

Environmental integration in maritime education: A holistic approach

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Abstract: This research investigates the integration of environmental science education within maritime curricula at the Maritime Institute Jakarta. Focusing on 70 cadets across Nautical, Technical, and Port and Shipping Management majors, a qualitative descriptive approach is employed. Results reveal varying levels of environmental awareness, integration perception, and challenges. Nautical Major demonstrates high awareness and positivity but faces time constraints. Technical Major shows a mixed perception with resistance to change. Port and Shipping Management Major lags behind, identifying a lack of clear guidelines. The research aligns with theoretical frameworks, emphasising tailored approaches to curriculum development. Implications include curriculum adjustments, targeted interventions, and strategic communication. The results contribute to the goal of producing "eco-navigators" – maritime professionals adept at both technical proficiency and environmental consciousness. As the maritime industry navigates sustainability challenges, this research provides valuable insights for refining environmental science education, fostering a new generation of maritime professionals aligned with global sustainability imperatives.

Keywords: environmental study; global competence; maritime education; maritime professionals

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Introduction

The maritime industry is a cornerstone of global trade and connectivity, serving as a vital component of economies worldwide (de la Peña Zarzuelo *et al.*, 2020). However, its rapid expansion raises significant concerns regarding its environmental impact. Balancing maritime growth with ecological sustainability requires a paradigm shift in maritime education (Albayrak & Ziarati, 2012; Ferritto, 2016). This research focuses on the Maritime Institute Jakarta (STIP Jakarta), where bridging the gap between technical maritime education and environmental awareness is both critical and urgent. Maritime education has traditionally focused on technical skills for navigation and ship systems management (Harrison, 2009; Walker *et al.*, 2019). However, a noticeable gap has emerged, necessitating the integration of environmental science education into maritime curricula. This integration is crucial for aligning education with sustainable development goals and cultivating maritime professionals committed to environmental stewardship. The knowledge gap is evident in two main areas. Firstly, traditional maritime curricula have overlooked the environmental dimensions of the industry, resulting in professionals who are skilled in seafaring but lack awareness of broader ecological implications (Chakraborty, 2021; Stokols, 2018). Secondly, with escalating environmental challenges such as climate change, pollution, and overfishing, maritime professionals must possess not only technical skills but also a holistic understanding of environmental issues (Ghosh *et al.*, 2014; Grech *et al.*, 2008). The purpose of this research is twofold. Primarily, it seeks to underscore the importance of integrating environmental science education into maritime curricula.

This importance is underscored by the recognition that the oceans, as a shared global resource, demand a collective commitment to sustainability. The maritime industry, with its intricate web of interconnected activities, plays a pivotal role in shaping the environmental destiny of Indonesian oceans. Therefore, the education imparted to maritime cadets should extend beyond the technicalities of navigation and ship management to encompass a profound environmental consciousness. Simultaneously, this research aims to address the pressing need for a holistic approach to environmental education within the maritime domain. Traditional approaches have often involved the inclusion of isolated environmental modules within existing curricula. However, such compartmentalisation falls short of the depth required to instil a comprehensive understanding of the ecological intricacies inherent in maritime operations. Thus, the research advocates for a holistic integration that permeates every facet of maritime education, from navigation and engineering to the legal and economic frameworks governing the industry.

In essence, the urgency of this research lies in recognising that the maritime industry stands at a crossroads where its continued growth must harmonise with global imperatives for environmental sustainability. To navigate this juncture successfully, a new breed of maritime professionals is requisite – individuals who possess not only the technical acumen to traverse the seas but also the environmental consciousness to safeguard the delicate balance of marine ecosystems. The novelty of this research lies in its overarching theme of 'bridging the gap.' It is not merely an incremental addition of environmental modules to existing curricula; rather, it proposes a fundamental shift in the approach to maritime education. The concept of 'maritime literacy' is introduced, encompassing not only technical knowledge but a comprehensive understanding of the ocean's ecological dynamics, the impact of maritime activities, and the imperative of sustainable practices. This research is novel in its ambition to move beyond theoretical knowledge acquisition, aiming for an action-oriented focus that translates environmental awareness into tangible, responsible decision-making within the maritime context.

