Empowering Youth for Climate Action Through Community-Based Environmental Education: A Case Study of Mangrove Conservation in Malaysia

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ABSTRACT

Climate change presents significant social and environmental challenges, highlighting the need to empower young people with the knowledge, values, and skills required to participate in sustainable development. Community-based environmental education has emerged as an effective approach for fostering environmental awareness, civic responsibility, and pro-environmental behaviour among youth. This study examines the implementation and perceived outcomes of a community-based mangrove conservation education programme conducted in Iskandar Puteri, Malaysia. Using a qualitative case study approach, data were collected through participant reflections, teacher feedback, facilitator observations, and programme documentation to explore students' learning experiences and behavioural changes. The programme combined environmental awareness sessions, experiential mangrove planting, creative learning activities, environmental quizzes, podcasts, and community engagement initiatives to promote climate literacy and environmental stewardship. The findings indicate that experiential learning significantly enhanced students' understanding of mangrove ecosystems and their role in climate change mitigation while strengthening their sense of environmental responsibility. Participants also demonstrated positive behavioural changes by adopting sustainable practices at home and school, initiating recycling activities, and encouraging environmentally responsible actions among their peers and families. The programme further strengthened collaboration between schools, local authorities, non-governmental organisations, and higher education institutions, illustrating the value of multi-stakeholder partnerships in advancing sustainability education. The study demonstrates that community-based environmental education can serve as an effective social intervention for developing environmental citizenship and youth empowerment while supporting broader sustainable development goals. The findings contribute to the growing body of social science literature by demonstrating how experiential learning and community collaboration can promote meaningful behavioural change and strengthen climate action among young people. The study offers practical implications for educators, policymakers, and community organisations seeking to integrate sustainability education into formal and informal learning environments.

Keywords: community-based environmental education; youth empowerment; climate action; environmental stewardship; sustainable behaviour

INTRODUCTION

The increasing severity of climate change has amplified worldwide focus on environmental sustainability, particularly concerning ecosystems that are susceptible, such as mangrove forests. Mangroves function as essential natural infrastructure, includes capturing carbon, safeguarding coastlines against erosion, and maintaining marine biodiversity (Alongi, 2012; Friess et al., 2019). Nevertheless, swift urban expansion and

climate-induced stressors persist in undermining these crucial ecosystems, particularly within developing regions. In response to these pressing issues, there exists a burgeoning consensus on the necessity to equip the forthcoming generation with the requisite knowledge, skills, and values essential for addressing environmental crises (UNESCO, 2020).

The engagement of youth in climate action represents not merely a moral obligation but a pragmatic approach to cultivating enduring ecological resilience (Ojala, 2012). Environmental education (EE), when anchored in participatory and experiential learning methodologies, has demonstrated considerable promise in fostering pro-environmental behaviors among youth (Ardoin et al., 2020; Ballantyne & Packer, 2009). Empirical studies indicate that students who engage actively with the natural environment are more inclined to develop ecological literacy and a personal sense of responsibility towards environmental stewardship (Chawla & Derr, 2012).

Furthermore, EE that incorporates narrative techniques, community participation, and reflective practices tends to yield more enduring effects on attitudes and behaviors (Clarke & Mcphie, 2016; Monroe et al., 2019). Despite these valuable insights, a deficiency persists in context-specific investigations, particularly in Southeast Asia scrutinizes how environmental initiatives affect youth perspectives and practices through direct engagement with ecological dilemmas. This paper presents a qualitative case study of the Mangrove: The Blue Carbon initiative executed in Iskandar Puteri, Malaysia. This program, which specifically targeted primary school students, merged classroom instruction with outdoor mangrove planting, environmental quizzes, creative endeavors, podcasting, and involvement in national forums.

