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Preparing Environmentally Responsive Teachers: Ecological Literacy of Preservice Teachers in a Climate-Vulnerable Coastal Community

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Abstract

Coastal communities in the Philippines are among the most vulnerable to the impacts of climate change, including flooding, coastal erosion, sea-level rise, and biodiversity loss. In this context, future elementary school teachers play a crucial role in promoting environmental awareness and strengthening community resilience to climate-related risks. This study investigated the ecological literacy of Bachelor of Elementary Education (BEED) students in a coastal municipality, focusing on ecological knowledge, environmental attitudes, ecological practices, and students' perceived roles as future educators in addressing climate change. A mixed-methods convergent parallel design was employed involving 70 purposively selected third- and fourth-year BEED students from Southern Luzon State University–Tagkawayan Campus. Quantitative data were collected through a validated ecological literacy survey, while qualitative insights were gathered from written reflections describing students' lived experiences with climate change. Data analysis included descriptive statistics, independent-samples *t*-tests, one-way ANOVA, Pearson correlation analysis, and thematic analysis. The findings revealed moderately high levels of ecological knowledge (M = 3.84) and strong pro-environmental attitudes (M = 4.12), but only moderate ecological practices (M = 3.73), indicating a gap between environmental awareness and consistent ecological behavior. No significant differences were found based on gender or year level; however, significant differences emerged with respect to coastal residence, with students living in coastal areas demonstrating higher ecological knowledge, attitudes, and practices. Pearson correlation analysis further revealed significant positive relationships among knowledge, attitudes, and practices, with environmental attitudes showing the strongest association with ecological practices. Qualitative findings highlighted students' lived experiences with flooding, typhoons, coastal erosion, and biodiversity loss, accompanied by expressions of concern, responsibility, and hope, as well as perceptions of institutional barriers that hinder sustained environmental advocacy. The study concludes that BEED students possess strong cognitive and affective foundations of ecological literacy shaped by their exposure to climate-related risks. However, the development of consistent ecological practices requires greater emphasis on experiential learning, curriculum integration, and stronger school–community partnerships. Strengthening ecological literacy within teacher education programs is therefore essential for preparing future educators to contribute to climate resilience and environmental sustainability in vulnerable coastal communities.

Keywords: Ecological Literacy, Climate Change Education, Teacher Education, Coastal Resilience, Environmental Attitudes, Preservice Teachers

1. Introduction

Climate change is widely recognized as one of the most pressing environmental challenges of the twenty-first century. Anthropogenic activities such as greenhouse gas emissions and land-use change continue to alter Earth's climate system, resulting in sea-level rise, intensified storms, and increasing climate variability (IPCC, 2014; IPCC, 2022). Coastal zones are particularly at risk, as they are highly exposed to storm surges, erosion, saltwater intrusion, and ecosystem degradation (IPCC, 2007). In developing countries, these vulnerabilities are further intensified by socio-economic constraints and limited adaptive capacity. In the Philippines, an archipelagic nation with extensive coastlines, many coastal municipalities face compounded risks due to environmental exposure and resource limitations (Bollettino et al., 2020). Studies have documented changes such as rising sea surface temperatures, degradation of coastal ecosystems, and the increasing intensity of typhoons (Szekielda et al., 2021). These conditions underscore the need to strengthen adaptive capacity and promote sustainable environmental practices at the community level.Education plays a critical role in addressing these challenges by fostering environmental awareness, critical thinking, and responsible action. In particular, the preparation of preservice teachers is essential, as they serve as key agents in shaping environmental understanding and behavior among future generations. Developing ecological literacy among future educators is therefore an important strategy for advancing climate resilience and sustainability in vulnerable communities.

1.1. Ecological Literacy and Environmental Education

The concept of *ecological literacy* (sometimes called *eco-literacy*) gained prominence through the works of David W. Orr (1992), who argued that for humanity to adequately respond to environmental crises, individuals must be able to "think like a planet," appreciating ecosystem interconnections, limits, and feedbacks (Orr, 1992) Ecological literacy is often conceptualized along three interrelated domains: knowledge (understanding ecological and environmental principles), attitudes/values (environmental orientations, ethical sensibilities), and practices/behaviors (the actions people take) (McBride, Brewer, Berkowitz, & Borrie, 2013). In the field of education and particularly teacher preparation, ecological literacy plays a vital role: teachers who are ecologically literate are better equipped to integrate sustainability, climate change, and environmental ethics into their curricula (Kazazoglu et al., 2025). Some scholars argue that climate education is among the most underinvested yet high-leverage interventions to enable adaptation and mitigation (EarthDay, 2023). A "teacher call to action" for environmental literacy highlights that teachers have moral, curricular, and professional imperatives to cultivate environmental consciousness in students (CA-ELI, 2022). In practice, environmental education aims to move beyond awareness to action fostering not only cognitive understanding but also emotional engagement, critical thinking, and participatory behavior (Regeneration, n.d.) A growing body of literature advocates integrating experiential learning, project-based approaches, community partnerships, and place-based pedagogy to deepen ecological literacy (Duda, 2022).

