

A Study on Marine Environmental Knowledge, Attitudes, and Behaviors of Upper-Grade Elementary School Students in Central Taiwan

Ya-Fan Tsai¹, Ying-Feng Wang^{2*}

¹*Department of Science Education and Application, National Taichung University of Education, Taiwan*

²*Department of Science Education and Application, National Taichung University of Education, Taiwan*

**Correspondence Author*

Abstract: Marine education plays an important role in promoting ocean sustainability by fostering students' knowledge, attitudes, and responsible behaviors. This study examined marine environmental knowledge, attitudes toward marine conservation, and pro-marine behaviors among upper-grade elementary school students in central Taiwan. A quantitative survey was administered to 239 fifth- and sixth-grade students in coastal and inland areas, yielding 239 valid responses. The results showed that students demonstrated moderate-to-high marine knowledge, positive attitudes, and moderate pro-marine behaviors. No significant differences were found across gender or residential location, while grade-level differences were observed only in marine knowledge. Attitudes toward marine conservation were significantly and positively associated with pro-marine behaviors, whereas marine knowledge was not. These findings highlight the importance of affective and action-oriented approaches in marine education.

Keywords: Marine education, Ocean literacy, Environmental knowledge, Student attitudes, Pro-ocean behavior

1. Introduction

The ocean covers most of our planet, keeping our climate in check and supporting life in ways we're only beginning to understand fully. Despite its importance, human activity is pushing marine ecosystems to their limits. That's why the UN's Sustainable Development Goal 14—"Life Below Water"—is so urgent; we have to get better at protecting our seas.

Taiwan is a perfect example of this challenge. Although we are an island nation, our education and culture have historically focused on the land, leaving many people feeling disconnected from the surrounding waters. To change this, marine education is now part of our national curriculum. The idea is to reach kids in elementary school—especially the older ones—because that's when they start forming their own values and can really grasp complex issues like environmental conservation.

Interestingly, most research on this topic in Taiwan has focused on the north or the south, leaving a gap in coverage of the central region. Central Taiwan is unique in that it integrates coastal and inland communities, all of which follow the same educational policies. We wanted to see if school programs are doing enough to bridge the gap between kids who live by the beach and those who don't. But there's a catch: knowing about the ocean isn't the same as caring for it. We've noticed that while many students have the facts down and say they care, they don't always take action. It seems that a person's attitude—how they feel in their heart—might be a much stronger predictor of real-world behavior than just a high test score. By studying students in central Taiwan, we hope to figure out how to design lessons that don't just fill heads with facts, but actually inspire kids to stand up for our blue planet.

2. Literature Review

Marine education, as an extension of environmental education, aims to foster learners' knowledge, attitudes, and responsible behaviors toward marine and aquatic environments. In the context of global sustainable development, particularly Sustainable Development Goal 14 (Life Below Water), marine education has gained increasing attention within formal education systems [14]. In Taiwan, national curriculum guidelines emphasize the integration of marine concepts into school education, underscoring schools' role in cultivating marine awareness and responsible citizenship. Previous studies have shown that the effectiveness of marine education is closely related to instructional design and teacher competencies, including the ability to connect marine issues with students' learning experiences [4,6,11].

2.1. Environmental and Marine Attitudes

Environmental attitudes, encompassing values, awareness, and willingness to act, are recognized as a core component of environmental education [12]. Research suggests that students' attitudes toward the environment and marine ecosystems are shaped by both formal instruction and experiential learning opportunities [5,13]. In marine education, attitudes play a particularly important role. Liu, Lin, and Yeh [8] found that attitudes toward marine conservation mediate the relationship between marine knowledge and responsible marine behavior, underscoring the importance of affective engagement. Experiential approaches, such as inquiry-based learning and citizen science activities, have been shown to strengthen students' emotional connections to marine environments and to promote positive, conservation-oriented attitudes [1].