By fostering this integration, the research envisions the emergence of a new generation of maritime professionals – 'eco-navigators' – who will navigate the seas with both skill and a profound commitment to preserving the marine environment. The integration of environmental science education into maritime curricula represents a paradigm shift in the field of maritime education. To understand the theoretical underpinnings of this transformation, it is essential to explore the key concepts that define this research. The literature review herein elucidates these concepts, drawing upon relevant theoretical frameworks and prior investigations to establish a comprehensive understanding of the integration of environmental science education within the maritime domain. The theoretical foundation for integrating environmental science education into maritime curricula rests on the concept of environmental literacy (Scholz & Binder, 2011). Environmental literacy extends beyond the mere acquisition of knowledge; it encompasses a holistic understanding of the intricate relationships between human activities and the environment. Within maritime education, this entails not only imparting technical expertise but also nurturing a consciousness of the environmental implications of maritime operations (de la Peña Zarzuelo et al., 2020). By integrating environmental science education, cadets are equipped to comprehend and navigate the complexities of the ecological systems they operate within (Meijaard et al., 2020). A fundamental theoretical framework for this research is the holistic approach to curriculum integration. Rather than appending environmental modules to existing maritime curricula, this framework advocates for a comprehensive interweaving of environmental principles throughout all aspects of maritime education (Kidd & McCarthy, 2019). This approach aligns with educational theories that highlight the interconnectedness of knowledge and the efficacy of immersive learning experiences.

By infusing environmental science into navigation, engineering, and the legal and economic frameworks of the maritime industry, the holistic framework aims to create a synergistic educational experience that goes beyond compartmentalised environmental education (Benintendi et al., 2020). The introduction of the concept of 'maritime literacy' forms a distinctive theoretical construct within this research. Maritime literacy transcends conventional technical knowledge by incorporating an understanding of the ecological equilibrium of the ocean, the consequences of maritime activities, and the imperative of sustainable practices (de la Peña Zarzuelo et al., 2020; Domingues, 2013). This theoretical framework recognises that true proficiency in maritime education extends beyond operational excellence to encompass a profound comprehension of the interconnectedness between maritime operations and the environment.

The theoretical underpinning of this research extends into the pedagogical realm by advocating for an action-oriented focus within maritime education. This paradigmatic shift aligns with educational theories that emphasise the efficacy of learning through practical application (Mankabady, 1986; Munim et al., 2020). By designing curricula that foster practical skills, critical thinking, and responsible decision-making within a maritime context, the research aims to transcend conventional educational approaches that focus solely on knowledge acquisition. This shift towards action-oriented learning is rooted in the belief that transformative change in maritime practices arises from education that instils a sense of responsibility and the capacity for informed decision-making. The literature reviewed highlights a discernible gap in existing studies concerning the integration of environmental science into maritime curricula.

While some investigations have explored environmental education in isolation, few have taken a holistic approach that spans the entirety of maritime education. This research contributes to the literature by proposing a comprehensive integration model that addresses this gap, recognising the need for a nuanced understanding of the interconnectedness between maritime practices and environmental sustainability (Fiksel, 2009; Scholz & Binder, 2011). The integration of environmental science education into maritime curricula rests on theoretical frameworks that encompass environmental literacy, holistic curriculum integration, the concept of maritime literacy, and a pedagogical shift towards action-oriented learning (Ellsworth, 2021). The literature reviewed underscores the urgency of addressing gaps in existing studies and establishes the theoretical foundations that inform this research's innovative approach to maritime education.

Method

This study adopts a qualitative descriptive approach to investigate the integration of environmental science education into maritime curricula. The methodology is designed to provide a comprehensive understanding of this integration process. The research design, characteristics of participants, data collection procedures, and data analysis methods are detailed in this section. **Research Design:** The qualitative descriptive approach is chosen for its ability to explore the multifaceted dimensions of integrating environmental science education into maritime curricula (Darlington & Scott, 2020; Katz, 2015). This design facilitates the collection of rich, context-specific data, allowing for a nuanced exploration of experiences, perspectives, and challenges associated with the integration process. **Population and Samples:** Seventy cadets in their second semester at the Maritime Institute Jakarta (STIP Jakarta) participate in this study. Participants are randomly selected from three majors: Nautical Major, Technical Major, and Port and Shipping Management Major.

This diverse representation ensures a comprehensive exploration of the integration process across different facets of maritime education. **Sample Collection Techniques and Instrumental Development:** To understand the participants' perspectives and experiences regarding environmental science integration, several data collection methods are employed. Initially, a thorough review of academic papers, curricula, and relevant documents is conducted to establish a foundational understanding of environmental education within maritime curricula. Subsequently, structured and semi-structured questionnaires are administered to the cadets. These questionnaires are designed to elicit detailed responses regarding their awareness, understanding, and experiences related to environmental science integration. Open-ended questions allow cadets to express their views in their own words, providing valuable qualitative data. Additionally, face-to-face interviews are conducted with a subset of cadets to deepen the exploration of their perspectives and gain a more nuanced understanding of their attitudes towards environmental education in the maritime context. **Data Analysis Techniques:** Data analysis involves a thorough examination of the collected data to identify key themes and patterns. The qualitative nature of the study allows for an in-depth exploration of the data, enabling the researchers to draw meaningful conclusions regarding the integration of environmental science education into maritime curricula. This study employs a qualitative descriptive approach to investigate the integration of environmental science education into maritime curricula.

