JUMPA | JURNAL MANAJEMEN PENDIDIKAN

JUMPA: Jurnal Manajemen Pendidikan
Vol. 06 No. 02 (2025): 189-202
Available online at https://ejournal.unuja.ac.id/index.php/jumpa/index

Interaction of Coastal Ethnoscience Learning and Ecological Attitudes in Elementary Science

Jumrah*, Imas Srinana Wardani, Prayogo

Universitas PGRI Adi Buana Surabaya, Indonesia

*Email Corresponding author: jumrahgusung@gmail.com

Abstract
Science learning in elementary school should foster students' conceptual understanding and critical thinking skills through contextual learning experiences. This study aimed to analyze the effect of coastal ethnoscience learning on elementary school students' conceptual understanding and critical thinking skills in science, as well as to examine the interaction between coastal ethnoscience learning and ecological attitudes in influencing both outcomes from a school management perspective. This study employed a quantitative approach with a 2×2 factorial quasi-experimental design (pretest-posttest non-equivalent control group) involving 34 fourth-grade students at SDN 25 Moko, Raja Ampat. Data were collected through a conceptual understanding test, a critical thinking skills test, an ecological attitudes questionnaire, and were supported by observations of learning implementation. The data were analyzed using ANOVA and MANOVA after the prerequisite tests had been satisfied. The results showed that coastal ethnoscience learning had a significant effect on conceptual understanding ($p = 0.006$) and critical thinking skills ($p < 0.001$). In addition, there was a significant interaction between coastal ethnoscience learning and ecological attitudes on conceptual understanding ($p = 0.017$; $\eta^2 = 0.010$) and critical thinking skills ($p = 0.045$; $\eta^2 = 0.071$). These findings indicate that the effectiveness of coastal ethnoscience learning is influenced by students' ecological attitudes. From a school management perspective, these results underscore the importance of school support in managing the potential of the coastal environment as a learning resource, strengthening ecological culture, and facilitating well-planned contextual learning to improve the quality of science learning in elementary schools.

Article History
Received : 12 August 2025
Revised : 23 November 2025
Accepted : 28 December 2025

Keywords: *Coastal Ethnoscience, Ecological Attitudes, Conceptual Understanding, Critical Thinking Skills, School Management*

DOI: https://doi.org/10.33650/jumpa.v6i2.14814
How to Cite:
Jumrah, Wardani, I. S., & Prayogo. (2025). Interaction of Coastal Ethnoscience Learning and Ecological Attitudes in Elementary Science. *JUMPA: Jurnal Manajemen Pendidikan, 6*(2), 189–202.

INTRODUCTION

Science learning in elementary schools in the twenty-first century is required not only to emphasize mastery of concepts but also to develop critical thinking skills so that students are able to interpret natural phenomena, evaluate information, and make responsible decisions (Putri et al., 2024; Ramdani et al., 2020). This emphasis becomes increasingly relevant as students' scientific literacy continues to show weaknesses in connecting concepts to real-life situations and in using reasoning to explain the cause-and-effect relationships underlying natural events (Evendi et al., 2025; Sari et al., 2025).

Under such conditions, learning that is overly teacher-centered and focused on memorization tends to result in a very limited level of understanding and fails to adequately develop students' critical thinking skills, thereby reducing their ability to explain the meaning of concepts, apply them in new contexts, or critically examine environmental issues in their surroundings (Auliah et al., 2025; Telegin & Mt-Kltyik, 2025). At the elementary school level, these challenges are related not only to classroom instructional strategies but also to how schools manage the learning process in ways that sustainably promote students' conceptual understanding and critical thinking skills.

