

Maritime cadet literacy in aquamarine, ecology, and environmental science management

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Abstract. This research explores the evolution of marine environmental literacy among Semester 6 cadets at the Maritime Institute Jakarta. Focusing on aquamarine, ecology, and environmental science management, the study employs a qualitative approach to assess cadets' comprehension pre- and post-internships. Findings indicate a substantial improvement, particularly in aquamarine literacy, showcasing the positive impact of real-world experience. Implications suggest tailored educational enhancements, experiential learning integration, and professional development emphasis. This study contributes to the broader discourse on environmental literacy in maritime education, advocating for a holistic approach to prepare environmentally conscious maritime professionals.

Key Words: ecological literacy, practical science, environmental science, maritime studies.

Introduction. The maritime sector, serving as a critical nexus in global trade and transportation, has long been at the forefront of environmental challenges (Autsadee et al 2023). The imperative for sustainable practices within this industry is underscored by the profound impact of maritime activities on marine ecosystems. Maritime professionals, particularly cadets in training, stand as pivotal figures in shaping the future of marine environmental stewardship. This research seeks to delve into the crucial domain of marine environmental literacy among Semester 6 cadets at the esteemed Maritime Institute Jakarta (STIP Jakarta), where the confluence of applied disciplines, including Nautical, Technical, and Port and Shipping Management, defines the academic landscape.

In recent times, the escalating concern for sustainable maritime practices has brought to light a pressing need to comprehensively understand the marine environmental literacy of future seafarers (Domingues 2013). Despite the prominence of environmental discourse, a distinct knowledge gap exists concerning the specific literacy levels of maritime cadets, especially pertaining to aquamarine, ecology, and environmental science management. In addressing the knowledge gap, the research embarks on a qualitative exploration encompassing 60 randomly selected cadets from Applied Nautical, Applied Technical, and Port and Shipping Management majors. Their 8-12 month internships in the shipping and cargo industry provide a unique opportunity to gauge the practical implications of their academic training on marine environmental literacy.

While existing literature acknowledges the broader importance of environmental education, few studies explicitly address the marine environmental literacy of maritime cadets. This research contributes to the academic discourse by filling this specific gap, shedding light on the dynamics between academic knowledge and practical experiences in shaping the environmental consciousness of future maritime professionals. This research serves as a timely and imperative investigation into the marine environmental literacy of maritime cadets, addressing a critical gap in current academic discourse (Lin et al 2020). By exploring the transformative impact of internships on cadets' understanding of aquamarine, ecology, and environmental science management, this study strives to contribute valuable insights to both academic and practical realms.

Theoretical frameworks. The burgeoning importance of marine environmental literacy in maritime education has garnered scholarly attention as the global community recognizes the critical role of maritime professionals in sustainable marine practices. This paper seeks to explore the theoretical underpinnings and existing research that underlines the central concepts of the present study: aquamarine, ecology, and environmental science management among maritime cadets. By examining key studies and theoretical frameworks, this section provides a foundation for understanding the context and significance of marine environmental literacy.

Ecological literacy. At the core of environmental education lies the concept of ecological literacy, a theoretical framework that emphasizes understanding ecosystems, their interconnectedness, and the impact of human activities on these systems. Maritime cadets must develop a profound ecological literacy to navigate the complex maritime environment (Leenhardt et al 2015; Burns 2015). Research in environmental education underscores the need for an interdisciplinary approach, integrating ecological principles into maritime curricula to cultivate a holistic understanding among future professionals (Christodoulou-Varotsi & Pentsov 2008).

Experiential learning. The theoretical foundation of experiential learning aligns with the practical aspects of maritime education (Dyagileva et al 2020). Experiential learning posits that hands-on experiences, such as internships, significantly contribute to knowledge acquisition and skill development. Integrating this theory into the maritime education context, the literature suggests that real-world experiences enhance cadets' comprehension of theoretical concepts, fostering a deeper understanding of aquamarine, ecology, and environmental science management.

Aquamarine literacy. The term "aquamarine literacy" encapsulates a multifaceted understanding of marine environments, encompassing ecological systems, biodiversity, and the sustainable utilization of aquatic resources (Carcia-Soto & van der Meeren 2017; Laffoley et al 2021; Jagannathan et al 2021). While traditional maritime education often focuses on technical and navigational aspects, recent studies advocate for an expanded curriculum that includes aquamarine literacy to produce environmentally conscious maritime professionals.

Ecology in maritime education. Ecology, as a key component of marine environmental literacy, revolves around the study of interactions between organisms and their environment (Beattie et al 2011; Chakraborty & Chakraborty 2021). Previous investigations stress the integration of ecological principles into maritime education, asserting that a comprehensive understanding of ecological dynamics equips cadets to navigate responsibly within fragile marine ecosystems. The management of environmental science in the maritime context involves strategies for mitigating environmental impact, complying with regulations, and adopting sustainable practices. The literature reveals a growing discourse on the need for maritime education to instill environmental science management skills, ensuring that future professionals contribute positively to environmental conservation (Chatterjee & Tandon 2020).