1.2. Coastal Vulnerability, Adaptation, and the Role of Local Actors

While large-scale infrastructural adaptation (e.g., sea walls, dykes) is often emphasized, many scholars note that local, behavioral, and ecosystem-based interventions are essential, particularly in low- and middle-income coastal areas (Wannewitz et al., 2024). Coastal adaptation in many developing-country contexts still relies heavily on household-level adjustments and community-based strategies rather than large public engineering (Wannewitz et al., 2024). Participatory vulnerability assessment tools (e.g., I-C-SEA Change) highlight the importance of local knowledge, stakeholder engagement, and bottom-up approaches in understanding climate risks in coastal zones (Licuanan et al., 2015). Moreover, coastal poverty and vulnerability dynamics are shaped by environmental changes (rising seas, storms), weak infrastructure, limited access to services, and resource constraints such as poor waste management and livelihood alternatives (Cheeseman et al., 2025). However, despite these pressing concerns, the translation of climate knowledge into sustained practices especially in coastal settings—often remains weak. Studies show that adaptation tends to be incremental, reactive, and narrowly scoped, rather than transformative or forward-looking (Wannewitz et al., 2024). Therefore, fostering agents who can bridge knowledge and practice is critical.

1.3. Rationale and Gap in the Philippine Context

The Philippines is highly vulnerable to climate change, particularly in coastal communities that experience frequent flooding, storm surges, coastal erosion, and biodiversity degradation. These risks have intensified due to stronger typhoons and rising sea levels, significantly affecting local livelihoods and ecosystems (Alcantara et al., 2023; Williams et al., 2020). In this context, strengthening climate resilience through education is essential, especially in communities directly exposed to environmental hazards.

Preservice teachers, particularly those enrolled in Bachelor of Elementary Education (BEED) programs, play a vital role in shaping environmental awareness and sustainability practices among future generations. Ecological literacy—encompassing ecological knowledge, environmental attitudes, and ecological practices—is a key factor in promoting pro-environmental behavior and climate-responsive action (McBride et al., 2013; Desmarais, 2024). Teacher education programs therefore serve as critical platforms for developing ecological literacy and integrating sustainability into classroom practice (Larasaty et al., 2024; Xiong et al., 2025).

However, despite increasing attention to environmental education, a persistent gap remains between environmental knowledge and actual ecological behavior. Studies indicate that awareness and positive attitudes do not always translate into consistent environmental practices (Aznar-Díaz et al., 2019; Pilare & Acledan, 2024). In the Philippine context, existing research has largely focused on climate change awareness and community-level adaptation, with limited attention given to the ecological literacy of preservice teachers, particularly in coastal and climate-vulnerable areas (Alcantara et al., 2023; Ouano, 2013). Moreover, few studies examine how lived experiences of climate-related events influence ecological knowledge, attitudes, and practices, and there is limited use of mixed-methods approaches to capture both measurable outcomes and contextual realities (Pouresmaieli et al., 2023; Muccione et al., 2025).

Addressing these gaps, the present study investigates the ecological literacy of BEED students in a coastal municipality, focusing on their ecological knowledge, environmental attitudes, ecological practices, and perceived roles as future educators in promoting environmental sustainability and climate resilience.

