

Integrating Electron Beam Technology Awareness and Community-Based Environmental Action: A Case Study in Aklan

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DOI: <https://doi.org/10.51244/IJRSI.2026.13010129>

Received: 19 January 2026; Accepted: 24 January 2026; Published: 07 February 2026

ABSTRACT

Scientific communication plays a vital role in increasing public understanding and acceptance of cutting-edge technologies related to environmental sustainability. This qualitative case study examines the OneLab electron beam (e-beam) awareness seminar and environmental tree planting activity conducted on 11–12 March 2025 in Aklan, Philippines. Participants included N = 48 individuals composed of teachers (n=20), students (n=10), local government unit officials (n=6), clergy/faith-based leaders (n=3), scientists/technical staff (n=5), community members (n=4). Data were collected through participant observation, semi-structured interviews, and document analysis, and analyzed using thematic coding. Findings indicate increased understanding and acceptance of e-beam technology, strengthened environmental ethics through experiential learning, and enhanced multi-sectoral collaboration. The study demonstrates that contextual science communication combined with participatory environmental action can translate advanced scientific knowledge into locally grounded practice.

Keywords: electron beam technology, nuclear science communication, environmental education, community engagement, OneLab, Philippines

INTRODUCTION

Public understanding of science and technology is essential for addressing environmental challenges such as pollution, climate change, and ecosystem degradation. In developing countries, limited knowledge of advanced technologies often hinders their acceptance and effective use, even when these technologies offer clear environmental benefits. Therefore, science communication and environmental education play a crucial role in bridging the gap between scientific innovation and community action.

In the Philippines, the Department of Science and Technology (DOST) has promoted nuclear science and related technologies as tools for sustainable development, environmental protection, and industrial innovation. Electron beam (e-beam) technology, as a radiation-based technology with applications in environmental management, has proven effective in wastewater treatment, sterilization, and pollution control. Despite its potential, public perception of nuclear energy-related technologies remains conditioned by misconceptions and perceived risks, underscoring the need for targeted science communication initiatives.

The OneLab Project provides a national framework for democratizing access to laboratory services, scientific expertise, and technological knowledge. Within this framework, the Department of Science and Technology (DOST) and the Philippine Nuclear Research Institute (PNRI) have conducted community seminars to enhance public understanding of nuclear technologies. The OneLab Electron Beam Awareness Seminars and the Environmental Tree Planting Activity in Aklan represent an integrated science communication and environmental education initiative that combines knowledge dissemination with experiential learning.

This paper documents and analyzes this activity as a qualitative case study, emphasizing the outcomes of science communication, environmental education, and community engagement. It provides applied evidence on how science-based outreach programs can promote environmental sustainability and informed public participation.

REVIEW OF RELATED LITERATURE

Scientific Communication and Public Acceptance of Nuclear Technologies

Public acceptance of nuclear and radiation-based technologies is strongly influenced by the quality and context of scientific communication. Studies by the International Atomic Energy Agency highlight that misconceptions about radiation risks persist, largely due to insufficient public engagement and a lack of specific explanations (IAEA, 2017, 2020). Effective science communication strategies, particularly those that use narrative, community-based and participatory approaches, have been shown to significantly increase trust and understanding of nuclear technologies.

The OECD (2019) highlights transparency, stakeholder engagement and relevance to everyday concerns as key determinants of public trust in science. In developing countries, these factors are particularly critical, as a lack of understanding of the technology can exacerbate fear and resistance. The National Research Council (2017) also shows that experiential and dialogue-based scientific communication enhances knowledge retention and informed decision-making among the public.

Electron Beam Technology and Environmental Applications

Electron beam (e-beam) technology is a well-established nuclear-related application with proven effectiveness in wastewater treatment, sterilization, sludge reduction and pathogen inactivation. According to the IAEA (2020), e-beam irradiation offers an energy-efficient and chemical-free alternative for environmental remediation, making it particularly suitable for densely populated and environmentally sensitive areas.