This reality is particularly evident in coastal areas, which are in fact rich in authentic scientific phenomena (Friess et al., 2020). Raja Ampat presents a marine ecosystem characterized by high biodiversity, tidal dynamics, and community life practices that have long been shaped by continuous interaction with the sea across generations (Aji et al., 2024; Mentansan et al., 2023). Such an environment provides highly valuable learning resources for science instruction, as scientific concepts can be constructed through direct observation, concrete experience, and dialogue with the local knowledge possessed by students and the community (Cotič et al., 2020). Field identification conducted at SDN 25 Moko, Raja Ampat, Southwest Papua, showed that students frequently interact with the coastal environment, for example by playing along the shoreline, observing fish, and witnessing changes in water conditions around the pier. These natural activities can in fact serve as entry points for learning to develop concepts related to ecosystems, food chains, adaptation, and water environmental quality, provided that they are designed as structured and meaningful learning experiences (Kevrekidis et al., 2024; Netto et al., 2025). The educational potential of the coastal environment will have a stronger impact if schools are able to manage it as a planned, integrated learning resource that is aligned with the developmental needs of elementary school students.

However, the coastal potential of Raja Ampat has often not been effectively connected to the learning process in ways that would enable students to benefit from it optimally (Lestari, 2025). At the elementary school level, science learning still frequently takes the form of content delivery and exercise-based activities that are not linked to students' everyday experiences. As a result, students' conceptual understanding and critical thinking skills have not developed optimally, even though they live in an environment that is rich in scientific phenomena (Surya et al., 2025). This gap between the richness of the local context and actual classroom practices calls for a more contextual, participatory, and life-relevant learning approach (Agnesti & Amelia, 2020). This gap not only indicates the need for instructional innovation at the classroom level, but also underscores the importance of a school management perspective. Schools need to manage instructional planning, the development of teaching materials, support for teachers, and the use of the surrounding environment as a learning resource so that coastal potential does not remain merely the backdrop of students' lives, but becomes an integral part of the science learning process.

One approach considered well suited to the characteristics of coastal areas is coastal ethnoscience learning, which links science concepts to the practices, experiences, and local knowledge of the surrounding community as the initial context for developing elementary school students' conceptual understanding (Hadi & Ahied, 2017). In this approach, local knowledge is not positioned as merely an "additional story," but as a source of phenomena to be analyzed scientifically (Akmal, 2021). Thus, learning not only strengthens conceptual understanding through real experiences, but also opens space for critical thinking through activities such as observing, comparing evidence, reasoning about relationships among variables, and drawing conclusions, particularly when students are invited to interpret coastal phenomena they encounter in their daily lives as learning objects relevant to their educational needs. As a result, the learning process tends to become more meaningful because concepts are constructed from realities that are close to students' own worlds (Andriani et al., 2020; Cotič et al., 2020). From a school management perspective, the implementation of coastal ethnoscience learning should not be understood merely as a teacher's methodological choice, but as part of the management of learning based on local potential. School support in the form of academic policies, the strengthening of learning culture, the provision of facilities, and the facilitation of collaboration with the surrounding environment becomes an important factor in ensuring that coastal ethnoscience learning can be implemented consistently and meaningfully.

The success of contextual learning is not always the same for every student; affective factors such as ecological attitudes may influence how students engage, respond to tasks, and process information during learning (Kuo et al., 2024). Students with stronger ecological attitudes are generally more sensitive to environmental issues, more motivated to understand the cause-and-effect relationships underlying natural changes, and more inclined to evaluate the impacts of human actions (Calculli et al., 2021). In contrast, students with lower ecological attitudes may demonstrate more limited engagement, so the benefits of contextual learning do not emerge optimally. On this basis, ecological attitudes should be considered not only as an expected outcome of learning, but also as a factor that may differentiate the effectiveness of a learning approach (Baierl & Bogner, 2025). In addition to being shaped by students' individual experiences, ecological attitudes also develop through the school climate, habitual practices, and an institutional culture of environmental care. Therefore, a school management perspective becomes relevant in explaining that the effectiveness of coastal ethnoscience learning may be influenced by how schools cultivate students' ecological awareness and responsibility in everyday life.