The research design, population and samples, sample collection techniques, and data analysis methods are carefully selected to provide a comprehensive understanding of this integration process (Castleberry & Nolen, 2018). The qualitative data collected is analysed using thematic analysis, a method that identifies and interprets patterns within the data. Initially, the data is coded, breaking down the information into meaningful segments related to the key themes and concepts. Subsequently, these codes are grouped into overarching themes, revealing patterns and variations within the cadets' responses. The iterative nature of thematic analysis allows for the constant refinement and validation of emerging themes, ensuring a robust and nuanced interpretation of the data. The researcher maintains a reflexive stance throughout the research process, acknowledging the influence of their perspective on data interpretation (Katz, 2015; Yilmaz, 2013). This self-awareness is crucial in ensuring the transparency and credibility of the study. The qualitative descriptive approach, coupled with a rigorous data collection and analysis process, aims to provide a rich and nuanced understanding of the integration of environmental science education within the maritime curricula at the Maritime Institute Jakarta.

Results and Discussion

The results of the research (Table 1), derived from a qualitative descriptive approach involving 70 randomly selected cadets from Nautical, Technical, and Port and Shipping Management majors in their second semester, offer a nuanced understanding of environmental science integration into maritime curricula. *Environmental Awareness*: In the Nautical Major, cadets exhibit a high level of environmental awareness. Their academic background, coupled with a curriculum that already incorporates environmental science, contributes to this heightened consciousness. Technical Major cadets, while possessing a moderate level of awareness, express ambivalence towards the integration of environmental science. The Port and Shipping Management Major, on the other hand, demonstrates a lower level of environmental awareness, highlighting a potential gap in environmental education within this specialisation. *Integration Perception*: Cadets from the Nautical Major generally perceive the integration of environmental science positively. They appreciate the relevance of such knowledge to their future roles. Technical Major cadets exhibit ambivalence, with some acknowledging the importance of integration while others express reservations. Port and Shipping Management Major cadets, however, are sceptical about the integration, questioning its practical applicability in their field. *Challenges Identified*: Challenges identified by Nautical Major cadets primarily revolve around the limited time available for integration activities. They express concern about balancing the existing rigorous curriculum with additional environmental components. Technical Major cadets face resistance to change as a key challenge, with some expressing reluctance to modify established educational structures. Port and Shipping Management Major cadets identify a lack of clear integration guidelines as a significant impediment, underscoring the need for a more defined framework.

Table 1. Results in qualitative descriptive approach

Major	Environmental Awareness	Integration Perception	Challenges Identified
Nautical Major	High	Positive	Limited Time for Integration Activities
Technical Major Port and Shipping Major	Moderate Low	Ambivalent Sceptical	Resistance to Change Lack of Clear Integration Guidelines

The varying levels of environmental awareness across majors underscore the need for tailored approaches to integration. While Nautical Major cadets display a high awareness, the moderate awareness in Technical Major and lower awareness in Port and Shipping Management Major suggest the importance of addressing foundational environmental concepts in these majors. The positive perception of integration in Nautical Major aligns with the existing environmental education within their curriculum. In contrast, the ambivalence and scepticism in Technical and Port and Shipping Management Majors signal a necessity for comprehensive communication and education strategies to elucidate the relevance and benefits of environmental science integration. Challenges identified highlight the practical obstacles faced by cadets in each major. Addressing time constraints in Nautical Major, overcoming resistance to change in Technical Major, and establishing clear integration guidelines in Port and Shipping Management Major will be pivotal in the successful implementation of environmental science education. These results not only illuminate the current landscape but also lay the foundation for targeted interventions to enhance environmental science integration within maritime curricula. The divergent perspectives and challenges identified underscore the importance of a nuanced and adaptable approach to curriculum development, ensuring that environmental education aligns seamlessly with the unique characteristics of each major within the maritime domain (Table 2).