International case studies from Japan and South Korea show that e-beam installations have successfully reduced microbial contamination in wastewater, while contributing to industrial sustainability goals (IAEA, 2020). In the Philippine context, DOST-PNRI has identified e-beam technology as a strategic innovation to address pollution challenges in coastal areas and heavily touristed areas, including Boracay Island (DOST-PNRI, 2022). Despite its technical feasibility, public perception remains a significant barrier to its adoption, thus reinforcing the need for community awareness initiatives.

Community Environmental Education and Experiential Learning

The literature on environmental education highlights the effectiveness of experiential learning approaches, such as tree planting and ecosystem restoration, in promoting environmental stewardship. Kolb's experiential learning theory states that knowledge becomes more meaningful when students actively participate in practical applications (Kolb, 2015).

Studies by FAO (2018) and UNEP (2019) show that community-led reforestation initiatives contribute to biodiversity conservation and climate change mitigation, while strengthening environmental ethics and collective responsibility. These results are enhanced when environmental action is complemented by a structured educational component that links practice with scientific justification.

Faith-Based and Value-Oriented Environmental Action

Religious institutions are playing an increasingly important role in environmental education and sustainability initiatives. Pope Francis' *Laudato Si'* (2015) calls for a dialogue between science, ethics and spirituality, framing ecological responsibility as a moral and scientific imperative.

Studies in the Philippines empirically support this integration. Delos Santos et al. (2024) show that faith-based science education increases understanding of scientific methodology, while Delos Santos et al. (2025) found that a *Laudato Si'*-inspired program in Aklan increased community engagement and policy alignment. These findings suggest that moral frameworks complement scientific rigor and increase acceptance.

Multi-Sectoral Collaboration and Sustainable Development

Multi-sectoral collaboration between government agencies, academia, civil society, and faith-based organizations is essential for sustainable development. The United Nations (2015) and the World Bank (2020) emphasize that partnerships enhance legitimacy, efficiency, and community ownership.

DOST's OneLab initiative exemplifies this collaborative model by democratizing access to scientific expertise and laboratory services (DOST, 2021). The Tangalan case demonstrates how nuclear science communication, environmental education, and participatory action can come together to support the Sustainable Development Goals related to education, clean water, climate action, and partnerships.

Study Objectives

This study aimed to:

Document the structure and implementation of the OneLab Electron Beam Awareness Seminar and Tree Planting Activity in Tangalan, Aklan.

Examine participant perceptions and learning outcomes related to electron beam technology and environmental management.

Analyze the role of science communication and experiential learning in technology acceptance.

Evaluate the contribution of multi-sector collaboration to community environmental education.

METHODOLOGY

Research Design

This study used a qualitative case study design to examine the integration of electron beam (e-beam) technology awareness and community environmental action through the OneLab Electron Beam Awareness Seminar (Figure 1), and Tree Planting Activity in Tangalan, Aklan (Figure 2). Qualitative case studies are suitable for investigating complex and context-dependent phenomena where social, cultural, and institutional factors interact.



Figure 1. Electron Beam Awareness Seminar at Malay Elementary School, Aklan. Source: Authors' documentation.

The Tangalan initiative is considered a unique instrumental case, selected for its potential to shed light on broader issues in science communication, technology acceptance, and participatory environmental education. This design encourages analytical rather than statistical generalizations, providing contextual insights that can be applied to similar community initiatives.



Figure 2. Community Tree-Planting Activity in Pudiot, Tangalan, Aklan. Source: Authors' documentation.

Data Collection

Data were gathered using participant observation, semi-structured interviews, and document analysis. Observations focused on engagement, interaction, and instructional strategies during the e-beam seminars on Day 1 at Malay Elementary School and Aklan State University, as well as the tree planting activity on Day 2 in Pudiot, Tangalan. Interviews involved DOST-PNRI scientists, local officials, educators, students, and community members. Documents reviewed included program agendas, presentation materials, and post-activity reports.

Interview Protocol

Semi-structured interviews were guided by an interview schedule consisting of open-ended questions focused on: (1) prior understanding of electron beam technology; (2) perceived risks and benefits; (3) reflections on the seminar and tree-planting activity; and (4) perceived value of multi-sectoral collaboration. Probing questions were used to elicit clarification and examples. The interview guide is available from the authors upon request.

