74% (N-Gain = 0.62, Moderate category). Achievement of the Minimum Completeness Criteria (KKM) also improved from 19% to 36%. These findings indicate that the 6-stage EJoy-ME syntax effectively bridges the gap between theoretical knowledge and pro-environmental action by fostering deep emotional and cognitive engagement within local ecosystem.*

Keywords: *Baros Mangrove; EJoy-ME; Environmental Literacy; Experiential Learning; Joyful Learning; Marine Edutourism.*

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INTRODUCTION

The acceleration of global environmental degradation and the increasing frequency of climate-related disasters have placed environmental education at the forefront of the international sustainable development agenda. In the context of Indonesia, a megadiverse maritime nation, the preservation of coastal ecosystems, particularly mangrove forests is not merely an ecological necessity but a cornerstone of socioeconomic resilience and disaster mitigation (Husamah et al., 2022). However, the efficacy of traditional pedagogical approaches in fostering environmental literacy remains highly contested, as evidenced by the persistently low performance of Indonesian

students in international assessments related to scientific and ecological competencies (Rita et al., 2025). Indonesia's reading literacy score in 2022 was the lowest among PISA scores in previous years, namely 359 (Jauhari, 2023). The disparity between the abundance of local natural resources and the limited environmental awareness of the younger generation underscores a systemic failure to bridge the gap between abstract theoretical knowledge and concrete pro-environmental action.

The Baros Mangrove area in Bantul, Yogyakarta, represents a critical site for exploring the intersection of community-based conservation and innovative educational interventions. This artificial ecosystem, initiated in 2003 through grassroots restoration efforts, provides a unique "living laboratory" where the principles of Experiential and Joyful Learning can be applied within a Marine Edutourism (EJoy-ME) framework. By transitioning the site from a passive tourism destination into a structured educational environment, the EJoy-ME model aims to cultivate a generation of students who are not only knowledgeable about marine ecology but are also equipped with the cognitive skills to analyze environmental issues and the emotional resilience to participate in long-term conservation (Rita et al., 2025).

The National Crisis of Environmental Literacy in the Indonesian Context

Environmental literacy is a multidimensional construct that encompasses knowledge of ecological systems, the ability to identify and analyze environmental problems, a set of pro-environmental attitudes, and the commitment to engage in sustainable behaviors. According to the framework established by the North American Association for Environmental Education (NAAEE), a truly literate individual understands the complex relationship between human activities and planetary well-being and possesses the self-efficacy to influence that relationship positively (Szczytko et al., 2018). In Indonesia, despite the integration of environmental themes into the national curriculum and the success of the Adiwiyata (Green School) program in many regions, the overall level of environmental literacy among junior and senior high school students remains critically low or, at best, moderate.

Empirical data from various regions illustrates a significant "cognitive skill gap" where students may memorize factual information about biology but struggle to apply it to real-world problems. For instance, a study at SMA N 1 Brebes found that while ecological knowledge scores were relatively high at 79.14%, cognitive skills, such as identifying the root causes of pollution or predicting the consequences of habitat loss, were as low as 33.78% (Rita et al., 2025). This discrepancy suggests that the Indonesian education system often prioritizes rote learning over higher-order thinking skills, leaving students ill-prepared to address the complex socio-scientific issues of the 21st century.

Table 1. Indonesia Student's Environmental Literacy

Environmental Literacy Indicator	Average Achievement (%)	Qualification
Ecological Knowledge	77.38% - 79.14%	Good
Cognitive Skills (Issue Analysis)	33.78% - 37.00%	Poor
Environmental Awareness/Concern	61.65% - 70.12%	Moderate/Good
Environmentally Responsible Behavior	59.50% - 66.52%	Sufficient

The data presented in the table 1 demonstrates that while students possess the "raw material" of knowledge, they lack the "processing tools" of literacy. This is particularly evident in coastal regions where the preservation of mangroves is essential. Without the ability to analyze issues, students cannot understand why a local developer's decision to clear mangroves for a resort is ecologically detrimental, even if they can list the parts of a mangrove root in a classroom setting (Marfiana et al., 2025). This failure of "contextualization" is the primary motivator for the development of the EJoy-ME model, which seeks to ground learning in the immediate physical and socioeconomic realities of the local environment (Hayati, Ma'rifah, Astutik, & Prayogo, 2025).