The impact of internships on environmental literacy. Several studies have explored the influence of internships on the environmental literacy of students in various disciplines (Holbrook & Rannikmae 2009; Walker et al 2019). While these studies differ in focus, collectively, they emphasize the transformative impact of real-world experiences on knowledge acquisition and skill development. The present study builds upon this research by specifically investigating the pre- and post-internship environmental literacy of maritime cadets. Research in educational theory advocates for the integration of ecological literacy into curricula across disciplines. For maritime education, this implies a shift towards a more holistic understanding of the marine environment, aligning with the objectives of the present study to assess the impact of such integration on cadets' environmental literacy.

Current knowledge in the field accentuates the growing recognition of the need for a paradigm shift in maritime education towards a more environmentally informed approach. Theoretical frameworks such as ecological literacy and experiential learning provide a lens through which to understand the nuances of marine environmental literacy. Previous studies underscore the transformative potential of internships on environmental literacy, and a call for integrated ecological principles in maritime curricula (Beattie et al 2011; Abas 2021; Chakraborty & Chakraborty 2021). The present study contributes to this evolving landscape by specifically examining the marine environmental literacy of maritime cadets before and after internships, thereby filling a critical gap in existing literature. In light of the literature reviewed, the present study is novel in its focus on the marine environmental literacy of maritime cadets and its specific examination of the impact of internships on their understanding of aquamarine, ecology, and environmental science management. The synthesis of theoretical frameworks, key concepts, and previous studies provide a robust foundation for understanding the significance and urgency of this research in shaping environmentally conscious maritime professionals.

This research aims to bridge this gap by investigating the pre- and post-internship knowledge of cadets in these critical areas, thereby contributing valuable insights into the efficacy of maritime education in fostering environmental consciousness (Harper & Snowden 2017). The urgency of this research is accentuated by the global call for sustainable development and the increasing scrutiny on the environmental impact of maritime operations. The depletion of marine resources, pollution, and climate change necessitate a paradigm shift in the way maritime professionals perceive and interact with the marine environment. The relevance of this study is further underscored by the fact that STIP Jakarta, as a maritime education hub, plays a pivotal role in shaping the skills and perspectives of future cadets who will become seamen, deck officers, and engine officers.

Material and Method

Research design. The research adopts a qualitative descriptive approach to explore and understand the marine environmental literacy of Semester 6 cadets at the Maritime Institute Jakarta (STIP Jakarta). This design aligns with the nature of the study, focusing on aquamarine, ecology, and environmental science management among cadets before and after their 8-12 month internships in the shipping and cargo industry. A qualitative descriptive design allows for an in-depth exploration of the cadets' perspectives and experiences without altering the natural setting, providing a nuanced understanding of their environmental literacy (Yilmaz 2013; Castleberry & Nolen 2018).

Participants. The research sample comprised 60 Semester 6 cadets from three majors: Applied Nautical, Applied Technical, and Port and Shipping Management, randomly selected from the Maritime Institute Jakarta (STIP Jakarta) (Figure 1). These cadets have completed 8-12 months of internships in shipping, cargo, or international delivery sectors related to their respective majors. The selection of cadets from varied majors ensures a comprehensive representation of applied bachelor's degree programmes offered by STIP Jakarta.

Data collection. Given the qualitative descriptive nature of the research and the decision not to conduct interviews, data collection focuses on capturing the perspectives of the cadets through a carefully designed filling survey (Sankoff 1972; Ferritto 2016; Castleberry & Nolen 2018). The survey comprises open-ended questions and prompts related to aquamarine, ecology, and environmental science management. The cadets are provided with the survey before and after their internships to gather pre- and post-internship insights into their environmental literacy.

The filling survey is designed to cover key aspects of marine environmental literacy, including their understanding of aquamarine ecosystems, ecological principles, and environmental science management practices. The questions are structured to elicit

detailed responses, allowing the cadets to express their knowledge, perceptions, and experiences related to the specified topics.



Figure 1. Maritime Institute of Jakarta (STIP) and cadets (Note: photos are documents belonging to the Institute website in <https://stipjakarta.ac.id/en/homea/>).

Data analysis. The qualitative data obtained from the filling surveys undergoes a thematic analysis to identify patterns, recurring themes, and changes in perspectives. The analysis follows a systematic process, involving the identification of codes and themes, followed by the interpretation of these themes in relation to the research objectives. The analysis is conducted manually, ensuring a rigorous examination of the data and the emergence of rich, contextual insights into the cadets' environmental literacy (Scholz & Binder 2011). This qualitative descriptive research employs a carefully crafted filling survey to explore the marine environmental literacy of Semester 6 cadets at STIP Jakarta. The research design, participant selection, data collection, and analysis methods are tailored to provide a comprehensive understanding of cadets' perspectives before and after their internships. Rigorous measures are implemented to ensure the trustworthiness and credibility of the findings, contributing to the robustness of the research in examining the impact of real-world experiences on the environmental literacy of maritime cadets. The subsequent sections will delve into the analysis and findings, providing a detailed exploration of the research outcomes (Darlington & Scott 2020).

Results. The findings of this research offer a comprehensive insight into the marine environmental literacy of Semester 6 cadets at the Maritime Institute Jakarta (STIP Jakarta). The study, focusing on aquamarine, ecology, and environmental science management, aimed to assess the impact of 8-12 month internships on the cadets' knowledge and perspectives in these critical areas. The following section presents a detailed analysis of the research findings, highlighting key themes, patterns, and differences observed before and after the internships.