1.4. Conceptual Framework of the Study

The present study is anchored on the Input–Process–Output (IPO) framework, which illustrates the systematic flow of inquiry from the characteristics of the respondents to the outcomes of the research. This framework is widely used in educational research to explain how variables are transformed through structured processes into meaningful outputs The input component consists of the ecological literacy dimensions of the respondents, including their ecological knowledge (e.g., understanding of climate change concepts, coastal issues, and environmental systems), environmental attitudes, and ecological practices such as conservation behaviors and sustainability-oriented actions. These components are essential indicators of ecological literacy, which is recognized as a foundation for promoting environmentally responsible behavior (McBride et al., 2013; Desmarais, 2024). The process involves the application of a mixed-methods approach, integrating quantitative and qualitative data collection techniques. Survey questionnaires were utilized to measure students' ecological literacy levels, while open-ended reflections captured their lived experiences and perspectives on climate change. This approach aligns with current research emphasizing the value of combining statistical analysis with experiential insights to achieve a more comprehensive understanding of environmental learning and behavior (Muccione et al., 2025; Abd Rahim et al., 2022). The process further includes systematic data analysis, such as descriptive and inferential statistics alongside thematic analysis, to synthesize findings holistically. The output of the study includes the development of an ecological literacy profile of BEED students, the identification of strengths and gaps in their knowledge, attitudes, and practices, and the formulation of evidence-based recommendations for enhancing environmental education. These outcomes are intended to support the development of more effective teacher education strategies that foster climate resilience and sustainability, particularly in vulnerable coastal contexts (Larasaty et al., 2024; Xiong et al., 2025). Overall, the IPO framework demonstrates how students' ecological literacy, when examined through a structured research process, can generate meaningful insights and actionable strategies to strengthen ecological education and advocacy.

2. Objectives of the Study

This study aims to examine the ecological literacy of Bachelor of Elementary Education (BEED) students of Southern Luzon State University in relation to climate change in the coastal environment of Tagkawayan, Quezon. Specifically, it seeks to:

Assess the level of ecological knowledge among BEED students regarding climate change and coastal environmental issues.

Determine the environmental attitudes of BEED students toward ecological protection and climate resilience.

Examine the extent of students' ecological practices, including environmental advocacy, conservation behaviors, and sustainable community involvement.

Explore students' personal perspectives on their roles as future educators in mitigating and adapting to the impacts of climate change.

Identify strategies for integrating climate change education and ecological literacy into teacher education programs to strengthen coastal resilience.

3. Methodology

3.1. Research Design

This study employed a mixed-methods design combining quantitative survey research with qualitative narrative inquiry. The integration of both approaches was deemed appropriate in order to (a) quantify ecological knowledge, attitudes, and practices of BEED students, and (b) capture nuanced reflections on their lived experiences of climate change in coastal contexts. Following Creswell & Plano Clark (2018), the design adopted a convergent parallel strategy where quantitative and qualitative data were collected concurrently and analyzed separately, then merged for interpretation.

3.2. Research Locale

The study was conducted at Southern Luzon State University – Tagkawayan Campus, located in Quezon Province, Philippines. Tagkawayan is a coastal municipality vulnerable to sea-level rise, flooding, and typhoon events, making it a relevant setting for examining ecological literacy in the context of climate change. It was conducted among third- and fourth-year

Bachelor of Elementary Education (BEED) students enrolled during the Academic Year 2024–2025. These students were chosen because of their advanced stage in teacher preparation and their potential readiness to articulate informed insights on ecological issues. A total of 70 respondents were purposively selected based on inclusion criteria, which required that they be active upper-year BEED students who voluntarily consented to participate. Students in the first and second years, as well as those on leave of absence, were excluded from the sample. The sample size satisfied the recommended minimum for survey-based studies with descriptive analysis (Comrey & Lee, 2013). The 70 BEED students representing the entire cohort of incoming and graduating preservice teachers at Southern Luzon State University–Tagkawayan Campus. Total population sampling was applied to capture ecological literacy across different stages of teacher preparation. While this approach provides a comprehensive institutional profile, the findings remain context-specific and may not be broadly generalizable.

3.3. Data Collection and Analysis

Data collection employed a mixed-methods approach. For the quantitative component, a structured survey questionnaire was adapted from validated ecological literacy scales (McBride et al., 2013; UNESCO, 2017). The instrument consisted of three subscales: Ecological Knowledge (15 items; multiple-choice and Likert-type; $\alpha = 0.81$), Environmental Attitudes (12 items; 5-point Likert scale; $\alpha = 0.86$), and Ecological Practices (10 items; 5-point Likert scale; $\alpha = 0.79$). Reliability of the survey was confirmed through Cronbach's alpha, using a pilot test with 20 non-participant students. Content validity was further established through expert review by two faculty members specializing in environmental science and one education specialist. For the qualitative component, open-ended questions were used to elicit students' personal narratives about their observations of climate change impacts in their community, their emotional responses to environmental hazards, and their perceived roles as future educators. Data were collected through written reflections to ensure authenticity and to minimize interviewer influence.The data gathering procedure involved several steps. Permission was first secured from the College Dean and campus administration. Informed consent was then obtained from all respondents, with assurances of voluntary participation and confidentiality. The survey was administered during regular class hours, followed immediately by the qualitative reflection activity. Completed instruments were checked carefully for accuracy and completeness prior to analysis.Data analysis was carried out using both quantitative and qualitative strategies. Quantitative data were analyzed through descriptive statistics, including mean, standard deviation, frequency, and percentage, to profile ecological knowledge, attitudes, and practices. Inferential statistics were employed to test group differences using independent-samples t-tests and one-way ANOVA, focusing on variables such as year level, gender, and coastal residence. Correlations among knowledge, attitudes, and practices were determined through Pearson's r. All quantitative analyses were performed using SPSS version 27 at a 95% confidence level. For the qualitative data, written reflections were transcribed and subjected to thematic analysis following Braun and Clarke's (2006) six-phase framework of familiarization, coding, theme generation, review, definition, and reporting. To enhance credibility, peer debriefing and member checking were conducted with selected participants. Triangulation was also applied by comparing emerging themes with quantitative results.