Ecological Evolution and Socioeconomic Significance of the Baros Mangrove Ecosystem

The Baros Mangrove area, located at the Opak River Estuary in Tirtohargo, Kretek, Bantul, serves as the geographic and pedagogical anchor for this implementation. Unlike many natural mangrove stands in Indonesia, Baros is primarily an artificial forest, the result of a deliberate and persistent community-led restoration project. The initiative was launched in 2003 by the NGO Relung (now Relung Indonesia Foundation) in response to chronic flooding and coastal abrasion that threatened the livelihoods of local farmers and livestock owners. From an initial planting area of 2.1 hectares, the site has expanded into a 26-hectare forest, providing a buffer zone for a larger 132-hectare conservation reserve.

The site's ecological function is twofold: disaster mitigation and biodiversity enhancement. The mangroves act as a bioshield, absorbing the energy of waves and protecting the inland agricultural zones from seawater intrusion (Wijayanti & Hadianti, 2025). Simultaneously, the forest provides a habitat for various species of birds, fish, and macro-invertebrates, thereby supporting the local fisheries and creating opportunities for nature-based tourism (Ihinegbu et al., 2023). The composition of the forest reflects a strategic selection of species tailored to the estuarine environment of the southern coast of Java.

Table 2. Mangrove Species at Mangrove Baros Ecosystem

Mangrove Species at Baros	Proportion (%)	Key Functional Adaptations
Avicennia sp.	60%	High salt tolerance, pneumatophores for gas exchange in muddy soil.
Rhizophora sp.	20%	Stilt roots for coastal stability and wave attenuation.
Bruguiera sp.	10%	Knee roots, efficient carbon sequestration in anaerobic sediments.
Nypa fruticans	10%	Resistance to lower salinity, important for estuarine palm biodiversity.

Despite its ecological success, the Baros ecosystem remains vulnerable. Recent assessments of its sustainability index on the ecological dimension yielded a score of 32.60%, categorizing it as "less sustainable" (Ihinegbu et al., 2023). This vulnerability is attributed to several factors, including the accumulation of riverborne pollutants, high sedimentation rates, and the pressures of unmanaged mass tourism. Furthermore, the lack of educational infrastructure, such as interpretive signage and specialized learning tools, has prevented the site from reaching its full potential as a center for environmental education (Ihinegbu et al., 2023). This context makes the implementation of EJoy-ME not only an educational intervention but also a strategic component of the site's long-term conservation management (Gunawan et al., 2025).

Theoretical Framework: Synthesizing Experiential and Joyful Learning

The EJoy-ME model is grounded in the convergence of two major pedagogical streams: Kolb's Experiential Learning Theory and the neuro-pedagogical principles of Joyful Learning (Hayati et al., 2023). This synergy is designed to address both the cognitive and affective deficiencies identified in current Indonesian environmental education practices.

Experiential Learning and the Transactional Nature of Knowledge

Experiential learning, as championed by John Dewey and later formalized by David Kolb, posits that learning is the process whereby knowledge is created through the transformation of experience (Warners et al., 2026). For the students at Baros, this means that "knowing" a mangrove is not the same as "observing" a diagram of one. Learning must be a transaction between the student and the muddy, saline environment of the estuary (Ord & Leather, 2011). Kolb's cycle consisting of concrete experience, reflective observation, abstract conceptualization, and active experimentation, provides a rigorous structure for this transaction (Wang, 2025).

Ejoy-ME is a model that integrates experiential and joyful learning strategies within the

context of the marine ecosystem. Through this approach, Ejoy-ME enables students to learn joyfully by engaging in hands-on activities and direct experiences in natural environments, particularly mangroves, which are an essential part of the marine ecosystem. In the "Doing" phase of EJoy-ME, students participate in the physical act of planting mangrove seedlings. This activity is not merely symbolic; it provides a direct, tactile understanding of the difficulty of restoration and the specific requirements for mangrove survival (Irawan, 2023). The reflection that follows allows students to move from the individual act to a systemic understanding of how a single plant contributes to the resilience of a whole coastline (Birdsall, 2021).