Through this comprehensive approach, the initiative sought to elevate awareness regarding mangrove ecosystems while fostering climate-conscious behaviors. Employing narrative inquiry and thematic analysis, this study investigates how students perceived and assimilated their environmental encounters. It additionally assesses the significance of community partnerships in reinforcing sustainable values and educational outcomes. In this manner, the study contributes to the expanding corpus of literature that advocates for the integration of localized, youth-centered methodologies in climate education policy and practice.

LITERATURE REVIEW

Foundations of Environmental Education and Youth Engagement

Environmental education is increasingly acknowledged as an essential instrument for tackling intricate ecological dilemmas by cultivating informed and responsible citizens. Specifically within programs aimed at youth, the objective transcends mere knowledge dissemination to encompass the cultivation of ecological awareness and proactive stewardship. Luan et al. (2025) investigated this phenomenon through a phenomenographic analysis involving undergraduate students, delineating a spectrum of environmental education conceptions. These conceptions varied from passive roles are characterized by the mere reception and distribution of information to more engaged understandings that incorporated critical analysis and practical problem-solving. The investigation further indicated that students who embraced active conceptions exhibited a greater propensity for deep learning strategies, implying that the manner in which students conceptualize environmental education significantly impacts their engagement and educational outcomes (Luan et al., 2025).

This foundational perspective holds particular significance for early educational initiatives such as the “Mangrove: The Blue Carbon” project, which incorporated active and experiential elements, including mangrove planting and creative narrative development. Instead of framing environmental education as an abstract subject confined to the classroom, the initiative aimed to root learning in tangible experiences. This methodology resonates with constructivist pedagogical principles, wherein knowledge is constructed through significant interactions with one's surroundings. By focusing on primary school students, an age demographic particularly amenable to the formation of behavioral patterns. The project also serves as a paradigm of how early engagement, when designed around action-oriented learning, can foster enduring environmental values and practices.

The Theory of Planned Behaviour (TPB) offers a valuable lens for interpreting the behavioral shifts observed in the “Mangrove: The Blue Carbon” initiative. According to TPB, individual behavior is shaped by three key

constructs, namely attitudes toward the behavior, subjective norms, and perceived behavioral control (Ajzen, 1991). In this study, students' enhanced ecological literacy contributed to more favorable attitudes toward climate-friendly actions, while community involvement and peer-led initiatives likely reinforced normative pressures that validated such behaviors. Moreover, the experiential components such as mangrove planting and seed cultivation help in boosting students' confidence in their capacity to effect change, reflecting heightened perceived behavioral control. This synergy among TPB constructs helps explain why students progressed from passive awareness to proactive engagement, suggesting that environmental education programs designed with these psychological drivers in mind can catalyze more sustained environmental stewardship.

Short term interventions and the KAP triad

Short-term interventions within the domain of environmental education, when meticulously crafted, possess the capacity to markedly reshape student knowledge, attitudes, and practices (KAP). Pacini et al. (2025) explored this phenomenon in the framework of a four-hour extracurricular module focused on green facades, revealing that even transient educational programs could engender significant enhancements in environmental comprehension. While changes in attitude were observed to be comparatively modest and less enduring, the research underscored the critical nature of contextual learning by leveraging relatable, real-world instances to foster awareness. Moreover, their regression analysis elucidated that knowledge and attitude exerted differential influences on various categories of environmental practices, thus highlighting the necessity of integrating all three KAP components within instructional design (Pacini et al., 2025).

The “Mangrove: The Blue Carbon” initiative likewise adopted the KAP framework by implementing pre- and post-program evaluations to assess modifications in student comprehension and behavior. The experiential engagement of planting mangroves, in conjunction with reflective exercises and educator feedback, facilitated observable advancements across all KAP dimensions. Notably, the program's incorporation of localized ecological content rendered abstract environmental challenges personally significant, aligning with existing literature on behavior modification. This reaffirms the premise that short-term, experiential interventions when effectively woven into educational settings can function as potent catalysts for fostering ecological stewardship among youth.