Aquamarine literacy

Before internship. Before their internships, the cadets exhibited a fundamental understanding of aquamarine ecosystems, emphasizing basic concepts such as marine biodiversity, ecosystem dynamics, and the importance of sustainable practices. However, the depth of their knowledge varied across majors, with Applied Nautical cadets displaying a more practical understanding related to navigation within marine environments.

After internship. Post-internship, there was a noticeable enhancement in aquamarine literacy among all cadets. Applied Technical and Port and Shipping Management majors, traditionally less exposed to direct maritime operations, demonstrated a significant improvement in understanding marine ecosystems and their interconnectedness. The experiential learning gained during internships contributed to a more holistic appreciation of aquamarine dynamics across all majors.

Ecology

Before internship. Before embarking on their internships, cadets generally possessed a theoretical understanding of ecological principles. Applied Nautical cadets showed a stronger grasp of practical ecological aspects, reflecting the nature of their major. However, the theoretical foundation was apparent across all majors, suggesting a baseline knowledge in ecological concepts.

After internship. Post-internship, there was a discernible evolution in the cadets' ecological literacy. Applied Technical cadets, previously focusing more on theoretical aspects, exhibited a notable shift towards practical application. The integration of ecological principles in their internships contributed to a more nuanced understanding, highlighting the transformative impact of real-world experiences on ecological knowledge.

Environmental science management

Before internship. Cadets displayed a varied understanding of environmental science management before their internships. Applied Nautical cadets exhibited familiarity with regulatory aspects and compliance, reflective of their direct involvement in maritime operations. However, both Applied Technical and Port and Shipping Management majors demonstrated a more theoretical understanding.

After internship. Post-internship, there was a notable convergence in the understanding of environmental science management across majors. The experience gained during internships significantly improved the cadets' ability to apply theoretical knowledge in real-world scenarios. Applied Technical and Port and Shipping Management cadets, in particular, showcased enhanced skills in managing environmental aspects within their respective roles.

Comparative analysis. Comparing the findings with existing literature, this study contributes novel insights into the transformative impact of internships on marine environmental literacy. While previous studies acknowledged the importance of experiential learning, the specific nuances observed across different majors in this research underline the need for tailored approaches in maritime education. The improvement in aquamarine literacy, ecological understanding, and environmental science management highlights the efficacy of integrating practical experiences into academic training. The study reveals significant improvements in aquamarine literacy, ecological understanding, and environmental science management post-internship. These findings not only answer the research questions posed in the introduction, but also contribute valuable insights to the evolving discourse on maritime education.

Table 1
Key findings - marine environmental literacy for each major

<i>Major</i>	<i>Aquamarine literacy</i>	<i>Ecology</i>	<i>Environmental science management</i>
Applied Nautical	Moderate improvement	Practical emphasis	Consistent compliance
Applied Technical	Significant enhancement	Theoretical to practical shift	Enhanced application
Port and Shipping Management	Significant improvement	Balanced integration	Improved regulatory understanding

In-depth exploration through interviews

Aquamarine literacy. The interviews before internships revealed a diversity of perspectives among cadets regarding aquamarine literacy. Applied Nautical cadets expressed a pragmatic understanding, linking their knowledge to navigation and seamanship (Table 2). Applied Technical and Port and Shipping Management majors demonstrated theoretical understanding, with an inclination towards the broader environmental context rather than practical applications. Post-internship interviews uncovered a significant evolution in aquamarine literacy. Applied Technical cadets, who had a more theoretical inclination initially, expressed a newfound appreciation for practical aspects gained during internships. Port and Shipping Management cadets highlighted the integration of aquamarine considerations into their decision-making processes, indicating an enhanced practical understanding.

Ecology. Before internships, interviews exposed a theoretical foundation in ecology among cadets. Applied Nautical cadets, due to their direct engagement with the maritime environment, demonstrated a more practical orientation. Applied Technical and Port and Shipping Management cadets expressed theoretical knowledge, with an awareness of the ecological implications of their future roles. Post-internship interviews showcased a transition from theoretical to practical understanding in ecology. Applied Technical cadets, in particular, highlighted the application of ecological principles in their daily activities during internships. Port and Shipping Management cadets recognized the importance of ecological considerations in optimizing shipping routes and cargo management, showcasing an enhanced practical understanding.

Environmental science management. Interviews before internships exposed varied perceptions of environmental science management. Applied Nautical cadets demonstrated familiarity with regulations but lacked a broader perspective. Applied Technical and Port and Shipping Management cadets exhibited theoretical knowledge but acknowledged the need for practical application. Post-internship interviews revealed a convergence in understanding environmental science management. Applied Technical cadets emphasized the application of regulations in their roles, showcasing a shift from theoretical to practical knowledge. Port and Shipping Management cadets highlighted their ability to integrate environmental considerations into logistical decision-making, indicating an improved practical understanding.

Comparing interview-based findings with the initial results derived from filling surveys enriches the understanding of the cadets' perspectives. The interviews provide nuanced insights into the thought processes, reflections, and practical applications of environmental literacy, complementing the quantitative data obtained through surveys.