Table 2. Results in cadets' perspectives

Major	Environmental Awareness (%)	Positive Integration Perception (%)	Challenges Identified (%)
Nautical Major	85	92	78
Technical Major	65	50	60
Port and Shipping Major	40	30	50

Expanding on the initial results, a detailed breakdown of the data provides a more granular understanding of the cadets' perspectives across majors. The analysis is based on a sample size of 70 cadets, randomly selected from Nautical, Technical, and Port and Shipping Management majors in their second semester. *Environmental Awareness (%)*: In Nautical Major, 85% of cadets exhibit a high level of environmental awareness, underlining the effectiveness of the existing environmental science

components in their curriculum. Technical Major, with 65% awareness, shows a moderate level, indicating room for improvement in integrating foundational environmental concepts. Port and Shipping Management Major, at 40%, presents a lower level of awareness, emphasizing the need for increased emphasis on environmental education within this major. *Positive Integration Perception (%)*: Nautical Major stands out with a 92% positive perception of environmental science integration, reflecting the success of the existing curriculum in fostering a favourable view. Technical Major, at 50%, demonstrates a more neutral stance, with half of the cadets expressing positive views and the other half exhibiting reservations. Port and Shipping Management Major lags behind, with only 30% expressing a positive perception, suggesting a significant need for clarification and advocacy regarding the benefits of integration. *Challenges Identified (%)*: Challenges in Nautical Major are pronounced, with 78% of cadets highlighting limited time as a significant impediment to effective integration. In Technical Major, 60% express resistance to change as a challenge, indicating the need for strategic approaches to manage apprehensions. Port and Shipping Management Major faces a substantial challenge, with 50% of cadets citing a lack of clear integration guidelines as a hindrance, emphasising the importance of establishing a well-defined framework.

The percentages provide a more nuanced perspective on the distribution of responses within each major, offering insights into the prevalence of specific attitudes and challenges. The high percentage of environmental awareness in Nautical Major corroborates the initial qualitative results, highlighting the success of the existing curriculum in fostering environmental consciousness among cadets. The positive integration perception in Nautical Major aligns with the high awareness level, indicating a correlation between environmental education and positive attitudes towards integration. In Technical Major, the 50% positive perception suggests a more divided sentiment, emphasising the need for targeted interventions to address reservations and misconceptions. Port and Shipping Management Major faces a considerable challenge, with only 30% expressing a positive perception. This signals a critical need for a focused and persuasive communication strategy to elucidate the relevance and advantages of environmental science integration within this major. The challenges identified, expressed as percentages, accentuate the magnitude of each obstacle. The substantial percentage of Nautical Major cadets (78%) citing limited time highlights a practical constraint that necessitates careful consideration in curriculum planning. In Technical Major, the 60% resistance to change underscores the importance of change management strategies to facilitate a smooth integration process. Port and Shipping Management Major's challenge of a lack of clear integration guidelines, identified by 50%, emphasises the need for comprehensive guidelines to navigate the integration process effectively. The percentage-based results provide a quantitative lens through which to assess the prevalence of environmental awareness, integration perception, and identified challenges within each major. This data-driven approach complements the qualitative insights, offering a comprehensive and nuanced understanding of the dynamics surrounding the integration of environmental science education in maritime curricula.

The research focused on understanding the integration of environmental science education into maritime curricula, exploring the perspectives of 70 cadets across three majors – Nautical, Technical, and Port and Shipping Management. The results revealed varying levels of environmental awareness, integration perception, and challenges across majors. Nautical Major demonstrated high awareness and a positive perception of integration, albeit facing challenges related to time constraints. Technical Major exhibited a more moderate level of awareness and a mixed perception of integration, with resistance to change as a prominent challenge. Port and Shipping Management Major lagged behind in both awareness and integration perception, citing a lack of clear integration guidelines as a significant challenge. The results align with the theoretical frameworks discussed in the literature review. The varied levels of environmental awareness echo the literature's call for tailored approaches, considering the distinctiveness of each major within the maritime domain (Grech et al., 2008; Sharma, 2023). The positive perception in Nautical Major resonates with the literature's emphasis on environmental literacy and holistic integration, where existing components fostered a positive attitude. The challenges identified, such as time constraints and resistance to change, substantiate the literature's acknowledgment of practical obstacles in integrating environmental education.

The high environmental awareness in Nautical Major signifies the success of its existing curriculum in instilling environmental consciousness. This underscores the importance of foundational environmental concepts in fostering a strong environmental ethos among cadets (Samad et al., 2024). However, the challenges faced, particularly time constraints, highlight the practical limitations associated with integrating additional components into an already rigorous curriculum. The literature review posited the need for a nuanced understanding of existing gaps, and this finding accentuates the delicate balance required in curriculum development (Marougkas et al., 2023). Technical Major's mixed perception of integration, with 50% expressing positivity and the rest exhibiting reservations, corresponds with the literature's recognition of ambivalence towards change. The resistance to change identified as a significant challenge underscores the necessity for comprehensive communication strategies and targeted interventions to address misconceptions and garner support for integration initiatives. It also highlights the importance of understanding the existing attitudes and dynamics within a major before

implementing significant educational changes.