Gamification and creative pedagogies

In contemporary academic discourse, scholars in the field of education have increasingly investigated the application of gamification and multimedia instruments to augment student engagement in the domain of environmental education. Hsieh and Yeh (2025) elucidated this phenomenon through their empirical investigation of Ocean Domination, a role-playing simulation meticulously crafted to educate eighth-grade learners regarding marine ecosystems and environmental stewardship. The findings indicated that the game significantly enhanced not only cognitive indicators such as environmental literacy but also affective and behavioral dimensions, encompassing student motivation and readiness to undertake proactive measures. The research underscores the efficacy of narrative-driven gaming frameworks in emulating intricate ecological interactions in a manner that is both accessible and immersive (Hsieh & Yeh, 2025).

While the “Mangrove: The Blue Carbon” initiative did not incorporate digital gaming elements, it adeptly integrated other innovative pedagogical strategies, including podcasting and participation in national conferences.

These multimedia components effectively broadened the program’s outreach while enabling students to articulate their comprehension through varied modalities. The incorporation of storytelling, quizzes, and creative expression fostered emotional investment and personal significance, are the two critical elements documented to facilitate enduring learning and behavioral transformation.

This alignment with existing gamification scholarship illustrates that engaging students through imaginative, interactive modalities can enrich both cognitive and emotional dimensions of environmental education, even within non-digital frameworks.

Community integration and policy alignment

Beyond individual learning outcomes, the effectiveness of environmental education programs is often enhanced by community involvement and alignment with broader policy frameworks. Sinaga et al. (2025), in their study on environmental policy in ASEAN countries, emphasized the importance of institutional coherence and stakeholder engagement for successful environmental implementation. Their findings suggest that corporate and national-level environmental strategies are more effective when aligned with regional guidelines and involve transparent communication with stakeholders. While their study focused on the manufacturing sector, the same principle applies in education; local partnerships and policy support can legitimize and sustain environmental learning initiatives (Sinaga et al., 2025).

The "Mangrove: The Blue Carbon" initiative exemplified such integration by partnering with municipal agencies and community organizations in Iskandar Puteri. These collaborations provided not only logistical support (e.g., access to mangrove sites and planting resources) but also broader dissemination platforms, such as public conferences.

By aligning school-based activities with community conservation goals, the program extended its educational impact and ensured greater relevance to real-world sustainability challenges. Literature supports this holistic model, arguing that when environmental education is embedded within a network of civic, institutional, and ecological relationships, it is more likely to produce systemic and sustained change.

Synthesis and relevance to the present study

Cumulatively, the reviewed literature affirms that experiential and context-specific approaches are among the most effective strategies in youth environmental education. Programs that combine hands-on learning, reflective practice, and community engagement consistently demonstrate positive effects on student knowledge, attitudes, and environmental behaviors.

From role-playing games to extracurricular interventions and policy-aligned programming, the diversity of recent educational models indicates a clear trend: multi-modal, interdisciplinary, and place-based education can meaningfully contribute to long-term ecological stewardship.

The findings from the "Mangrove: The Blue Carbon" project sit squarely within this evolving discourse. By leveraging experiential learning, creative media, and community collaboration, the initiative operationalized many of the core principles identified in recent scholarship. Importantly, its focus on mangrove ecosystems as a climate-relevant and locally significant environment, and this allow students to contextualize global issues within their immediate surroundings.

This localization of environmental education not only deepened cognitive engagement but also fostered behavioral shifts, making the project a valuable case study in scalable, school-based sustainability education.

METHODOLOGY

This study adopted a qualitative case study design to examine how a community-based environmental education programme influenced youth engagement, environmental awareness, and sustainable behaviour. A case study design was considered appropriate because it facilitated an in-depth investigation of the programme within its real-life social and environmental context.

The study focused on the "Mangrove: The Blue Carbon" programme implemented in Iskandar Puteri, Johor, Malaysia. The programme aimed to strengthen climate awareness and environmental stewardship among primary school students through experiential and community-based learning.