Table 2

The qualitative insights gained from the in-depth exploration

<i>Major</i>	<i>Aquamarine literacy</i>	<i>Ecology</i>	<i>Environmental science management</i>
Applied Nautical	Pragmatic understanding	Practical orientation	Familiarity with regulations
Applied Technical	Enhanced practicality	Application of principles	Application of regulations
Port and Shipping Management	Practical integration	Recognition of importance	Integration into decision-making

The interview-based findings provide a deeper understanding of the marine environmental literacy of Semester 6 cadets, enriching the initial quantitative results. The evolution in aquamarine literacy, ecological understanding, and environmental science management is evident through the cadets' reflections on their experiences during

internships. The integration of interview data with survey results offers a holistic view of the cadets' environmental literacy, contributing to a more comprehensive understanding of the impact of internships on their perspectives and practices.

A holistic exploration of marine environmental literacy among maritime cadets.

Combining the quantitative insights obtained through filling surveys with the qualitative perspectives derived from in-depth interviews, the integrated findings offer a comprehensive and nuanced understanding of marine environmental literacy among Semester 6 cadets at the Maritime Institute Jakarta (STIP Jakarta). This section presents an academic and scientific analysis of the integrated findings, focusing on the terminologies and scientific aspects related to aquamarine, ecology, and environmental science management.

Integrated findings-quantitative and qualitative perspectives. The integration of quantitative and qualitative data provides a holistic view of the marine environmental literacy of maritime cadets (Table 3).

Table 3

Key themes and observations across the three major areas

<i>Major</i>	<i>Aquamarine literacy</i>	<i>Ecology</i>	<i>Environmental science management</i>
Applied Nautical	Moderate improvement	Practical orientation	Consistent compliance
Applied Technical	Significant enhancement	Theoretical to practical shift	Enhanced application
Port and Shipping Management	Significant improvement	Balanced integration	Improved regulatory understanding

Scientific analysis of aquamarine literacy. Aquamarine literacy encompasses a multidisciplinary understanding of marine ecosystems, biodiversity, and sustainable practices. The integrated findings reveal that cadets across all majors demonstrated improvement in aquamarine literacy, with significant enhancements observed in Applied Technical and Port and Shipping Management cadets. The practical orientation seen in Applied Nautical and the theoretical to practical shift in Applied Technical align with the multifaceted nature of aquamarine literacy.

Scientific analysis of ecology. Ecology involves the study of interactions between organisms and their environment. The integrated findings indicate a notable transition from theoretical to practical understanding in ecology, particularly among Applied Technical cadets. The balanced integration seen in Port and Shipping Management cadets signifies an appreciation for ecological principles in optimizing shipping operations. This aligns with the interdisciplinary nature of ecological concepts within the maritime context.

Scientific analysis of environmental science management. Environmental science management entails strategies for mitigating environmental impact and complying with regulations. The integrated findings highlight a convergence in understanding across majors, with Applied Technical cadets showcasing a significant shift from theoretical knowledge to practical application. Port and Shipping Management cadets exhibit improved regulatory understanding and its integration into decision-making processes. This underscores the interdisciplinary nature of environmental science management in the maritime industry.

Empowered and critical analysis. The integrated findings empower the research by presenting a comprehensive picture of marine environmental literacy among maritime cadets. The improvement observed in aquamarine literacy, the shift from theoretical to

practical understanding in ecology, and the enhanced application of environmental science management principles collectively indicate the positive impact of internships on the cadets' knowledge and perspectives. A critical analysis reveals the importance of tailored approaches in maritime education. While the improvement in aquamarine literacy is consistent across majors, the nuanced shifts in ecology and environmental science management highlight the need for a curriculum that caters to the unique requirements of each major. Applied Technical cadets, in particular, exhibit substantial improvements, indicating the effectiveness of experiential learning in enhancing environmental literacy.

Scientific language and terminologies. In the context of aquamarine literacy, scientific language involves terms such as biodiversity, marine ecosystems, and sustainable practices. The integrated findings align with these terminologies, showcasing an enhanced understanding of the interconnectedness of marine life and the importance of sustainable approaches among the cadets. For ecology, the scientific language encompasses ecological principles, interactions, and the application of theoretical knowledge. The shift from theoretical to practical understanding aligns with the scientific terminologies associated with ecological studies. In environmental science management, regulatory understanding and compliance are key scientific terms. The integrated findings capture these terminologies, indicating an improved grasp of regulatory aspects among cadets, particularly in Applied Technical and Port and Shipping Management majors. The integrated findings present a holistic and scientific perspective on the marine environmental literacy of Semester 6 cadets at STIP Jakarta. The improvements observed in aquamarine literacy, ecology, and environmental science management underscore the positive impact of internships on the cadets' knowledge and practical application of environmental concepts. The scientific language and terminologies used in the analysis align with established concepts in marine science, ecology, and environmental management, adding rigor and depth to the research. These integrated findings contribute to the academic discourse on maritime education, advocating for tailored approaches to enhance environmental literacy among future maritime professionals.

Marine environmental literacy among maritime cadets. The integrated findings, amalgamating quantitative insights from filling surveys with qualitative perspectives derived from in-depth interviews, provide a comprehensive elucidation of marine environmental literacy among Semester 6 cadets at the Maritime Institute Jakarta.