3.4. Ethical Considerations

The study adhered strictly to ethical standards consistent with the Philippine National Ethical Guidelines for Health and Social Research (2017). Participation was entirely voluntary, and respondents were informed of their right to withdraw at any time without penalty. Anonymity was assured through the numerical coding of responses, while all data were stored securely with restricted access limited to the researchers.

4. Results and Discussion

The results indicate that BEED students demonstrate a strong foundation in ecological literacy, particularly in terms of knowledge and environmental attitudes. However, their engagement in ecological practices appears less consistent, suggesting a gap between environmental awareness and actual behavior. This pattern reflects a common issue in environmental education, where cognitive understanding and positive attitudes do not always translate into sustained action. Similar findings have been reported in previous studies, which highlight the complexity of promoting consistent pro-environmental behavior among preservice teachers (Ouano, 2018; Pilare & Acledan, 2024).

Table 1. Ecological Literacy of BEED Students (Quantitative Results)

Domain	Mean	Interpretation
Ecological Knowledge	3.84	Moderately High
Environmental Attitudes	4.12	Strong/Very Favorable
Ecological Practices	3.73	Moderate Engagement
Overall Composite Mean	3.90	Moderately High Ecological Literacy

Scale: 1.00–1.80 (Very Low), 1.81–2.60 (Low), 2.61–3.40 (Moderate), 3.41–4.20 (High), 4.21–5.00 (Very High)

The qualitative reflections of the students further reinforced the quantitative findings. Many respondents described their lived experiences of climate change in the coastal environment, citing frequent flooding, shoreline erosion, saltwater intrusion, and increasingly destructive typhoons. These observations align with documented climate risks in Philippine coastal municipalities, where rising sea levels and intensified storms exacerbate vulnerability (Reyes, 2012; Bollettino et al., 2020). Beyond environmental observations, students expressed emotions ranging from fear and concern to determination and hope, reflecting

an emerging sense of ecological responsibility. Such affective dimensions of ecological literacy are consistent with studies that highlight the role of emotional engagement in motivating pro-environmental behavior. For example, Aznar-Díaz et al. (2019) found that trainee teachers in Spain held strong positive attitudes toward biodiversity preservation, which contributed to their sense of responsibility to act (Aznar-Díaz et al., 2019).

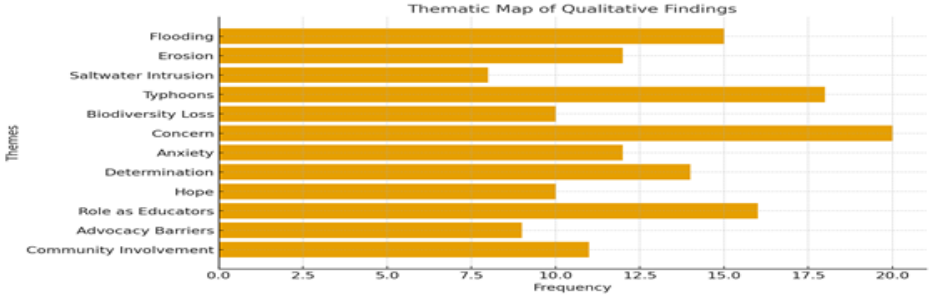
Table 2. Thematic Map of Qualitative Findings

Theme/Category	Frequency (No. of Mentions)	Sample Narratives / Insights
Flooding	15	"Our barangay often experiences flooding during heavy rains."
Erosion	12	"The shoreline is gradually disappearing."
Saltwater Intrusion	8	"We noticed saltwater mixing into freshwater wells."
Typhoons	18	"Typhoons now seem stronger and more destructive."
Biodiversity Loss	10	"We observed fewer fish and mangrove species."
Concern	20	"I worry about what the future holds for our community."
Anxiety	12	"Sometimes I feel helpless when disasters strike."
Determination	14	"I want to teach children how to protect our environment."
Hope	10	"Despite challenges, I believe we can make a difference."
Role as Educators	16	"As future teachers, we must be role models in environmental care."
Advocacy Barriers	9	"We lack strong support for consistent community projects."
Community Involvement	11	"Students should collaborate with barangay officials."