Joyful Learning: Creating the Neuro-Biological Conditions for Deep Learning

Joyful learning is often misunderstood as a superficial focus on games and entertainment. In the EJoy-ME model, it is viewed as a critical strategy to optimize the brain's receptivity to learning (Mahajan, 2024). Rooted in the RAD model (Reticular Activating System, Amygdala, and Dopamine) proposed by researchers like Judy Willis, joyful learning addresses the sensory, emotional, and motivational pathways of the brain. Reticular Activating System: The novelty of the boat trip and the presence of wildlife (e.g., monkeys and birds) capture the students' attention more effectively than a classroom lecture. Amygdala: By conducting learning in a non-threatening, enjoyable tourism environment, the "affective filter" is lowered. When students feel happy and safe, information flows freely to the prefrontal cortex, where high-level analysis occurs. Dopamine: The satisfaction of successful planting or the discovery of a unique organism triggers dopamine release, which strengthens memory consolidation and enhances long-term retention of environmental concepts (Mahajan, 2024).

RESEARCH METHOD

The research was conducted as part of community service. This research employed an experimental method with a quasi-experimental pretest-posttest design to measure changes in students' environmental literacy. This design allowed for the assessment of the model's effectiveness by comparing initial literacy levels with those achieved after the intervention.

Subjects and Timing

The implementing program was conducted in December 2026. The subjects involved in this study were 42 junior high school students, specifically from SMP IT Ar Rahmah and SMP Muhammadiyah Kretek. This selection targeted students in the Bantul region who have direct proximity to the Baros Mangrove ecosystem.

Treatment Variable: The EJoy-ME Model

The independent variable in this study is the Experiential and Joyful Learning Marine Edutourism (EJoy-ME) model. EJoy-ME is a specialized environmental education approach that integrates marine tourism with experiential and joyful learning strategies. The model focuses on the issue analysis domain of environmental literacy, aiming to build students' capacity to analyze causes, consequences, and solutions for ecological problems.

Instructional Syntax of EJoy-ME

The treatment was implemented following a structured 6-stage syntax designed to facilitate a deeper emotional and cognitive connection to the environment.

1. **Leisure "Fun"**: This initial stage builds students' enthusiasm by providing a fun, non-threatening atmosphere using ecotourism attractions. In Baros, this involved wildlife watching and exploring the ecosystem to create a positive emotional bond. When sttudent plant mangrove in coastal area of Baros, students expressed excitement by voluntarily exploring how to plant mangroves and identifying the best locations for planting. This condition demonstrates their active engagement and joyful learning experience.

Figure 1. Implementation of Baros Mangrove Planting by Students

2. **Experiencing "Doing"**: Students engage in hands-on activities, such as planting mangrove seedlings and direct observation of the flora and fauna. Learning something which is not naturally in their local environment, made students can train their competence for doing the observation. Learning about unfamiliar aspects of the environment helps students develop their

observation skills. This circumstance strengthens how Ejoy-ME supports competency growth through hands-on learning. Student use all their modal for learning on the activities. This stage provides the concrete experience necessary for transactional learning.

Figure 2. Students Explore Mangrove Baros Ecosystem

3. **Reflecting "What Happened?"**: Students share their learning experiences and feelings with peers. This reflection is crucial for internalizing the sensory data collected during the "Doing" phase.