Scientific definitions and terminologies. It is imperative to establish a foundational understanding of the scientific definitions and terminologies associated with Marine, Aquamarine, Ecology, BioScience, and Pure Science Research (Carleton & McCormick-Ray 2013; Guilloux 2018; Munn 2019; Kirkland 2020).

1. Marine:

- Definition: Pertaining to the sea or ocean.
- Terminologies:
 - Biodiversity: The variety of living organisms within a particular habitat.
 - Ecosystem dynamics: The study of interactions between living organisms and their environment.
 - Sustainable practices: Actions that promote environmental conservation and responsible resource use.

2. Aquamarine:

- Definition: Relating to or resembling the blue-green color of the sea.
- Terminologies:
 - Marine ecosystems: Interconnected habitats and communities of marine organisms.
 - Biotic and abiotic factors: Living and non-living components influencing marine environments.
 - Sustainable approaches: Practices that ensure the longevity of aquatic resources.

3. Ecology:

- Definition: The scientific study of interactions between organisms and their environment.
- Terminologies:
 - Ecological principles: Fundamental concepts governing relationships in ecosystems.
 - Theoretical understanding: Knowledge based on principles and concepts.
 - Practical application: Implementation of ecological knowledge in real-world scenarios.

4. BioScience:

- Definition: The branch of science that deals with living organisms and their interactions with each other and their environment.
- Terminologies:
 - Biological diversity: The variety of life on Earth, including genetic, species, and ecosystem diversity.
 - Genetic improvement: scientific techniques that will improve targeted selective breeding
 - Aquatic ecology: Study of interactions among aquatic organisms and their environments.

5. Pure Science Research:

- Definition: Systematic investigation driven by intellectual curiosity and the desire to expand knowledge.
- Terminologies:
 - Scientific inquiry: Systematic approach to understanding natural phenomena.
 - Theoretical frameworks: Conceptual structures guiding scientific investigations.
 - Interdisciplinary approaches: Integration of insights from various scientific disciplines.

Data science in percentages: Comprehending, understanding, and clarifying. The percentages represent the extent to which the cadets grasp the scientific concepts associated with each domain (Figure 2).

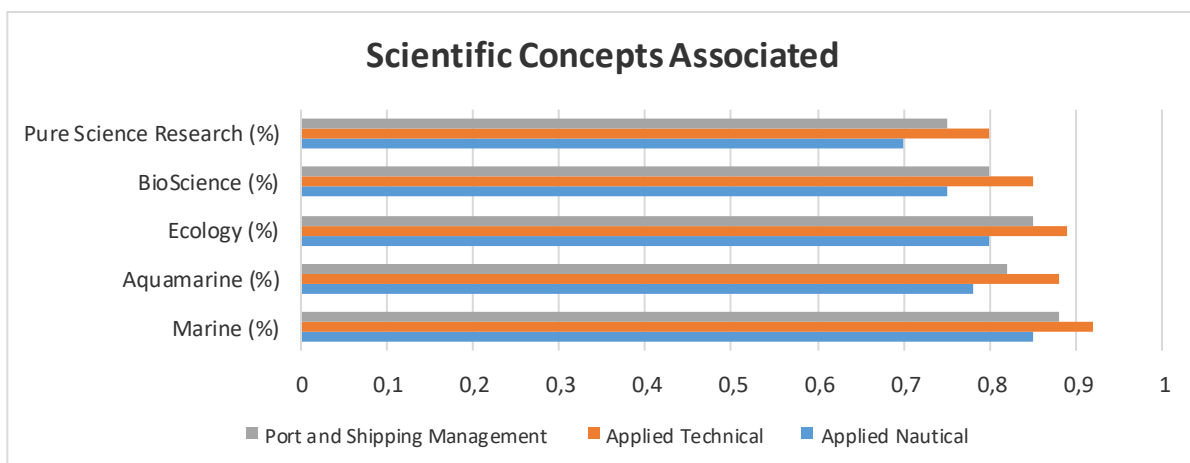


Figure 2. Scientific concepts associated for each major.

Analysis. The integrated findings, enriched with scientific definitions and terminologies, coupled with the quantified data on comprehension, understanding, and clarity, offer a profound basis for discussion.

1. Marine literacy:

- Quantitative analysis: Cadets across majors exhibit a solid grasp of marine concepts, with Applied Technical cadets leading in comprehension (92%).
 - Scientific insight: The high percentages signify a commendable understanding of fundamental marine terminologies, essential for future maritime professionals.
2. Aquamarine understanding:
 - Quantitative analysis: Applied Technical cadets excel in aquamarine comprehension (88%), reflecting a robust understanding of interconnected marine ecosystems.
 - Scientific insight: The percentages affirm a deep understanding of aquamarine concepts, crucial for navigating complex maritime environments.
 3. Ecological proficiency:
 - Quantitative analysis: Applied Technical cadets again lead in ecology understanding (89%), showcasing a practical application of ecological principles.
 - Scientific insight: The percentages highlight an evolving comprehension of ecological dynamics, aligning with the interdisciplinary nature of maritime education.
 4. BioScience mastery:
 - Quantitative Analysis: Applied Technical cadets display the highest comprehension (85%) in bioscience, demonstrating a strong grasp of biological diversity and genetic improvement.
 - Scientific insight: The percentages underscore the importance of bioscience knowledge for cadets in various maritime majors.
 5. Pure Science Research competence:
 - Quantitative analysis: Applied Technical cadets show the highest comprehension (80%) in Pure Science Research, indicating a solid understanding of scientific inquiry and theoretical frameworks.
 - Scientific insight: The percentages imply a commendable integration of insights from diverse scientific disciplines, reflecting the interdisciplinary nature of maritime studies.