Despite these positive orientations, students acknowledged limitations in their actual ecological practices. While they engaged in simple actions such as waste segregation, energy conservation, and tree planting, they admitted to less consistent involvement in advocacy efforts and community-based initiatives. This mirrors findings from the study of geography education students in Indonesia, who demonstrated strong knowledge and positive attitudes but moderate application of environmental practices (Kazazoglu et al., 2025)). Furthermore, barriers such as lack of resources, insufficient institutional support, and limited opportunities for sustained engagement were identified. This suggests that in coastal Philippine contexts, direct exposure alone is insufficient without institutional support. These constraints are echoed in other Philippine studies, where preservice teachers highlighted the absence of curriculum integration and structured platforms for climate education as major impediments to practice (Magallanes, 2019; Pilare & Acledan, 2024).

The results therefore suggest that BEED students possess the cognitive and affective foundations of ecological literacy, but these must be strengthened through structured experiential learning, curriculum integration, and community partnerships. As Cordero et al. (2008) argued, climate change education must go beyond theoretical instruction and provide students with practical experiences to foster resilience and sustainability. In the Philippine context, Alcantara et al. (2023) emphasized the importance of participatory approaches that connect communities, schools, and local governments in addressing climate risks in coastal areas (Alcantara et al., 2023). In line with these perspectives, the findings of this study reinforce the need for BEED students to be given meaningful opportunities to transform their awareness and values into high-impact ecological practices.

Figure 1. Thematic Map



In summary, the results affirm that BEED students in Tagkawayan, Quezon demonstrate strong ecological knowledge and environmental values, shaped partly by their direct exposure to the realities of climate change in coastal environments. However, the consistency and depth of their ecological practices remain moderate, largely due to structural and contextual barriers. These findings are consistent with national and international studies on preservice teachers, which highlight the common challenge of bridging the gap between awareness and action. Addressing this gap requires intentional strategies in teacher education,

including experiential climate education, school-community partnerships, and institutional support that empowers students to lead as advocates and educators in the fight against climate change.

Table 3. Independent Samples t-Test Results for Gender Differences in Ecological Literacy

Variable	Male (n = 28) M (SD)	Female (n = 42) M (SD)	t	df	p
Ecological Knowledge	3.78 (0.42)	3.88 (0.39)	-1.24	68	.219
Environmental Attitudes	4.08 (0.45)	4.15 (0.41)	-0.87	68	.389
Ecological Practices	3.66 (0.48)	3.79 (0.44)	-1.56	68	.124

Note. $p < .05$ indicates statistical significance.

Table 3 presents the results of the independent-samples t-test conducted to determine whether significant differences exist between male and female BEED students in terms of ecological knowledge, environmental attitudes, and ecological practices. The findings indicate that there were no statistically significant differences between male and female respondents across all three domains of ecological literacy.

For ecological knowledge, female students (M = 3.88, SD = 0.39) obtained slightly higher mean scores than male students (M = 3.78, SD = 0.42). However, this difference was not statistically significant, $t(68) = -1.24$, $p = .219$. Similarly, for environmental attitudes, female students (M = 4.15, SD = 0.41) demonstrated marginally higher scores than male students (M = 4.08, SD = 0.45), but the difference was likewise not significant, $t(68) = -0.87$, $p = .389$. In terms of ecological practices, females (M = 3.79, SD = 0.44) again showed slightly higher engagement compared to males (M = 3.66, SD = 0.48), yet the result remained statistically non-significant, $t(68) = -1.56$, $p = .124$.

Since all p-values exceeded the .05 level of significance, the null hypothesis of no gender difference was retained. These findings suggest that ecological literacy among BEED students is relatively consistent regardless of gender. The absence of significant gender differences may indicate that exposure to environmental education, climate-related experiences in the coastal context, and institutional learning opportunities are similarly accessible to both male and female students. This consistency is encouraging for teacher education programs, as it suggests that ecological literacy development is not gender-dependent within this cohort.