This is precisely why it is important to examine the interaction between coastal ethnoscience learning and ecological attitudes in relation to two key outcomes of science learning, namely conceptual understanding and critical thinking skills among elementary school students (Sekaringtyas et al., 2024). To date, many studies have tended to examine the direct effect of contextual approaches on learning outcomes or to investigate ecological attitudes as a single variable, without exploring how the two interact in shaping students' cognitive achievement. In fact, within the context of coastal education, it is highly possible that coastal ethnoscience learning exerts its strongest impact on particular groups of students, for example those with high ecological attitudes, while its effect may be less pronounced in other groups (Muhammad, 2025). This gap in understanding the interaction pattern therefore constitutes an important research niche, particularly at the elementary school level and within local coastal contexts that possess distinctive ecological and cultural characteristics (Bhure et al., 2021; Lovren & Jablanovic, 2023). Accordingly, testing the interaction between these two variables becomes more meaningful when framed within a school management perspective, because the school is the institutional space that manages learning experiences, ecological culture, and organizational support that enable coastal ethnoscience-based learning to function more effectively across students with different characteristics.

Bibliometric analysis using VOSviewer on the Scopus database for the period 2020–2025 indicates that research on science learning in elementary schools has predominantly focused on STEM/STEAM-based experimental approaches oriented toward conceptual understanding, critical thinking, and academic performance. Although these cognitive variables have been explored quite extensively, approaches that integrate local cultural contexts, particularly ethnoscience based on coastal ecosystems, have not yet emerged as a dominant theme in the research landscape. In addition, affective variables such as ecological attitudes have not been significantly linked to contextual learning models within the mapped keyword networks. This suggests that previous studies have tended to examine the direct effects of instructional approaches on learning outcomes without investigating the interaction between local wisdom-based approaches and students' ecological characteristics.

Therefore, a research gap remains in relation to coastal ethnoscience-based learning and ecological attitudes in influencing elementary school students' conceptual understanding and critical thinking skills in science. This study addresses that gap by examining the interaction model between the two variables simultaneously, thereby offering both conceptual and empirical contributions to the development of contextual science learning based on coastal environments. The findings also indicate that the dimension of school management has rarely been positioned as an analytical perspective in studies of science learning grounded in local contexts, even though the success of its implementation is closely related to how schools manage the integration of environmental potential, school culture, and classroom learning. Based on the results of the VOSviewer analysis using the Scopus database for 2020–2025, these trends are illustrated in the **Figure 1**.