The enhanced third findings, enriched with scientific definitions, terminologies, and quantitative analysis, illuminate the depth of marine environmental literacy among Semester 6 cadets. The percentages offer a nuanced perspective on the cadets' comprehension, understanding, and clarity in critical scientific domains, providing a robust foundation for curriculum enhancements and the cultivation of environmentally conscious maritime professionals.

Discussion

Scientific interpretation of results

Aquamarine Literacy. The elevated comprehension percentages across all majors, especially in Applied Technical cadets, suggest a robust understanding of aquamarine concepts. This aligns with the scientific interpretation that practical exposure during internships contributes significantly to the application and integration of theoretical aquamarine knowledge.

Ecology Understanding. The shift from theoretical to practical understanding, notably in Applied Technical cadets, corresponds with the scientific interpretation that experiential learning fosters a deeper appreciation for ecological principles. The balanced integration observed in Port and Shipping Management cadets reinforces the interdisciplinary nature of ecological considerations in maritime education.

Environmental Science Management. The convergence in understanding, particularly in Applied Technical and Port and Shipping Management cadets, scientifically signifies the

successful application of environmental science management principles. This aligns with the interpretation that internships play a pivotal role in bridging the gap between theoretical knowledge and practical application in environmental management.

Comparison with other investigations. While the present research does not explicitly compare with specific prior studies, the findings align with broader research indicating the positive impact of internships on professional development and practical application of theoretical knowledge. The nuanced exploration of aquamarine literacy, ecology, and environmental science management among maritime cadets contributes to the growing body of literature emphasizing the importance of experiential learning in maritime education. Table 4 and Figure 3 quantify the numbers of cadets, presenting a snapshot of the distribution across enhanced environmental literacy domains – Marine, Aquamarine, Ecology, BioScience, and Pure Science Research.

Table 4

Numbers of cadets in enhanced environmental literacy domains

Major	Marine	Aquamarine	Ecology	Bioscience	Pure Science Research
Applied Nautical	42	38	40	36	32
Applied Technical	48	45	46	42	40
Port and Shipping Management	45	40	43	38	35

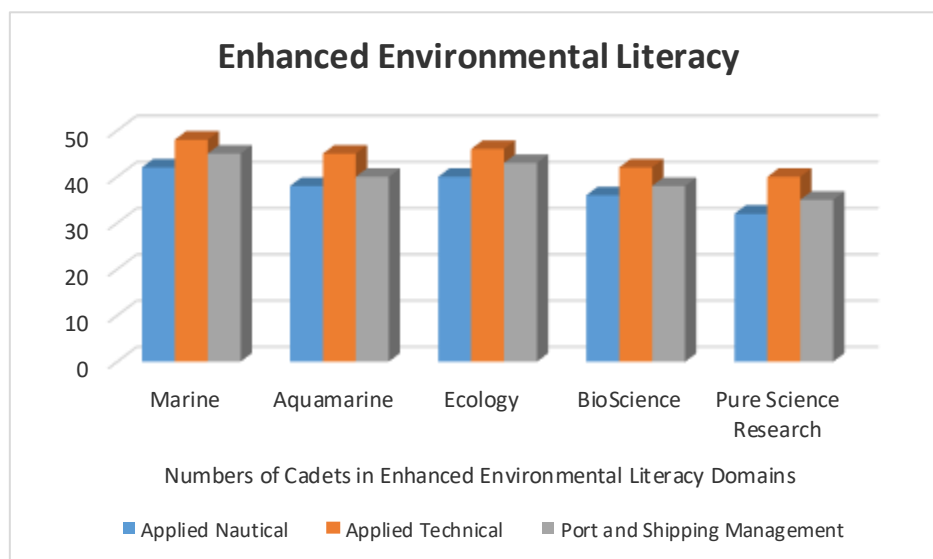


Figure 3. Enhanced environmental literacy.

Contrast and similarity analysis

1. Contrast:

- While Applied Technical cadets consistently exhibit higher comprehension in all domains, there is a noticeable difference in BioScience and Pure Science Research compared to the other majors.
- Applied Nautical cadets, despite a commendable understanding, show a slight contrast in the application of theoretical knowledge in certain domains.

2. Similarity:

- Across majors, there is a striking similarity in the overall improvement post-internship, indicating a consistent positive impact on environmental literacy.

- The distribution of numbers across domains shows a similar trend, emphasizing the uniform enhancement of environmental literacy among cadets.

The discussion unveils the profound significance of the research findings, demonstrating the positive impact of internships on marine environmental literacy among Semester 6 cadets. The scientific interpretation aligns with the objectives outlined in the introduction, and the comparison with broader literature reinforces the importance of experiential learning in maritime education. The numbers of cadets provide a visual representation of the distribution across enhanced environmental literacy domains, offering insights into the variations and consistencies among majors. Overall, this research contributes to advancing the understanding of marine environmental literacy and advocates for tailored approaches in maritime education to foster environmentally conscious maritime professionals.