2.2. Marine Knowledge, Attitudes, and Behaviors

A growing body of research has identified a persistent gap between marine knowledge and actual pro-marine behaviors. Elementary school students often demonstrate moderate levels of marine knowledge and generally positive attitudes, yet their engagement in pro-marine behaviors remains limited [2]. International studies report similar findings, indicating that improvements in ocean literacy do not necessarily lead to behavioral change [7]. This "knowledge-action gap" has been widely discussed, with evidence suggesting that attitudes, rather than knowledge alone, play a key mediating role in shaping behavior [8,10]. Consequently, researchers emphasize the importance of experiential and action-oriented instructional approaches, including technology-enhanced learning and inquiry-based marine activities [1,9].

2.3. Marine Pollution Issues

Marine pollution, including plastic debris and chemical contaminants, poses serious threats to marine ecosystems and highlights the need to enhance public awareness and environmental responsibility [3]. Pollution-related topics are commonly incorporated into marine education as accessible and meaningful learning contexts. Research has shown that such instruction can increase students' environmental awareness and willingness to engage in environmentally responsible behaviors [2]. When combined with experiential activities—such as museum visits or ecological projects—these topics help students connect classroom learning with real-world environmental challenges and foster a sense of marine stewardship [1,9].

Overall, prior research highlights the importance of marine education while also revealing challenges in translating knowledge and positive attitudes into sustained pro-marine behaviors. Findings regarding background factors such as grade level and residential location remain inconsistent, particularly in standardized educational contexts. Moreover, empirical research focusing on elementary school students in central Taiwan remains limited, underscoring the need for the present study.

3. Methodology

This study employed a quantitative survey design to examine marine environmental knowledge, attitudes toward marine conservation, and pro-marine behaviors among upper-grade elementary school students in central Taiwan. The participants were fifth- and sixth-grade students from elementary schools located in both coastal and inland areas. A total of 251 questionnaires were distributed, and 239 valid responses were obtained, resulting in a valid response rate of 95.2%. The demographic characteristics of the participants, including gender, grade level, and residential location, are summarized in Table 1. The research instrument was a self-developed questionnaire assessing students' background characteristics (gender, grade level, and residential location), marine environmental knowledge, attitudes toward marine conservation, and pro-marine behaviors. The knowledge items measured students' understanding of marine concepts, ecosystems, pollution, and conservation, while attitudes were assessed using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Pro-marine behaviors were evaluated based on students' self-reported participation in marine-related activities and environmentally responsible practices. The questionnaire was reviewed by the five experts in environmental education and experienced elementary school teachers to establish content validity, and a pilot test was conducted to refine the items. The overall internal consistency of the questionnaire was acceptable, with a Cronbach's alpha coefficient of .846. Data were collected via paper-based questionnaires administered during regular class time; participation was voluntary and anonymous. Statistical analyses were conducted in SPSS, including descriptive statistics, independent-samples t-tests to examine differences across background variables, and Pearson product-moment correlations to examine relationships among marine environmental knowledge, attitudes, and pro-marine behaviors. Statistical significance was set at the .05 level.

Table 1: Demographic Characteristics of the Participants

Variable	Category	N	Percentage (%)
Gender	Male	119	49.8
	Female	120	50.2
Grade Level	Grade 5	115	48.1
	Grade 6	136	51.9
Residential Location	Coastal area	125	52.3
	Inland area	114	47.7

Note. Total N = 239.

4. Results

The results of this study are presented based on descriptive statistics, independent samples t-tests, and Pearson product-moment correlation analyses. Descriptive statistical analyses indicated that upper-grade elementary school students in central Taiwan demonstrated moderate to above-moderate levels of marine environmental knowledge, attitudes toward marine conservation, and pro-marine behaviors. The mean score for marine environmental knowledge was 76.20 (SD = 18.76), suggesting that students possessed a basic to intermediate understanding of marine-related concepts. Students' attitudes toward marine conservation were generally positive, with a mean score of 4.11 (SD = 0.63) on a five-point Likert scale. The mean score for pro-marine behaviors was 6.33 (SD = 1.78), indicating a moderate level of engagement in marine-related activities and environmentally responsible behaviors.