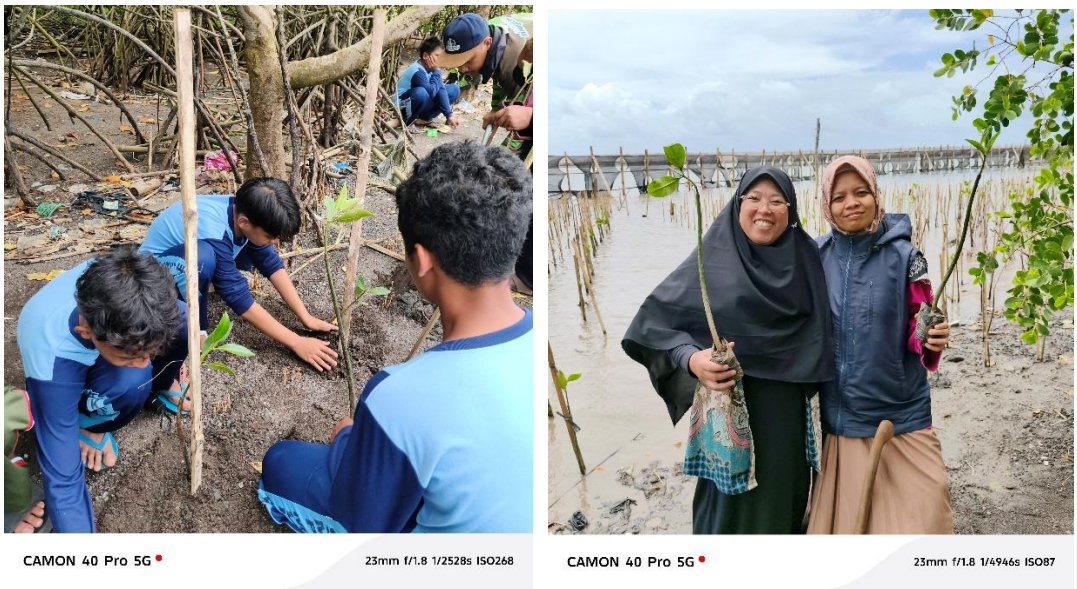

Figure 3. Students Reflection Guides by Lecturer and Teachers

4. **Processing "What's Important?"**: Students analyze their reflections to form new abstract concepts. This stage moves learners from observation to identifying the core ecological and human impacts on the site.

5. **Generalizing "So What?"**: Students relate their local experiences to broader environmental issues and climate challenges. They are required to make decisions or propose general rules based on their knowledge.

6. **Testing in New Situations**: Students apply their outcomes to propose pro-environmental actions or solve new environmental problems. This demonstrates the transformation of literacy into action competence.

Data Collection and Analysis

Literacy data were collected through pretest and post-test instruments consisting of validated multiple-choice questions for knowledge and issue analysis, alongside Likert-scale questionnaires for attitudes and behaviors. The data were analyzed quantitatively using normalized gain (N-Gain) and t-tests to determine the significance of the literacy improvement.

RESULTS & DISCUSSIONS

Analysis of Implementation Results: Cognitive Gains and Minimum Completion Criteria Attainment

The implementation resulted in a measurable increase in students' environmental literacy average. However, the N-Gain analysis reveals that the magnitude of improvement varied significantly across different literacy domains (Wahyuningsih et al., 2026).

Table 3. Student's Environmental Literacy Score

Literacy Indicator	Pretest (%)	Posttest (%)	N−Gain	Classification
Overall Average Literacy	46.55	52.33	0.11	Low
Understanding Functions	50.00	86.00	0.72	High
Problem Identification	21.00	74.00	0.67	Moderate
Solution Formulation	31.00	74.00	0.62	Moderate