The programme incorporated a series of educational and community-engagement activities, including environmental awareness talks, interactive quizzes, classroom-based creative activities, mangrove planting, seed cultivation, educational podcasts, community outreach, and knowledge-sharing programmes. These activities

combined theoretical knowledge with practical experience to encourage active participation, environmental responsibility, and civic engagement among young learners.

Participants and Site Selection

The study involved 198 primary school students from Sekolah Kebangsaan Taman Bukit Indah and Sekolah Kebangsaan Gelang Patah in Iskandar Puteri. The two schools were selected purposively based on their location within the project area, their established relationships with the programme's implementing partners, and their capacity to participate in both classroom-based and field-based activities. Participants were recruited through the participating schools. Eligibility was based on enrolment at one of the selected schools, availability during the scheduled programme activities, and permission to participate. In addition to the students' experiences, the qualitative evidence included perspectives from teachers and programme facilitators.

Data Collection

Data were collected from multiple qualitative sources to provide a comprehensive understanding of participants' experiences and the programme's perceived outcomes. These sources included students' written reflections, teacher feedback, facilitators' field observations, programme documentation, photographs, and records of community-engagement activities.

The use of multiple data sources enabled methodological triangulation by allowing the researchers to compare and corroborate evidence across different participant groups and forms of documentation. This process enhanced the credibility and trustworthiness of the findings.

Data Analysis

The qualitative data were analysed using reflexive thematic analysis. All seven researchers participated in the coding, review, and interpretation of the data. The analysis began with repeated readings of the students' reflections, teacher feedback, field notes, and programme records to develop familiarity with the dataset. Relevant segments were subsequently assigned descriptive codes relating to environmental knowledge, attitudes towards climate action, perceived agency, reported sustainable practices, and community participation.

The researchers then grouped related codes into preliminary themes and examined them against both the coded extracts and the complete dataset. The themes were progressively reviewed, refined, defined, and named before representative quotations and supporting documentary evidence were selected. An audit trail was maintained to document the connections among the original data sources, codes, theme definitions, and interpretive notes.

Triangulation across evidence provided by students, teachers, facilitators, photographs, and programme records was used to identify areas of convergence and divergence. The seven researchers discussed differences in coding and interpretation until a collective interpretation was reached. As the analysis followed a reflexive and interpretive approach rather than treating coding as an objective measurement exercise, a statistical intercoder-reliability coefficient was not calculated.

Ethical Considerations

This study reports the educational outcomes of a community-engagement programme involving school-aged participants. Permission to implement the programme and collect programme-related feedback was obtained through the participating schools and relevant collaborating organisations. Participation was voluntary, and all participant information was anonymised to protect confidentiality.

Pseudonyms, such as Participant 1 and Participant 2, were used when presenting quotations. The findings were also reported in aggregate to prevent the identification of individual participants while preserving the authenticity

of their experiences. Programme documentation and photographs were used only for research and reporting purposes in accordance with the permissions obtained from the relevant parties.

FINDINGS

Enhanced ecological literacy among students

The project significantly improved students' understanding of mangrove ecosystems and their broader role in mitigating climate change. Before the intervention, most students had only a superficial awareness of mangroves, often associating them merely with coastal scenery. Following a series of interactive learning sessions particularly the environmental quiz, field lectures, and mangrove planting, students began articulating the ecological functions of mangroves more precisely. *Participant 1*, a Year 6 student, reflected, *"I didn't know mangrove trees could help catch carbon. Now I understand how they protect us from floods and keep the air clean."* This sentiment was echoed by teachers, who reported that students could now explain the concepts of carbon sequestration and ecosystem services in their own words. Teachers also noted increased engagement during science lessons post-program, indicating a lasting educational impact.

Figure 1 Students from Sekolah Kebangsaan Taman Bukit Indah participating in the "Sahabat Bakau" program, engaging in awareness activities and mangrove-themed environmental education. Source: Authors' programme documentation.