Although female students demonstrated slightly higher mean scores across all domains, the differences were minimal and may reflect normal variation rather than systematic disparity. Overall, the results imply that initiatives to strengthen ecological literacy in teacher education can be designed inclusively without the need for gender-specific interventions.

Table 4. One-Way ANOVA Results for Year Level Differences in Ecological Literacy

Variable	3rd Year (n = 35) M (SD)	4th Year (n = 35) M (SD)	F	df	p
Ecological Knowledge	3.80 (0.41)	3.88 (0.40)	2.11	(1, 68)	.129
Environmental Attitudes	4.09 (0.44)	4.15 (0.42)	1.78	(1, 68)	.176
Ecological Practices	3.69 (0.47)	3.77 (0.45)	3.02	(1, 68)	.056

Note. $p < .05$ indicates statistical significance.

Table 4 presents the results of the one-way analysis of variance (ANOVA) conducted to determine whether ecological literacy differs between third-year and fourth-year BEED students. The findings indicate that no statistically significant differences were observed between the two year levels across ecological knowledge, environmental attitudes, and ecological practices. With respect to ecological knowledge, fourth-year students (M = 3.88, SD = 0.40) demonstrated slightly higher mean scores than third-year students (M = 3.80, SD = 0.41). However, the difference was not statistically significant, $F(1, 68) = 2.11$, $p = .129$. Similarly, environmental attitudes showed marginally higher scores among fourth-year students (M = 4.15, SD = 0.42) compared with third-year students (M = 4.09, SD = 0.44), but this difference was also not significant, $F(1, 68) = 1.78$, $p = .176$. For ecological practices, fourth-year students (M = 3.77, SD = 0.45) again showed slightly higher engagement than third-year students (M = 3.69, SD = 0.47). Although this difference approached statistical significance, it remained above the .05 threshold, $F(1, 68) = 3.02$, $p = .056$. This suggests a possible trend toward increased ecological practice among more advanced students, though the difference was not strong enough to be considered statistically significant. Overall, the results indicate that ecological literacy among BEED students is relatively consistent across year levels. This may suggest that exposure to environmental education and climate-related experiences occurs throughout the teacher education program rather than increasing sharply at later stages. Nevertheless, the slightly higher mean scores among fourth-year students may reflect cumulative academic exposure, field experiences, or increased awareness gained during the later phases of teacher preparation. These findings highlight the importance of integrating ecological literacy consistently across all year levels in teacher education programs to ensure progressive development of knowledge, attitudes, and sustainable practices among future educators.

Table 5. One-Way ANOVA Results for Coastal Residence Differences in Ecological Literacy

Variable	Coastal Residents (n = 40) M (SD)	Non-Coastal (n = 30) M (SD)	F	df	p
Ecological Knowledge	4.00 (0.38)	3.80 (0.40)	5.42	(1, 68)	.023*

Variable	Coastal Residents (n = 40) M (SD)	Non-Coastal (n = 30) M (SD)	F	df	p
Environmental Attitudes	4.32 (0.36)	3.70 (0.45)	12.87	(1, 68)	.001*
Ecological Practices	4.20 (0.39)	4.00 (0.44)	4.68	(1, 68)	.034*

Note. $p < .05$ indicates statistical significance.

The one-way analysis of variance (ANOVA) was conducted to determine whether ecological literacy differs between BEED students residing in coastal and non-coastal areas. The results indicate statistically significant differences across ecological knowledge, environmental attitudes, and ecological practices. Coastal residents demonstrated significantly higher ecological knowledge (M = 4.00, SD = 0.38) compared with non-coastal students (M = 3.80, SD = 0.40), $F(1, 68) = 5.42$, $p = .023$. This suggests that direct exposure to coastal environmental challenges may enhance students' understanding of climate change and ecological issues. A more pronounced difference was observed in environmental attitudes, where coastal residents (M = 4.32, SD = 0.36) showed significantly stronger pro-environmental orientations than non-coastal students (M = 3.70, SD = 0.45), $F(1, 68) = 12.87$, $p = .001$. This finding may reflect heightened environmental awareness resulting from firsthand experiences with climate-related hazards such as flooding, typhoons, and coastal erosion. Similarly, ecological practices were significantly higher among coastal residents (M = 4.20, SD = 0.39) compared with non-coastal respondents (M = 4.00, SD = 0.44), $F(1, 68) = 4.68$, $p = .034$. This indicates that proximity to vulnerable coastal environments may encourage more active participation in environmentally responsible behaviors.