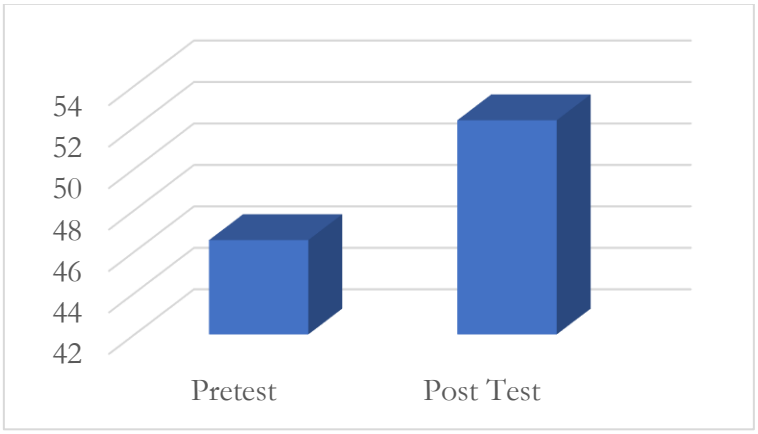

Figure 4. Diagram of Environmental Literacy Pretest Posttest

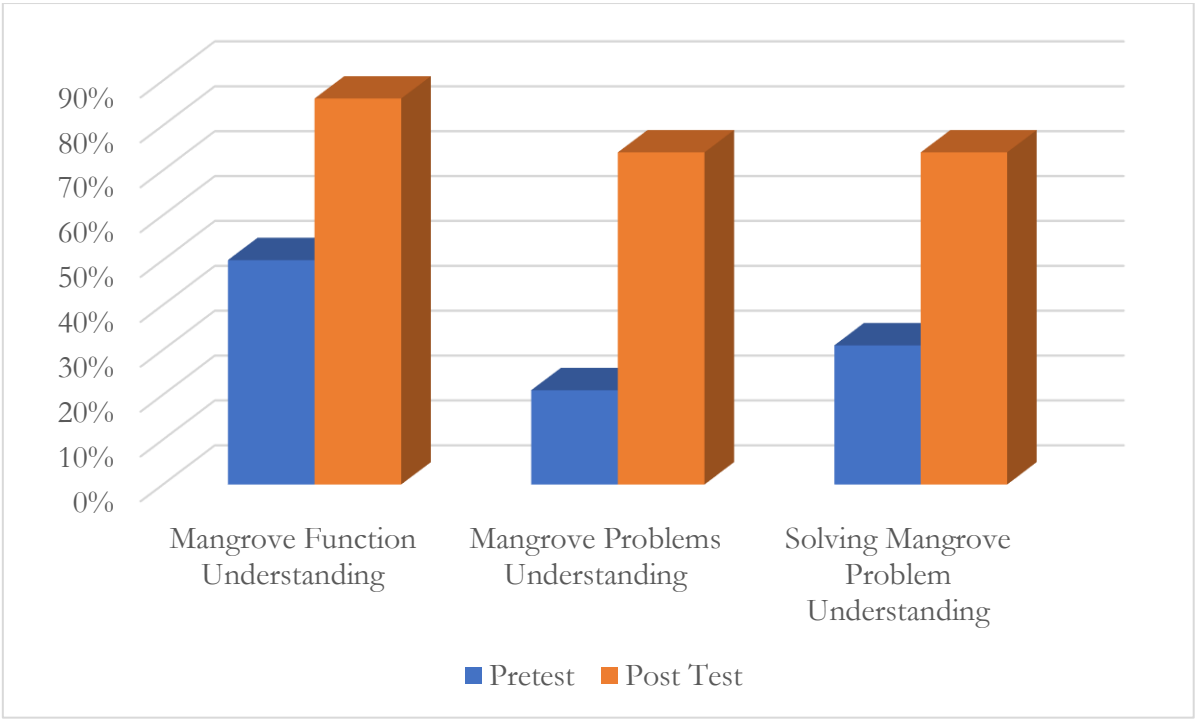

Figure 5. Pretest Posttest Diagram of Mangrove Ecosystems Understanding

The overall N-Gain of 0.11 indicates a "Low" improvement category for general environmental literacy (Hayati, Ma'rifah, Astutik, & Irmawanty, 2025). This result is consistent with findings in other Indonesian contexts where broad literacy shifts require longer-term interventions and consistent reinforcement. Nevertheless, the achievement of Minimum Completeness Criteria (KKM) showed a positive trend, with the percentage of students reaching the threshold increasing from 19% to 36% (+89.5% relative growth) (Wahyuningsih et al., 2026).

Transformation of Issue-Analysis Skills

While the overall gain was low, the EJoy-ME model proved highly effective in the high-level cognitive domain of "Issue Analysis." The N-Gain for problem identification (0.67) and solution formulation (0.62) falls within the "Moderate" category, nearly reaching the high threshold. Before the intervention, only 21% of students could accurately identify environmental threats at Baros; this surged to 74% following the field experience (Wahyuningsih et al., 2026).

This transformation highlights the strength of the EJoy-ME syntax in bridging the "context-gap" of traditional education (Mahajan, 2024). By allowing students to move through the "Reflecting" and "Processing" stages, the model enables them to connect the "Fun" of tourism with the "Logic" of conservation (Meilinda, 2017). The jump in the "Understanding Functions" indicator (N-Gain=0,72, High category) further demonstrates that direct interaction with the mangrove ecosystem is far more effective for conceptual mastery than textbook learning (Rita et al., 2025).

Achievement of Minimum Completeness Criteria

In the Indonesian education system, the Minimum Completeness Criteria (KKM) is the standard of mastery for a particular subject. For science and environmental topics, this is typically set around a score of 70 (Hapsari & Murtini, 2012).