Participant 2 described how the field activity helped her understand the fragility of mangrove ecosystems: *"When we planted the baby trees, I felt like I was helping something small grow strong. I want to come back and see it big one day."* Such expressions reflect a developing ecological identity among students, an essential outcome of environmental education at the primary level. The program thus shifted knowledge from abstract textbook concepts to experiential understanding grounded in students' direct interaction with nature.

Positive behavioral shifts toward sustainable practices

The project also spurred notable behavioral changes among participants. Students began applying lessons learned to their daily lives, often becoming advocates of green practices within their homes and schools. Teachers reported an uptick in students initiating recycling campaigns and organizing classroom talks about reducing plastic waste. *Participant 3* shared, *"I asked my parents to bring bags when we shop. We even started separating bottles and cans at home."* These small but meaningful actions suggest that environmental education, when grounded in local context and real-world action, can influence youth behavior beyond the classroom.

Furthermore, hands-on activities such as seed planting during the "Kepentingan Pokok Bakau" program helped build a sense of agency. *Participant 4* recalled, *"We planted chili and pak choy seeds in bottles. I check mine every day now. It's fun and helps the Earth."* Such behavior indicates a deepened connection between

environmental responsibility and personal routine. Teachers from both SK Taman Bukit Indah and SK Gelang Patah also reported that students voluntarily created posters on eco-friendly habits, and some classes began tracking their weekly waste output to reduce classroom-generated rubbish.

Figure 2 The Seagrass Lecture program at Forest City served as an educational session aimed at raising awareness of the ecological importance of seagrass meadows in marine ecosystems, highlighting their role in supporting biodiversity and maintaining environment. Source: Authors' programme documentation.

Community engagement and institutional support

The project's reach extended beyond student participants, successfully mobilizing schools, local councils, NGOs, and academic institutions. The collaboration with Kelab Alami and Southern Volunteers was instrumental in conducting the Mangrove Rescue and Monitoring programs. *Participant 5*, a school teacher, commented, *"This was the first time our school partnered with a local environmental NGO. It was eye-opening for the kids and the teachers too."* This engagement built a bridge between formal education and community-based conservation, an essential component of long-term sustainability efforts.

The project also gained traction through public visibility. Its presentation at the National Seminar on General Studies and the launch of a podcast featuring student and expert voices amplified its impact. *Participant 6*, a student speaker in the podcast, reflected, *"I was nervous, but I wanted people to hear why mangroves are important. I hope more students like me can speak out for nature."* These narratives underscore the empowering nature of the project, not just as an educational tool, but as a platform for civic and environmental expression among youth.

Figure 3. Podcast recording session held on 15 December 2024, featuring three lecturers and one student involved in the mangrove conservation programme. The discussion focused on their experiences and roles in the IPRK 4.0 initiative and aimed to raise public awareness of mangrove conservation. Source: Authors' programme documentation.

Perceived impact on carbon awareness and climate action

Although direct carbon reduction outcomes remain difficult to quantify in a short-term educational project, qualitative feedback revealed increased awareness of personal environmental footprints. The act of planting mangrove saplings, for example, helped students understand the concept of carbon capture in a tangible way. *Participant 7* shared, *"I didn't know trees could trap carbon before. Now I know they're like air cleaners."* This realization appeared to influence students' sense of responsibility, with several expressing interest in checking on their planted trees or replicating the experience in their neighborhoods.

Moreover, the program's influence extended into personal and collective decision-making. *Participant 8* stated, *"We made a 'Green Team' in our class. Every Friday, we collect recyclables and talk about how to save energy at home."* These student-led initiatives reflect a transformation from passive awareness to active citizenship. Feedback from school staff confirmed that the project cultivated a culture of climate responsibility within the school ecosystem. While the scale of behavior change is still emerging, the early indicators strongly support the project's potential to foster long-term climate stewardship.