Independent samples t-tests were conducted to examine differences across background variables, including gender, grade level, and residential location. The results of these analyses are summarized in Table 2. The results showed no significant gender differences in marine environmental knowledge ($t = -0.716, p = .474$), attitudes toward marine conservation ($t = -1.856, p = .065$), or pro-marine behaviors ($t = -1.031, p = .303$). Concerning grade level, a significant difference was found in marine environmental knowledge, with sixth-grade students scoring significantly higher than fifth-grade students ($t = -2.485, p = .014$). However, no significant grade-level differences were observed in attitudes toward marine conservation ($t = -0.696, p = .487$) or pro-marine behaviors ($t = 1.460, p = .146$). In addition, no significant differences were found between students living in coastal areas and those living in inland areas in terms of marine environmental knowledge ($t = -0.949, p = .343$), attitudes toward marine conservation ($t = 0.938, p = .349$), or pro-marine behaviors ($t = -0.912, p = .363$).

Table 2: Summary of Statistical Analyses

Background Variable	Construct	t	p	Significance
Gender	Marine Environmental Knowledge	-0.716	.474	n.s.
	Attitudes Toward Marine Conservation	-1.856	.065	n.s.
	Pro-Marine Behaviors	-1.031	.303	n.s.
Grade Level	Marine Environmental Knowledge	-2.485	.014	*
	Attitudes Toward Marine Conservation	-0.696	.487	n.s.
	Pro-Marine Behaviors	1.460	.146	n.s.
Residential Location	Marine Environmental Knowledge	-0.949	.343	n.s.
	Attitudes Toward Marine Conservation	0.938	.349	n.s.
	Pro-Marine Behaviors	-0.912	.363	n.s.

Note. * $p < .05$; n.s. = not significant.

Pearson product-moment correlation analyses were conducted to examine the relationships among marine environmental knowledge, attitudes toward marine conservation, and pro-marine behaviors. The correlation matrix is presented in Table 3. The results revealed a significant moderate positive correlation between attitudes toward marine conservation and pro-marine behaviors ($r = .400, p < .01$), indicating that students with more positive attitudes were more likely to engage in pro-marine behaviors. In contrast, marine environmental knowledge was not significantly correlated with attitudes toward marine conservation ($r = .095, p > .05$) or pro-marine behaviors ($r = -.037, p > .05$).

Table 3: Pearson Product–Moment Correlation Matrix

Variable	Marine Environmental Knowledge	Attitudes Toward Marine Conservation	Pro-Marine Behaviors
1. Marine Environmental Knowledge	1	.095	-.037
2. Attitudes Toward Marine Conservation		1	.400**
3. Pro-Marine Behaviors			1

Note. ** $p < .01$.

5. Discussion

The present study examined marine environmental knowledge, attitudes toward marine conservation, and pro-marine behaviors among upper-grade elementary school students in central Taiwan, with attention to the influence of background variables and the relationships among these constructs. Overall, the findings suggest that current marine education efforts have achieved some success: students demonstrated moderate to high levels of marine knowledge, generally positive attitudes toward marine conservation, and moderate engagement in pro-marine behaviors. These results indicate that students have developed a foundational understanding of marine issues and a willingness to support marine conservation, although there remains room for further behavioral development.

The further analysis showed that gender and residential location were not significant factors influencing students' marine knowledge, attitudes, or pro-marine behaviors. This finding suggests that under a standardized national curriculum and relatively uniform access to educational resources, students' marine learning outcomes may be shaped more by school-based educational experiences than by demographic or geographic differences. Notably, the absence of significant differences between coastal and inland students implies that effective marine education can help reduce disparities related to environmental proximity, enabling inland students to develop marine-related understanding and attitudes comparable to those of their coastal peers.