Table 4. KKM Achievement of Student's Environmental Literacy

Metric	Pretest (%)	Post-test (%)	Relative Growth
Students Reaching KKM (Score ≥ 70)	19%	36%	+89.5%
Overall Average Literacy Score	46.55	52.33	+12.4%

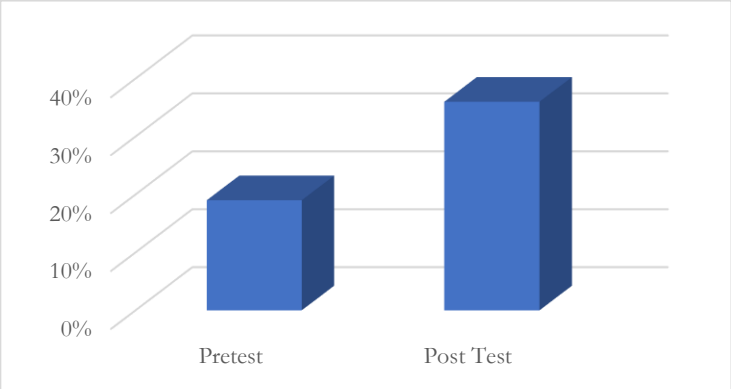

Figure 6. Diagram of KKM Achievement

The near-doubling of the percentage of students reaching the KKM is a powerful indicator of the model's impact on "low-performing" students. It suggests that the experiential and joyful nature of the program is highly effective at engaging students who may struggle with the traditional "memorize-and-test" format of the standard curriculum (Jeet & Pant, 2023).

Deeper Insights: The Transformation of Issue-Analysis Skills

The most striking results of the implementation are found in the breakdown of student understanding regarding specific aspects of the mangrove ecosystem. The gains in understanding "Problems" and "Solutions" significantly outpaced the gains in general knowledge.

Table 5. Pretest Posttest of Student's Environmental Literacy

Domain of Understanding	Pretest Success (%)	Post-test Success (%)	Growth (Percentage Points)
Mangrove Ecosystem Functions	50%	86%	+36%
Mangrove Ecosystem Problems	21%	74%	+53%
Mangrove Problem Solutions	31%	74%	+43%

This data reveals a profound shift in the students' "Issue Analysis" competency—the very skill that is most deficient in the national student profile.[3] The jump from 21% to 74% in identifying problems indicates that before the intervention, students were almost entirely unaware of the anthropogenic and natural threats facing the Baros mangroves, such as waste pollution, sedimentation, and illegal conversion. By moving through the "Reflecting" and "Processing" stages of the EJoy-ME syntax, they were able to connect their direct observations of "trash in the roots" or "dead seedlings" to broader systemic issues.

From Passive Awareness to Proactive Action Competence

The increase in the "Solutions" domain (from 31% to 74%) suggests that the EJoy-ME model does not just teach students about "what is wrong"; it empowers them with the cognitive tools to conceive of "what can be done". This is the essence of "action competence", a key goal of Education for Sustainable Development (ESD). When students participate in planting (the "Doing" phase), they realize that they have the physical power to contribute to restoration. This physical efficacy then translates into cognitive efficacy during the "Testing in New Situations" stage, where

they propose management strategies for the Baros area.

Synergistic Analysis: Why EJoy-ME Outperforms Traditional Models

The success of the EJoy-ME implementation at Baros can be explained through several interconnected mechanisms that extend beyond the simple "field trip" concept. These insights represent the "second-order" benefits of the marine edutourism framework (Hayati, Ma'rifah, Astutik, & Irmawanty, 2025). Traditional curricula often use generic or non-local examples (e.g., studying the Amazon rainforest), which creates a sense of detachment (Marfiana et al., 2025). EJoy-ME at Baros utilizes "local potential" and the specific history of the Opak River estuary. This contextualization makes the learning "meaningful" because it directly relates to the students' own geographic and cultural identity. When students learn about the *Avicennia* and *Rhizophora* species at Baros, they are learning about the very trees that protect their local rice fields from abrasion (Djumanto, 2020). This relevance is a powerful catalyst for engagement.

Challenges in Community Management and Sustainability

Despite the positive outcomes of the implementation, several systemic challenges remain that could hinder the long-term sustainability of environmental literacy gains in the Baros area.
Sustainability Index and Ecological Degradation

The "less sustainable" status of the Baros ecological dimension (32.60%) is a serious concern. The high sensitivity of the "mangrove ecosystem diversity level" indicator suggests that the current monoculture-heavy planting practices (60% *Avicennia*) may not be sufficient for long-term resilience (Yunus et al., 2023). Furthermore, the survival rate of planted mangroves globally is often as low as 20% due to unsuitable site selection or lack of maintenance (Wodehouse et al., 2024). For the EJoy-ME program to remain effective, the site itself must be managed according to professional conservation standards, which include natural regeneration and hydrological restoration.