Overall, the findings suggest that residential context plays a meaningful role in shaping ecological literacy, with coastal exposure potentially strengthening both environmental awareness and sustainable practices among preservice teachers.

Table 6. Pearson Correlation Matrix for Ecological Literacy Domains

Variable	1	2	3
1. Ecological Knowledge	—	.42*	.30*
2. Environmental Attitudes	.36*	—	.49*
3. Ecological Practices	.30*	.52*	—

Note. Values represent Pearson correlation coefficients (r).
$p < .05$ (two-tailed).

Table 6 presents the Pearson correlation coefficients examining the relationships among ecological knowledge, environmental attitudes, and ecological practices. The results indicate statistically significant positive relationships across all three domains ($p < .05$), suggesting that the components of ecological literacy are interrelated. Ecological knowledge was found to have a moderate positive correlation with environmental attitudes ($r = .42$, $p < .05$). This indicates that students with stronger understanding of climate change concepts and coastal environmental systems tend to exhibit more favorable pro-environmental attitudes. The finding supports the theoretical premise of ecological literacy frameworks, which posit that cognitive understanding contributes to the formation of environmental values and orientations. Ecological knowledge also demonstrated a weaker but still significant positive correlation with ecological practices ($r = .30$, $p < .05$). While this suggests that increased knowledge is associated with more sustainable behaviors, the strength of the relationship is relatively modest. This pattern highlights the commonly observed gap between awareness and action, wherein knowledge alone does not automatically translate into consistent ecological practice. Environmental attitudes showed the strongest relationship with ecological practices ($r = .49$, $p < .05$). This moderate-to-strong positive correlation indicates that students who hold stronger pro-environmental values are more likely to engage in environmentally responsible behaviors such as conservation, advocacy, and sustainable community involvement. This finding underscores the important mediating role of attitudes in transforming knowledge into action. Interestingly, slight variations in correlation values across domains suggest that while all components are interconnected, environmental attitudes may serve as the more immediate predictor of ecological practices compared to knowledge alone. This aligns with environmental behavior theories which emphasize the role of affective and value-based orientations in motivating sustainable action. Thus, the correlation analysis confirms that ecological literacy is multidimensional and interdependent. Strengthening ecological knowledge in teacher education programs may contribute to more positive environmental attitudes, which in turn can enhance ecological practices. However, the moderate strength of the correlations suggests that additional factors—such as experiential learning, institutional support, and community engagement—may also influence the consistent application of sustainable behaviors among preservice teachers.

5. Conclusions

This study investigated the ecological literacy of Bachelor of Elementary Education (BEED) students in a climate-vulnerable coastal municipality. The findings indicate that respondents demonstrated moderately high ecological knowledge and strong

pro-environmental attitudes. However, ecological practices were only moderate, revealing a gap between environmental awareness and consistent behavioral engagement. Inferential analysis showed no statistically significant differences in ecological literacy across gender and year level, suggesting that ecological literacy development is relatively uniform among students within the teacher education program. In contrast, significant differences were observed based on coastal residence. Students residing in coastal areas exhibited higher ecological knowledge, environmental attitudes, and ecological practices compared to non-coastal students. This suggests that direct exposure to climate-related environmental risks may contribute to stronger ecological awareness and engagement. Pearson correlation analysis revealed significant positive relationships among ecological knowledge, environmental attitudes, and ecological practices. Environmental attitudes demonstrated the strongest association with ecological practices, indicating that affective and value-based orientations may play a critical role in influencing sustainable behavior. However, the moderate strength of these relationships suggests that knowledge alone is insufficient to ensure consistent ecological action. Overall, the study concludes that BEED students possess a solid cognitive and affective foundation of ecological literacy, influenced by both academic preparation and lived environmental experiences. Strengthening experiential learning, curriculum integration, and institutional support mechanisms within teacher education programs is necessary to enhance the translation of ecological awareness into sustained ecological practice. Developing ecologically literate preservice teachers is essential for advancing environmental education, climate resilience, and sustainable development in vulnerable coastal communities.