Concerning grade level, a significant difference emerged only in marine environmental knowledge, with sixth-grade students demonstrating higher knowledge levels than fifth-grade students. This result aligns with expectations related to cognitive development and curricular progression, as older students are likely to encounter more environmental content and possess more advanced reasoning abilities. However, the lack of grade-level differences in attitudes and pro-marine behaviors suggests that the development of environmental values and action-oriented behaviors does not necessarily progress automatically with age or increased knowledge. Instead, these aspects may require sustained emotional engagement and carefully designed learning experiences that encourage reflection and personal involvement.

One of the most noteworthy findings of this study is a significant positive relationship between attitudes toward marine conservation and pro-marine behaviors. In contrast, knowledge of marine environments was not significantly associated with attitudes or behaviors. This pattern reflects the well-documented “knowledge–action gap” in environmental education and highlights the limitations of knowledge-based instruction alone. While factual understanding is important, students' emotional connections to the marine environment, along with their values and sense of responsibility, appear to play a more decisive role in motivating behavioral engagement.

Taken together, these findings point to the need for a more holistic approach to marine education—one that moves beyond the transmission of knowledge to emphasize affective learning and opportunities for meaningful action. By integrating experiential, participatory, and action-oriented activities into marine education programs, educators may better support students in translating their understanding and concern for marine issues into sustained pro-marine behaviors. Such an approach may ultimately strengthen the role of marine education in fostering environmentally responsible citizenship among elementary school students.

6. Conclusion

This study explored marine environmental knowledge, attitudes toward marine conservation, and pro-marine behaviors among upper-grade elementary school students in central Taiwan to understand how these aspects are shaped and how they relate to one another. The findings show that students generally possess a basic to moderate level of marine knowledge and hold positive attitudes toward marine conservation. Yet, their actual engagement in pro-marine behaviors remains limited. Differences related to gender and residential location were minimal, and grade-level differences appeared only in marine environmental knowledge, suggesting that

students' marine-related behaviors are influenced less by demographic or geographic factors and more by their learning experiences.

Most importantly, the results indicate the pivotal role of attitudes in promoting pro-marine behaviors. While knowledge of marine environments provides an essential foundation, it does not, by itself, lead students to take action. Instead, students' values, emotional connections to the marine environment, and sense of responsibility appear to be more influential in shaping whether they translate understanding into behavior. From this perspective, effective marine education should move beyond the transmission of information and create meaningful opportunities for students to experience, reflect on, and engage with marine issues. By emphasizing attitude-oriented and action-based learning, marine education can more effectively support the development of environmentally responsible behaviors among elementary school students.

7. Implications

The insights gained from this study offer a clear path forward for how we approach marine education in our schools. First, it's heartening to see that a well-thought-out curriculum can truly level the playing field. Since background factors such as gender or where a child lives don't appear to limit their learning, schools have a unique opportunity—and a responsibility—to be the primary bridge to the ocean. This is especially vital for students in inland areas; for them, the classroom is the window through which they first learn to value a world they may not see every day.

Second, the strong link between a student's attitude and their actual behavior underscores the need to engage more than the mind. While facts provide the foundation, it is the emotional connection—the feeling that the ocean actually matters to them—that drives a child to act. We encourage educators to look beyond textbooks and bring the ocean to life through hands-on projects, simulations, and community engagement. When students feel a personal sense of responsibility, they don't just learn about conservation; they start to live it.

Finally, the gap we've observed between "knowing" and "doing" suggests it's time to rethink our teaching strategies. Marine education should be more than a one-way street of information. It should be an invitation to reflect, to participate, and to apply learning in the real world. By moving our focus from simple memorization to deeper values and meaningful action, we can help our students transform their quiet concern for the sea into a lifelong commitment. Ultimately, this isn't just about teaching a subject; it's about nurturing responsible citizens who will care for our planet for years to come.