Management and Infrastructure Deficiencies

The Baros area currently lacks the "educational infrastructure" necessary to scale the EJoy-ME model (Wijayanti & Hadianti, 2025). The narrow, rocky access roads and the absence of meeting rooms, prayer rooms (mushola), and adequate toilets make it difficult for large school groups to visit regularly. Additionally, the site lacks "interpretive media", such as species name boards or QR-coded educational trails, that could facilitate independent or self-guided learning (Marfiana et al., 2025).

Teacher Readiness and Professional Development

The transition from a "teacher-centered" lecture style to a "facilitator-centered" experiential style is a significant challenge for many Indonesian educators. Implementing the 6-stage EJoy-ME syntax requires a deep understanding of both ecology and neuro-pedagogy. Without dedicated teacher training and the provision of ready-to-use "EJoy-ME kits," the model may remain an occasional activity rather than a permanent fixture of the science curriculum (Gunawan et al., 2025).

CONCLUSION

The implementation of the Experiential and Joyful Learning Marine Edutourism (EJoy-ME) model at the Baros Mangrove area represents a critical advancement in the field of Indonesian environmental education. The results of this community service project demonstrate that the "literacy gap", particularly in the domain of cognitive issue-analysis skills, can be bridged through the systematic integration of authentic experience and joyful engagement. The transition of student understanding from a baseline of 21% to a post-intervention 74% in identifying environmental problems provides robust empirical evidence for the transformative potential of the EJoy-ME syntax. By leveraging the local potential of the Baros ecosystem, the model transforms students from passive recipients of ecological facts into active participants in coastal resilience. The 6 stage syntax ensures that the sensory joy of the marine environment is systematically converted into the cognitive power of analysis and the moral commitment of action. As Indonesia strives to achieve its Sustainable Development Goals and build a climate-resilient society, the lessons learned at Baros provide a scalable and effective paradigm for cultivating an environmentally literate citizenry. The Baros Mangrove is no longer just a wall against the sea; it is a gateway to a more sustainable and ecologically intelligent future for the youth of Bantul.

Recommendations for Stakeholders and Future Outlook

To capitalize on the successes of the Baros implementation and ensure that environmental literacy becomes a permanent competency for junior high students in Bantul, the following strategies are recommended.

For the Bantul Regency Government and Local Schools

1. Curricular Integration: The local government should issue policies encouraging or mandating the use of the Baros Mangrove area as a "Context-Based Learning Resource" for the Merdeka Curriculum (Taharu, 2025). This should include cross-disciplinary projects that link Biology, Geography, and Social Sciences through the EJoy-ME framework (Restu et al., 2017).

2. Infrastructure Investment: Utilizing the Tourism Special Allocation Fund (DAK Pariwisata), the government should improve the physical infrastructure at Baros, focusing on "Educational Ecotourism" facilities. This includes creating an outdoor classroom, a seedling nursery for student use, and comprehensive interpretive signage (Irawan, 2023).

For the Baros Youth Management Group (KP2B)

1. Transition to "Edutourism Hub": The management group should transition from providing "general tourism" to "educational tourism." This involves training local guides to become "facilitators" who can guide students through the EJoy-ME syntax.
2. Citizen Science Initiatives: KP2B can partner with schools to involve students in "monitoring activities" (e.g., survival rates of seedlings, water quality testing). This creates a "feedback loop" where the students' learning contributes directly to the site's conservation database.

For Researchers and Educational Innovators

1. Development of Digital Scaffolding: To address the lack of on-site guides, researchers should develop mobile applications or interactive e-modules based on the Baros ecosystem (Fithriyah et al., 2025). These tools can provide "virtual smart school" features, allowing students to access information about mangrove species and issues via their smartphones during the trip.
2. Longitudinal Literacy Tracking: Future research must move beyond pretest-posttest analysis to track long-term "behavioral shifts" (Fithriyah et al., 2025). This involves monitoring whether students who participated in the EJoy-ME program continue to engage in pro-environmental behaviors (e.g., recycling, community activism) as they move into high school and adulthood.

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