6. Recommendations

The findings of this study indicate that while BEED students possess moderately high ecological knowledge and strong pro-environmental attitudes, their ecological practices remain only moderate. This gap between awareness and sustained action suggests the need for stronger practical integration of ecological literacy within teacher education programs. Climate change education and environmental sustainability concepts should be systematically embedded across the Bachelor of Elementary Education curriculum rather than confined to science-related courses. Integrating ecological themes into professional education subjects, including teaching strategies, curriculum planning, and field study components, may enhance the translation of environmental knowledge into pedagogical practice. Given the significant influence of coastal residence on ecological literacy, contextualized and place-based learning approaches should be prioritized. Incorporating local environmental issues, community-based environmental projects, and partnerships with local government units and environmental organizations can provide preservice teachers with meaningful opportunities to apply ecological knowledge in real-world settings. Experiential learning strategies such as service-learning, coastal conservation initiatives, and sustainability-focused community immersion may strengthen ecological practices and reduce the observed gap between attitudes and behavior.

Institutional support mechanisms should also be reinforced to sustain environmental engagement among preservice teachers. Establishing structured environmental programs, providing training in climate change education, and supporting student-led sustainability initiatives can create a supportive environment that encourages consistent ecological action. Strengthening institutional sustainability policies may further ensure that ecological literacy development is maintained as a core priority within teacher preparation programs. Future research may further examine the long-term development of ecological literacy and explore additional factors influencing ecological practices, including institutional culture, resource availability, and community engagement structures. Continued assessment and monitoring of ecological literacy outcomes may guide evidence-based improvements in curriculum design and teacher education policy.

7. Educational and Policy Implications for Teacher Education

The findings of this study offer important implications for teacher education policy, curriculum development, and environmental education practice, particularly in climate-vulnerable coastal contexts. While BEED students demonstrated high ecological knowledge and strong pro-environmental attitudes, their ecological practices were only moderate, indicating a persistent gap between environmental awareness and sustained action. This suggests that existing teacher education curricula may adequately address theoretical environmental knowledge but may not sufficiently provide structured opportunities for experiential engagement and behavioral application. Addressing this gap is critical if pre-service teachers are to effectively model and promote ecological responsibility among future elementary learners. From a curriculum enhancement perspective, the results support the need for a stronger integration of climate change education and ecological literacy across teacher preparation programs. Environmental concepts should not be confined to science-related subjects but embedded across professional education courses, including teaching methods, curriculum development, assessment, and field study experiences. Such integration would ensure that ecological literacy becomes a foundational teaching competency rather than an isolated topic. Incorporating dedicated coursework on environmental sustainability, disaster risk reduction, and coastal ecosystem education—particularly in climate-exposed regions—can further strengthen contextual relevance and teacher preparedness. The moderate level of ecological practices observed among students also underscores the importance of experiential and practice-oriented learning approaches. Policy directions in teacher education should prioritize service-learning, community immersion, environmental action projects, and place-based pedagogy as required components of training. Structured engagement with

coastal communities, environmental agencies, and local government initiatives can help pre-service teachers translate knowledge and attitudes into consistent environmental behaviors. Embedding such experiences within field study and practice teaching components would allow future teachers to develop both environmental competencies and pedagogical skills for sustainability education. Additionally, the qualitative findings indicate that students' ecological awareness is strongly influenced by firsthand experiences with climate-related hazards such as flooding, coastal erosion, typhoons, and biodiversity decline. These lived experiences highlight the importance of contextualized and localized environmental education. Teacher education policies should encourage curriculum localization that reflects community realities, environmental vulnerabilities, and indigenous ecological knowledge. This approach can enhance relevance, deepen student engagement, and foster culturally responsive environmental teaching practices. Institutional support also emerged as a critical factor affecting ecological practice. Students noted limited opportunities for sustained environmental advocacy and insufficient structural support for environmental initiatives. This implies that higher education institutions should adopt institutional sustainability policies that include funding support, partnerships with environmental organizations, and the establishment of environmental leadership programs for students. Integrating sustainability benchmarks into teacher education accreditation standards may further ensure continuity and accountability in ecological literacy initiatives. Importantly, strengthening ecological literacy among BEED students has broader implications for the basic education sector. As future elementary teachers, these graduates will shape the environmental knowledge, attitudes, and behaviors of young learners. Enhancing ecological literacy at the teacher preparation level therefore creates a multiplier effect, potentially improving environmental awareness, climate resilience, and sustainability practices among future generations of students. This positions teacher education as a strategic entry point for national climate education and sustainable development efforts. Overall, this study contributes to the growing recognition that ecological literacy in teacher education must move beyond awareness toward transformative practice. Comprehensive curriculum integration, experiential learning opportunities, institutional support systems, and policy alignment are essential to prepare future educators as effective environmental stewards. By strengthening ecological literacy among pre-service teachers, education systems can play a pivotal role in fostering environmentally responsible citizens and resilient communities in the face of accelerating climate change.

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