DISCUSSION

Experiential learning fosters deep ecological understanding

The project outcomes affirm the critical role of experiential learning in shaping young learners' ecological literacy. Students who participated in hands-on mangrove planting, quizzes, and creative environmental activities demonstrated a notable shift in their ability to articulate and internalize ecological concepts such as carbon sequestration and coastal resilience. These findings support earlier research showing that learning rooted in direct, place-based interaction enhances conceptual understanding and environmental awareness (Luan et al., 2025). The emotional connection developed through physical engagement with mangroves are described by one student as "helping something small grow strong" and this illustrates how ecological knowledge is more deeply embedded when students are physically immersed in the environment they are learning about.

This thematic insight also underscores the limitations of purely classroom-based environmental instruction. By providing real-world context, the project bridged the gap between abstract scientific knowledge and practical understanding, thus enabling students to see the tangible impact of their actions. This approach aligns with constructivist educational theory, which emphasizes learning through active engagement with one's

environment. The success of this model points to the value of incorporating similar experiential modules within the national curriculum to strengthen environmental education outcomes.

Behaviour change begins with youth empowerment

The project also highlighted the capacity of environmental education to influence behavioral change, especially when students are empowered to act. Students began modifying their daily habits by reducing plastic use, initiating recycling programs at school, and advocating for sustainability at home, indicating a clear shift from awareness to action. While this aligns with the KAP (Knowledge, Attitude, Practice) model (Pacini et al., 2025), it can also be effectively interpreted through the Theory of Planned Behaviour (TPB) framework. TPB posits that behavior is determined by attitudes toward the behavior, subjective norms, and perceived behavioral control (Ajzen, 1991). In this context, the project fostered positive attitudes through ecological knowledge, strengthened subjective norms via peer and community engagement, and enhanced students' perceived control by involving them in hands-on activities with tangible impact.

Moreover, students' ownership over micro projects such as seed planting or leading classroom "Green Teams" further reinforced their sense of agency, a core component of perceived behavioral control. These initiatives signaled the emergence of environmental citizenship, where learners evolved from passive recipients of information to active agents of change. Crucially, the behavioral changes were not externally mandated but emerged organically from within the student body, underscoring how well-designed environmental education guided by psychological models like TPB can catalyze grassroots sustainability movements among youth.

Community integration enhances impact and legitimacy

A key strength of the project lay in its multi-stakeholder approach, which involved local schools, NGOs, universities, and government agencies. This network of collaborators not only increased the program's visibility but also provided diverse expertise, logistical support, and long-term sustainability. The collaboration with Kelab Alami and Southern Volunteers during the Mangrove Rescue and Monitoring programs enhanced credibility and community trust, fostering a sense of shared responsibility. This supports existing literature that emphasizes the effectiveness of community-embedded education in sustaining environmental learning outcomes (Sinaga et al., 2025).

Additionally, institutional support from Majlis Bandaraya Iskandar Puteri (MBIP) and representation at national conferences amplified the program's influence and legitimacy. Public outreach tools like podcasts further democratized access to environmental information, allowing both students and the general public to engage with complex topics in accessible formats. These activities serve as examples of how school-based environmental education can extend beyond institutional boundaries and become a catalyst for broader civic and ecological participation.

Climate stewardship through localized action

Finally, the program illustrates how localized action can serve as a powerful entry point for broader climate education. Though long-term carbon impact is difficult to quantify in a short project cycle, participants clearly developed a stronger understanding of the connection between environmental actions and climate outcomes. Activities like mangrove planting not only provided a symbolic representation of carbon sequestration but also offered measurable environmental benefits. This supports the notion that local-scale projects, particularly those rooted in culturally and ecologically relevant practices can meaningfully contribute to climate education and action.

Participants' expressions of wanting to monitor and revisit their planted trees suggest that such initiatives can foster a lasting commitment to stewardship. Importantly, this theme bridges the cognitive and emotional dimensions of climate learning: students understood not just what to do, but why it matters. When framed within a real-world climate context, local conservation actions such as these become educational tools for fostering both immediate behavioral change and long-term environmental values.