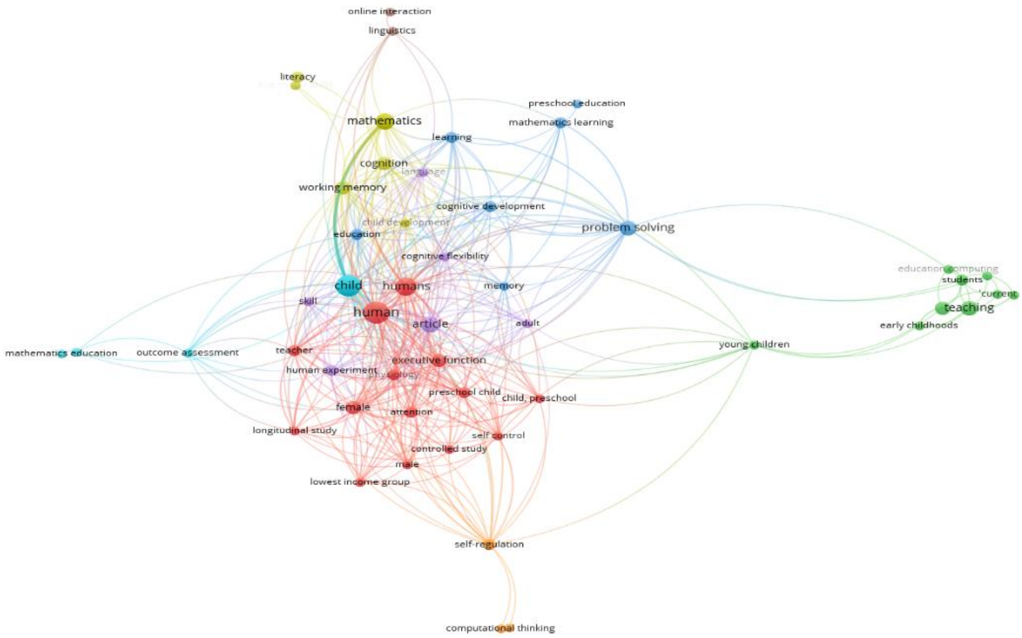

Figure 1. Mapping and Visualization Results Generated by VOSviewer

Thus, there remains a notable gap in research on how coastal ethnoscience-based learning and ecological attitudes influence elementary school students' conceptual understanding and critical thinking skills in science, particularly when examined from a school management perspective. This study addresses that gap by simultaneously testing the interaction model between the two variables, thereby providing both conceptual and empirical contributions to the development of contextual science learning based on coastal environments. Such development is not solely dependent on classroom instructional strategies, but also on school governance support in managing local potential, ecological culture, and the learning process in an integrated manner.

Based on the foregoing explanation, this study is directed toward analyzing the effects of coastal ethnoscience learning and ecological attitudes, as well as examining the interaction between the two on elementary school students' conceptual understanding and critical thinking skills from a school management perspective.

RESEARCHS METHOD

This study employed a quantitative approach using a quasi-experimental design to examine the effects of coastal ethnoscience-based learning and ecological attitudes on students' conceptual understanding and critical thinking skills. A quasi-experimental method was selected because the participants were drawn from intact classroom groups, making random assignment impractical in the natural school setting (Kvia et al., 2025; Mohamad et al., 2024; Scippo, 2024). The study applied a 2 × 2 factorial design within a pretest–posttest non-equivalent control group framework, allowing for the simultaneous examination of main effects and interaction effects between instructional treatment and students' ecological attitudes (Kohan et al., 2024; Song et al., 2025; x, 2022). This design is particularly appropriate in social science research to explore how instructional strategies interact with learner characteristics. To provide a clearer overview of the research procedure and factorial structure, the design of this study is illustrated in **Figure 2**.