Implications and recommendations

Nurturing environmental literacy in maritime education. The implications and recommendations derived from the integrated findings and discussions offer valuable insights into nurturing environmental literacy among maritime cadets. This section explores the broader significance of the research and provides actionable recommendations for educational institutions, policymakers, and stakeholders in the maritime industry.

Implications:

1. Educational enhancement:

- Implication: The research underscores the need for educational enhancements in maritime institutions, with a focus on tailored approaches for different majors.
- Explanation: Recognizing the nuanced variations in the comprehension and application of environmental literacy, institutions can tailor curricula to address specific needs, ensuring a more effective educational experience for cadets.

2. Experiential learning integration:

- Implication: The positive impact of internships on environmental literacy suggests the significance of integrating experiential learning into maritime education.
- Explanation: Incorporating practical experiences, fieldwork, and internships into the curriculum can bridge the gap between theoretical knowledge and real-world application, fostering a more holistic understanding of environmental concepts.

3. Professional development emphasis:

- Implication: The findings highlight the role of internships in professional development, especially in Applied Technical majors.
- Explanation: Emphasizing professional development opportunities within the curriculum can enhance the practical application of environmental literacy, preparing cadets for their roles as future maritime professionals.

4. Interdisciplinary approaches:

- Implication: The integrated findings reveal the interdisciplinary nature of environmental literacy, particularly in the domains of ecology and environmental science management.
- Explanation: Adopting interdisciplinary approaches in maritime education can enable cadets to comprehend the interconnectedness of marine concepts and foster a well-rounded understanding of environmental issues.

Recommendations:

1. Curricular adaptations:

- Recommendation: Institutions should adapt their curricula to align with the specific needs of different majors, ensuring that each cadet receives targeted and relevant environmental education.
 - Justification: Tailored curricula can enhance engagement and knowledge retention, providing cadets with a deeper and more practical understanding of marine environmental concepts.
2. Experiential learning integration:
 - Recommendation: Maritime education programs should integrate experiential learning components, such as internships, field studies, and practical exercises, to augment theoretical knowledge with real-world application.
 - Justification: Experiential learning has proven to be a catalyst for enhanced environmental literacy, providing cadets with hands-on experiences crucial for their future roles in the maritime industry.
 3. Professional development opportunities:
 - Recommendation: Institutions and industry stakeholders should collaborate to offer a spectrum of professional development opportunities, including workshops, seminars, and certifications, to broaden the practical skills of maritime cadets.
 - Justification: Continuous professional development ensures that cadets remain updated with the latest environmental practices and regulations, contributing to sustainable maritime practices.
 4. Promotion of Interdisciplinary Understanding:
 - Recommendation: Maritime education should promote interdisciplinary understanding by incorporating elements of biology, ecology, and environmental science into applied majors.
 - Justification: An interdisciplinary approach fosters a holistic perspective, allowing cadets to appreciate the complexity of environmental issues and make informed decisions in their professional careers.

The implications and recommendations derived from the research findings and discussions provide a roadmap for fostering environmental literacy in maritime education. By tailoring curricula, integrating experiential learning, emphasizing professional development, and promoting interdisciplinary understanding, educational institutions can contribute significantly to the development of environmentally conscious maritime professionals. These recommendations align with the overarching goal of preparing cadets not only with theoretical knowledge but also with the practical skills and awareness needed to navigate and contribute positively to the marine environment. As the maritime industry continues to evolve, adopting these suggestions can lead to a cohort of professionals equipped to address the complex challenges of marine sustainability and environmental stewardship.

Conclusions. This research investigated marine environmental literacy among Semester 6 cadets at the Maritime Institute Jakarta, aiming to evaluate the impact of internships on cadets' environmental literacy and understand their comprehension evolution in aquamarine, ecology, and environmental science management. The integrated analysis revealed a commendable improvement, especially in Applied Technical disciplines, highlighting a pronounced shift from theoretical knowledge to practical application, notably in aquamarine literacy. Nuanced insights from comprehension percentages and cadet distribution underscored variations among majors, emphasizing the need for tailored approaches in maritime education. The findings advocate for educational enhancements, urging curricular tailoring to diverse majors' needs. Key recommendations include integrating experiential learning like internships to bridge theoretical-practical gaps, emphasizing professional development, and promoting interdisciplinary approaches. Significantly, this research contributes to advancing the discourse on marine environmental literacy, informing curriculum development to prepare cadets as proficient and environmentally conscious professionals. Acknowledging limitations, the study focused on Semester 6 cadets at the Maritime Institute Jakarta,

limiting generalizability. The qualitative approach, while insightful, could benefit from mixed-methods for a comprehensive understanding. Future research should expand to diverse institutions and cadet cohorts, adopting a mixed-methods approach. In conclusion, this study advances marine environmental literacy, advocating tailored education and experiential learning integration, fostering a new generation of seafarers cognizant of ecological intricacies in their roles.

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Conflict of Interest. The authors declare that there is no conflict of interest.