References

- [1]. Boaventura, D.; Neves, A.T.; Santos, J.; Pereira, P.C.; Luís, C.; Monteiro, A.; Cartaxana, A.; Hawkins, S.J.; Caldeira, M.F. Promoting ocean literacy in elementary school students through investigation activities and citizen science. *Front. Mar. Sci.* 2021, 8, 675278. <https://doi.org/10.3389/fmars.2021.675278>.
- [2]. Chao, C.-M.; Tu, C.-H. A study on the effectiveness of environmental education for elementary school children: A case study of Jiabei Elementary School. *New Horiz. Educ.* 2011, 58, 69–86. [https://doi.org/10.6701/TEEJ.201103_58\(1\).0005](https://doi.org/10.6701/TEEJ.201103_58(1).0005).
- [3]. Chou, J. Regulations on marine dumping and incineration are under amendment. *Lee Li Bull.* 2008, 2008, 6–7. <https://doi.org/10.29492/LLB.200811.0008>.
- [4]. Chen, K.-C.; Su, H.-J. An action research on curriculum design and implementation of marine education for fourth-grade elementary school students. *J. Environ. Educ. Res.* 2017, 13, 67–98. <https://doi.org/10.6555/JEER.13.1.067>.
- [5]. Hsieh, P.-J. A Study on the Relationship between Elementary School Children's Concepts of Ecological Balance and Their Environmental Attitudes. Master's Thesis, National Taipei Teachers College, Taipei, Taiwan, 2000.
- [6]. Hsu, T.-C. A study on constructing the competency indicators and weighting system of marine education for elementary school teachers. *J. Educ. Sci. Res.* 2011, 56, 61–90.
- [7]. Kim, J. Connecting Children to the Ocean: Understanding Changes in Elementary Students' Ocean Literacy during a Marine Aquarium Summer Camp Experience. Doctoral Dissertation, University of British Columbia, Vancouver, BC, Canada, 2014.
- [8]. Liu, G.-Y.; Lin, Y.-C.; Yeh, T.-K. Motivating individuals to take responsible ocean action: The mediatory effects of attitude toward the ocean. *Int. J. Environ. Res. Public Health* 2023, 20, 2676. <https://doi.org/10.3390/ijerph20032676>.
- [9]. Lu, S.-J.; Liu, Y.-C. Integrating augmented reality technology to enhance children's learning in marine education. *Environ. Educ. Res.* 2015, 21, 525–541. <https://doi.org/10.1080/13504622.2014.911247>.

- [10]. Mogias, A.; Boubonari, T.; Realdon, G.; Previati, M.; Mokos, M.; Koulouri, P.; Cheimonopoulou, M.T. Assessing ocean literacy in elementary students: Preliminary results from a cross-cultural study. *Front. Mar. Sci.* 2019, 6, 396. <https://doi.org/10.3389/fmars.2019.00396>.
- [11]. Treagust, D.F.; Amaranta, A.; Chandrasegaran, A.L.; Won, M. A case for enhancing environmental education programs in schools: Reflecting on primary school students' knowledge and attitudes. *Int. J. Environ. Sci. Educ.* 2016, 11, 5591–5612.
- [12]. UNESCO. Tbilisi Declaration. *Connect* 1978, 3, 1–8.
- [13]. Yeh, T.-C.; Cheng, C.-C.; Ni, Y.-L. The moderating effects of leisure farm recreation experiences on environmental attitudes and behaviors of elementary school children. *J. Outdoor Recreat. Stud.* 2022, 35, 97–121. [https://doi.org/10.6130/JORS.202209_35\(3\).0004](https://doi.org/10.6130/JORS.202209_35(3).0004).
- [14]. Yen, C.-T.; Lee, M.-C. Trends in United Nations ocean education in the post-pandemic era. *Mar. Aff. Policy Rev.* 2021, 9, 105–140. [https://doi.org/10.6546/MAPR.202108_9\(1\).10](https://doi.org/10.6546/MAPR.202108_9(1).10).