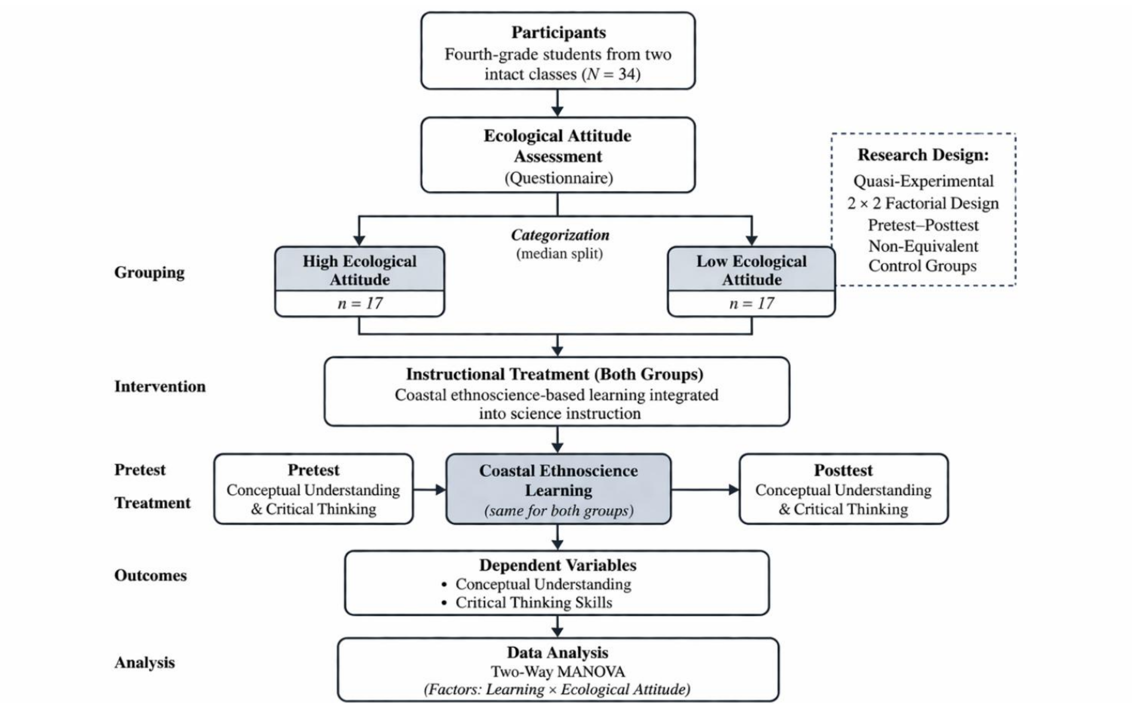

Figure 2. Research Design of the Study

The figure presents the sequence of the research process, including participant grouping based on ecological attitudes, the implementation of coastal ethnoscience-based learning, and the measurement of conceptual understanding and critical thinking skills, followed by multivariate analysis.

The population of this study consisted of fourth-grade students at SDN 25 Moko, Raja Ampat Regency, with a sample of 34 students drawn from two intact classes using purposive sampling. This approach was chosen due to the use of existing classroom groups, which is common in quasi-experimental educational research where ecological validity is prioritized. Students' ecological attitudes were measured using a questionnaire and categorized into high and low groups for factorial analysis. Data were collected using three instruments: a multiple-choice test for conceptual understanding, a critical thinking test based on indicators such as analysis and evaluation (Mohammadi et al., 2022), and a Likert-scale questionnaire to assess ecological attitudes. All instruments were validated by experts and demonstrated good reliability, with coefficients of 0.871 for conceptual understanding, 0.802 for critical thinking, and 0.833 for ecological attitudes.

The research procedure consisted of preparation, implementation, and post-intervention stages. Students completed a pretest before participating in coastal ethnoscience-based learning, followed by a posttest to measure changes in conceptual understanding and critical thinking skills. Data were analyzed using SPSS version 25, beginning with descriptive statistics and prerequisite tests for normality and homogeneity, which confirmed that the data met parametric assumptions. Hypothesis testing was conducted using factorial ANOVA to examine main effects and MANOVA to analyze interaction effects between learning and ecological attitudes (Jia, 2025; Saedi et al., 2023; ud Din & Hayat, 2021). All analyses were performed at a significance level of 0.05. In this study, the school management perspective was used as a contextual framework to interpret how institutional support and learning environment influence the effectiveness of coastal ethnoscience-based learning.

RESULT AND DISCUSSION

Result

In the findings section, the results of the data analysis obtained from the implementation of learning in the experimental and control groups are presented. The findings are organized systematically in accordance with the research objectives, including the effect of coastal ethnoscience learning, the effect of ecological attitude categories (high vs. low), and the interaction effect of both on students' conceptual understanding and critical thinking skills.

The Effect of Coastal Ethnoscience-Based Learning on Students' Conceptual Understanding

To test the research hypothesis, a statistical analysis was conducted to determine the significance of the effect of coastal ethnoscience-based learning on the science conceptual understanding of fourth-grade students in Class IV-A of elementary school. The results of the analysis are presented in **Table 1**.

Table 1. ANOVA Test of Coastal Ethnoscience Learning on Conceptual Understanding

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	5.203	1	5.203	.028	.006[b]
	Residual	2767.738	15	184.516		
	Total	2772.941	16			

a. Dependent Variable: X1

b. Predictors: (Constant), Y1

Based on **Table 1**, the results of the ANOVA test in the linear regression analysis yielded an F value of F(1,15) = 0.028 with Sig. = 0.006. Because the significance value was smaller than 0.05, the regression model was considered significant. Thus, it can be concluded that Y1 had a significant effect on X1, and therefore the research hypothesis was accepted.