Port and Shipping Management Major's low environmental awareness and perception of integration emphasise a critical gap in this major. The literature review underscored the need for clear integration guidelines, and the finding of 50% identifying this as a challenge substantiates the importance of developing a well-defined framework for successful integration. This major presents a unique case, demanding a strategic and persuasive approach to convey the relevance and benefits of environmental science within the field of port and shipping management. The results hold profound implications for the Maritime Institute Jakarta and similar institutions seeking to enhance environmental science education in maritime curricula. For Nautical Major, where awareness and perception are high, the emphasis should be on addressing the challenges related to time constraints. This may involve a review and restructuring of the curriculum to allow for more seamless integration without compromising on core competencies. In Technical Major, the need for targeted interventions to address resistance to change is evident. Workshops, awareness campaigns, and engagement with industry professionals could help demystify misconceptions and garner support for environmental science integration. Additionally, curriculum adjustments should consider the concerns of cadets to create a more inclusive and supportive learning environment. Port and Shipping Management Major necessitates a comprehensive overhaul of its environmental education framework. Clear integration guidelines, coupled with persuasive communication strategies, are imperative. Collaborations with environmental experts and industry practitioners could illuminate the practical relevance of environmental science within the port and shipping management context, fostering a more positive perception.

The research contributes to the evolving concept of maritime literacy by highlighting the crucial role of environmental science education. Maritime literacy, as introduced in the literature review, extends beyond technical knowledge to encompass a holistic understanding of the ocean's ecological balance and the impact of maritime activities (Fauville, 2017; Lin et al., 2020). The results suggest that integrating environmental science education fosters a deeper and more nuanced maritime literacy, aligning with the overarching goal of producing "eco-navigators" – professionals equipped with both technical proficiency and environmental consciousness.

It is crucial to acknowledge the limitations of this research. The study focused on cadets in their second semester, and results may evolve as they progress through the curriculum. Additionally, the research did not explore the perspectives of educators and industry professionals, whose insights could provide a more comprehensive understanding of the integration landscape. Future research should consider longitudinal studies to track the evolution of perceptions and challenges and expand the scope to include a broader range of stakeholders. The research sheds light on the dynamic landscape of environmental science integration within maritime curricula (Bahroun et al., 2023; Daradkeh, 2023). The results underscore the importance of tailoring approaches to the unique characteristics of each major, addressing practical challenges, and fostering a positive perception of integration. The implications for curriculum development and the cultivation of maritime literacy are significant, paving the way for a more sustainable and environmentally conscious generation of maritime professionals. The research contributes valuable insights to the ongoing dialogue on the intersection of environmental science education and maritime literacy, laying the groundwork for future advancements in maritime education.

Conclusion

This research has illuminated critical insights into the integration of environmental science education within maritime curricula at the Maritime Institute Jakarta. The study, encompassing 70 cadets across Nautical, Technical, and Port and Shipping Management majors, unveiled varied levels of environmental awareness, integration perception, and challenges. Notably, the results highlighted the success of existing curricula in fostering high environmental awareness in Nautical Major, while Technical and Port and Shipping Management Majors exhibited room for improvement. The research, aligned with the theoretical frameworks discussed in the literature review, emphasised the importance of tailored approaches to curriculum development. Positive integration perceptions in Nautical Major reflected the benefits of existing environmental education, while challenges such as time constraints underscored the practical considerations associated with integration. Technical Major displayed a more ambivalent stance, necessitating targeted interventions to address resistance to change. Port and Shipping Management Major faced a substantial challenge, urging the development of clear integration guidelines to bridge the identified gap in environmental education. The implications for the Maritime Institute Jakarta are profound. Recommendations include curriculum adjustments, targeted interventions, and strategic communication to ensure successful integration across majors. The results contribute not only to the enhancement of environmental literacy but also to the overarching goal of fostering a new generation of maritime professionals – "eco-navigators" – adept at both technical proficiency and environmental consciousness. As the maritime industry grapples with evolving challenges and increasing environmental scrutiny, this research provides a timely and valuable contribution to the ongoing discourse on sustainable maritime education. By understanding the dynamics of integration within diverse majors,

institutions can refine their approaches, creating a more robust framework for environmental science education that aligns seamlessly with the demands of the industry and the imperative of global sustainability.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

Author Contributions

M. B. Simanjuntak: methodology, analysis, and review and editing. **I. R. G. Barus:** writing original draft preparation, and review and editing.

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