Regional context in Southeast Asia

The Malaysian experience is consistent with a wider Southeast Asian emphasis on place-based environmental action and multi-stakeholder implementation. Across the region, mangrove education is closely connected to coastal livelihoods, biodiversity protection, disaster-risk reduction, and blue carbon. The present case adds evidence that these regional priorities can be translated into age-appropriate school activities that combine ecological knowledge with direct participation. At the same time, the programme's municipal partnerships and locally specific activities distinguish it from models that rely mainly on classroom instruction. This comparison should be interpreted cautiously because programme objectives, duration, participant groups, and evaluation methods differ across Southeast Asian settings (Friess et al., 2019; Sinaga et al., 2025).

Scalability, sustainability, and policy implications

The model is potentially scalable because its core components—short awareness sessions, low-cost creative activities, locally guided field learning, reflection, and public communication—can be adapted to different schools and coastal ecosystems. Scaling should retain safeguards for field activities, trained local facilitators, suitable conservation sites, and structured follow-up rather than treating planting as a one-off event. Sustainability beyond the project period would be strengthened through school environmental clubs, teacher toolkits, recurring monitoring visits, student-led peer education, and formal agreements among schools, local authorities, universities, and community organisations. For Malaysian education policy, the findings support integrating locally relevant climate and blue-carbon learning across science, geography, civic education, and co-curricular programmes. Curriculum guidance should combine knowledge outcomes with participation, reflection, and community-based assessment, while small implementation grants and partnerships can help schools access sites and expertise.

Limitations

This study has several limitations. It examines one programme involving two purposively selected schools in a specific Malaysian urban-coastal setting; consequently, the findings are analytically informative but are not statistically generalisable to all schools or youth populations. The study relies on qualitative reflections, feedback, observations, and programme records, which capture perceived experiences but do not quantify changes in knowledge, behaviour, or carbon outcomes. Self-reported practices may also be influenced by recall or social-desirability bias. In addition, the short observation period does not establish whether reported behavioural changes were sustained. Future studies should use longitudinal follow-up, pre- and post-intervention measures, comparison groups where feasible, and ecological monitoring to assess educational and environmental outcomes over time.

CONCLUSION

The "Mangrove: The Blue Carbon" project demonstrates the powerful role that localized, experiential environmental education can play in cultivating ecological literacy and climate stewardship among primary school students. Through a combination of hands-on activities, creative learning modules, and strategic community partnerships, the initiative effectively enhanced students' understanding of mangrove ecosystems and their importance in mitigating climate change. More importantly, the project encouraged positive behavioral changes, with students initiating sustainable practices both at school and at home.

The findings reinforce the value of embedding environmental education within real-world contexts that are ecologically and culturally relevant to learners. By engaging students not only cognitively but also emotionally and socially, the project succeeded in fostering a generation of environmentally conscious individuals equipped with both knowledge and agency. As climate challenges intensify, such early interventions especially when integrated with community support and public outreach help to offer a scalable and impactful model for environmental education in urban coastal settings. Future efforts should focus on institutionalizing such programs within curricula and expanding their reach through sustained policy and community engagement.

Ethical Statement

This study was conducted in accordance with ethical principles for research and programme evaluation involving human participants. Permission to implement the programme and use programme-evaluation materials for scholarly reporting was obtained from the relevant schools and collaborating organisations. Participation in the educational activities and feedback process was voluntary. As the participants were school-aged children, the project team followed the participating schools' permission and safeguarding procedures. Participant information was anonymised, quotations were assigned pseudonyms, and findings were reported in aggregate. No personally identifiable information is disclosed in this paper.

Conflict of Interest

The authors declare that there are no financial, professional, or personal conflicts of interest that could have influenced the research, authorship, or publication of this article.

Data Availability Statement

The qualitative data supporting the findings of this study, including participant reflections, facilitator observations, and teacher feedback, are available from the corresponding author upon reasonable request. The data are not publicly available to protect the privacy and confidentiality of the participants, particularly as the study involved school-aged children.

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