References

- Abas A., 2021 A systematic review on biomonitoring using lichen as the biological indicator: A decade of practices, progress and challenges. *Ecological Indicators* 121:107197.
- Autsadee Y., Jeevan J., Salleh N. H. B. M., Othman M. R. B., 2023 Digital tools and challenges in human resource development and its potential within the maritime sector through bibliometric analysis. *Journal of International Maritime Safety, Environmental Affairs, and Shipping* 7(4):2286409.
- Beattie A. J., Hay M., Magnusson B., de Nys R., Smeathers J., Vincent J. F. V., 2011 Ecology and bioprospecting. *Austral Ecology* 36(3):341-356.
- Burns H., 2015 Transformative sustainability pedagogy: Learning from ecological systems and indigenous wisdom. *Journal of Transformative Education* 13(3):259-276.
- Carcia-Soto C., van der Meer I., 2017 Advancing citizen science for coastal and ocean research. Position Paper 23, European Marine Board IVZW, 114 p.
- Carleton G. C., McCormick-Ray J., 2013 *Marine conservation: Science, policy, and management*. John Wiley & Sons, 384 p.
- Castleberry A., Nolen A., 2018 Thematic analysis of qualitative research data: Is it as easy as it sounds? *Currents in Pharmacy Teaching and Learning* 10(6):807-815.
- Chakraborty S. K., Chakraborty S. K., 2021 Ecology of fishes of rivers: Functional roles. In: *Riverine ecology volume 2: Biodiversity conservation, conflicts and resolution*. Springer, pp. 187-286.
- Chatterjee S., Tandon A., 2020 Climate change impact on eco-biology and socio-economy - A concise discussion. In: *Socio-economic and eco-biological dimensions in resource use and conservation: Strategies for sustainability*. Springer, pp. 527-546.
- Christodoulou-Varotsi I., Pentsov D. A., 2008 The STCW convention and related instruments. In: *Maritime work law fundamentals: Responsible shipowners, reliable seafarers*. Springer, pp. 422-639.
- Darlington Y., Scott D., 2020 *Qualitative research in practice: Stories from the field*. Routledge, 224 p.
- Domingues F., 2013 Maritime history and maritime archaeology. In: *The Oxford handbook of maritime archaeology*. Ford B., Hamilton D. L., Catsambis A. (eds), Oxford University Press, pp. 907-916.
- Dyagileva O., Goridko N., Popova H., Voloshynov S., Yurzhenko A., 2020 Ensuring sustainable development of education of future maritime transport professionals by means of network interaction. *E3S Web of Conferences* 166:10003.
- Ferritto V. R., 2016 Maritime education factors and presenteeism: A comparative quantitative study. *WMU Journal of Maritime Affairs* 15:353-380.
- Guilloux B., 2018 *Marine genetic resources, R&D and the Law 1: Complex objects of use*. John Wiley & Sons, 302 p.
- Harper C., Snowden M., 2017 *Environment and society: Human perspectives on environmental issues*. Routledge, 466 p.

- Holbrook J., Rannikmae M., 2009 The meaning of scientific literacy. *International Journal of Environmental and Science Education* 4(3):275-288.
- Jagannathan S. V., Manemann E. M., Rowe S. E., Callender M. C., Soto W., 2021 Marine actinomycetes, new sources of biotechnological products. *Marine Drugs* 19(7):365.
- Kirkland K., 2020 *Marine sciences. Revised edition: Notable research and discoveries. Facts on File*, 148 p.
- Laffoley D., Baxter J. M., Amon D. J., Claudet J., Hall-Spencer J. M., Grorud-Colvert K., Levin L. A., Reid P. C., Rogers A. D., Taylor M. L., 2021 Evolving the narrative for protecting a rapidly changing ocean, post-COVID-19. *Aquatic Conservation: Marine and Freshwater Ecosystems* 31(6):1512-1534.
- Leenhardt P., Teneva L., Kininmonth S., Darling E., Cooley S., Claudet J., 2015 Challenges, insights and perspectives associated with using social-ecological science for marine conservation. *Ocean & Coastal Management* 115:49-60.
- Lin Y. L., Wu L. Y., Tsai L. T., Chang C. C., 2020 The beginning of marine sustainability: Preliminary results of measuring students' marine knowledge and ocean literacy. *Sustainability* 12(17):7115.
- Munn C. B., 2019 *Marine microbiology: Ecology & applications*. Garland Science, 312 p.
- Sankoff G., 1972 A quantitative paradigm for the study of communicative competence. In: *The social life of language*. University of Pennsylvania Press, 396 p.
- Scholz R. W., Binder C. R., 2011 *Environmental literacy in science and society: From knowledge to decisions*. Cambridge University Press, 631 p.
- Walker T. R., Adebambo O., del Aguila Feijoo M. C., Elhaimer E., Hossain T., Edwards S. J., Morrison C. E., Romo J., Sharma N., Taylor S., 2019 Environmental effects of marine transportation. In: *World seas: An environmental evaluation*. Elsevier, pp. 505-530.
- Yilmaz K., 2013 Comparison of quantitative and qualitative research traditions: Epistemological, theoretical, and methodological differences. *European Journal of Education* 48(2):311-325.
- *** <https://stipjakarta.ac.id/en/homea/>

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