Data Analysis and Trustworthiness

Data were analyzed using thematic analysis. Open coding identified significant statements, followed by axial coding to develop themes related to technology awareness, environmental ethics, and collaboration. Trustworthiness was enhanced through triangulation and cross-validation across data sources.

Participant Profile

Participants were purposively selected based on their roles in the activity:

Teachers (n=20), Students (n=10), Local Government Unit officials (n=6), Clergy/Faith-based leaders (n=3), Scientists/technical staff (n=5), Community members (n=4)

Ethical Considerations and Limitations

This study adhered to ethical standards for qualitative and community-based research. Participation was voluntary, and informed consent was obtained from interview participants. Personal identifiers were excluded, and all data were anonymized and reported in aggregate to protect confidentiality. Information about electron beam (e-beam) technology was communicated accurately and transparently, avoiding exaggeration of benefits or minimization of risks. Faith-based reflections inspired by Laudato Si' were included in a culturally sensitive and non-coercive manner, with participation remaining optional.

As a qualitative single-case study, findings are context-specific and not statistically generalizable. Data relied on participant observations and self-reported perceptions, which may be subject to response bias. The study focused on immediate learning outcomes and did not assess long-term behavioral or policy impacts. Despite these limitations, the case provides useful analytical insights into integrating science communication, experiential learning, and ethical framing in community-based environmental initiatives.

RESULTS AND DISCUSSION.

Four major themes emerged from the analysis:

- A. Improved Understanding and Acceptance of E-beam Technology: Participants reported clearer distinctions between nuclear power and radiation-based applications, reducing fear and misconceptions.
- B. Experiential Learning Strengthening Environmental Ethics: Tree planting reinforced seminar content by linking scientific knowledge with tangible environmental action.
- C. Trust Building through Transparency and Dialogue: Open discussion with scientists increased trust in institutions and technologies.
- D. Multi-sectoral Collaboration as an Enabler of Action: Partnerships among academia, government, and faith-based organizations enhanced participation and legitimacy.

Key Findings

The study found that contextualized science communication combined with experiential environmental activities improves understanding, trust, and acceptance of radiation-based technologies.

Implications

Results highlight the value of integrating scientific, ethical, and cultural dimensions in community-based technology education.

Policy Recommendations

Institutions should institutionalize science communication programs that combine technical education with participatory environmental action through sustained multi-sectoral partnerships.

Conceptual Framework

A Conceptual framework is presented in Figure 3 to illustrate the gist of the paper:



Figure 3. Conceptual framework of the activity

CONCLUSION AND RECOMMENDATIONS

This study demonstrates that integrating science communication with community-based environmental action is an effective approach to increasing public understanding, acceptance, and ethical appreciation of advanced technologies such as electron beam (e-beam) irradiation. The OneLab Electron Beam Awareness Seminar, held in Malay and Makato, Aklan, followed by a tree planting activity in Pudiot, Tangalan, illustrated how complex nuclear energy technologies can be meaningfully contextualized within local environmental concerns, cultural values, and community priorities.

Dialogue-driven and contextualized science communication helps reduce misconceptions and concerns about nuclear and radiation-based technologies by linking electron beam applications to tangible benefits for the environment and public health. Incorporating experiential learning through tree planting translates abstract scientific concepts into concrete environmental action, strengthening environmental ethics, responsible stewardship, and collective responsibility. The integration of faith-based reflection, inspired by *Laudato Si'*, further complements scientific discourse by providing a moral framework that fosters ongoing participation and interest.

Multi-sectoral collaboration between government agencies, academic institutions, faith-based organizations, and local communities has enhanced program credibility, broadened participation, and aligned local initiatives with national development priorities and the United Nations Sustainable Development Goals. Overall, the Aklan case study provides practical evidence that advanced technologies can be effectively introduced at the community level when integrated into a participatory, culturally resonant, and ethically based framework.

Therefore, it is recommended that community-based science communication initiatives on advanced technologies be institutionalized, combined with experiential environmental activities, and strengthened through ongoing multi-sectoral partnerships to promote scientific literacy, environmental sustainability, and responsible use of technology.

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