The Effect of Coastal Ethnoscience-Based Learning on Students' Critical Thinking Skills

To address the research hypothesis, a statistical test was conducted through regression analysis to determine the significance of the effect of coastal ethnoscience-based learning on the critical thinking skills of fourth-grade elementary school students. The results of the analysis are presented in **Table 2**.

Table 2. ANOVA Test of Coastal Ethnoscience Learning on Students' Critical Thinking Skills

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.077	1	.077	.001	.000[b]
	Residual	1288.982	15	85.932		
	Total	1289.059	16			
a. Dependent Variable: X2						
b. Predictors: (Constant), Y2						

Based on **Table 2**, the results of the ANOVA test in the linear regression analysis showed an F value of $F(1,15) = 0.001$ with Sig. = 0.000 ($p < 0.001$). Because the significance value was smaller than 0.05, the regression model was considered significant, indicating that the coastal ethnoscience learning variable had a significant effect on critical thinking skills. Therefore, the alternative hypothesis was accepted.

To Determine the Interaction Between Coastal Ethnoscience-Based Learning and Ecological Attitudes in Influencing Students' Conceptual Understanding

Hypothesis testing was conducted to determine whether there was an interaction between coastal ethnoscience learning and ecological attitude categories (high and low) in influencing students' science conceptual understanding. This hypothesis was tested using factorial MANOVA through the Tests of Between-Subjects Effects procedure. The results of the interaction analysis are presented in **Table 3**.

Table 3. Interaction Between Learning Approach and Ecological Attitudes on Conceptual Understanding

Tests of Between-Subjects Effects							
Source	Dependent Variable	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	Y1	612.108[a]	3	204.036	1.667	.223	.278
	X1	2472.858[b]	3	824.286	35.709	.000	.892
Intercept	Y1	61785.473	1	61785.473	504.900	.000	.975
	X1	62374.932	1	62374.932	2702.163	.000	.995
K1	Y1	6.368	1	6.368	.052	.823	.004
	X1	2367.469	1	2367.469	102.562	.000	.888
K2	Y1	589.950	1	589.950	4.821	.047	.271
	X1	31.350	1	31.350	1.358	.265	.095
K1 * K2	Y1	16.816	1	16.816	.137	.017	.010
	X1	5.976	1	5.976	.259	.019	.020
Error	Y1	1590.833	13	122.372			
	X1	300.083	13	23.083			

Tests of Between-Subjects Effects			
Total	Y1	78650.000	17
	X1	86213.000	17
Corrected Total	Y1	2202.941	16
	X1	2772.941	16
a. R Squared = .278 (Adjusted R Squared = .111)			
b. R Squared = .892 (Adjusted R Squared = .867)			

Based on **Table 3**, the results of the Tests of Between-Subjects Effects indicated a significant interaction between coastal ethnoscience learning and ecological attitude categories (high vs. low) on science conceptual understanding (Y1), with F(1,13) = 0.137 and Sig. = 0.017 (< 0.05). Thus, the effect of coastal ethnoscience learning on science conceptual understanding depended on students' ecological attitude categories, with the magnitude of the interaction effect being classified as small (Partial η^2 = 0.010).

The Interaction Between Coastal Ethnoscience-Based Learning and Ecological Attitudes (High vs. Low) in Influencing Students' Critical Thinking Skills

To test the hypothesis, a factorial MANOVA was conducted by examining the interaction effect between coastal ethnoscience learning and ecological attitude categories on students' critical thinking skills. The results of the analysis are presented in **Table 4** under Multivariate Tests.

Table 4. Interaction Between Learning Approach and Ecological Attitudes on Critical Thinking Skills

Multivariate Tests[a]							
	Effect	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Intercept	Pillai's Trace	.995	1126.078[b]	2.000	12.000	.000	.995
	Wilks' Lambda	.005	1126.078[b]	2.000	12.000	.000	.995
	Hotelling's Trace	187.680	1126.078[b]	2.000	12.000	.000	.995
	Roy's Largest Root	187.680	1126.078[b]	2.000	12.000	.000	.995
K1	Pillai's Trace	.208	1.578[b]	2.000	12.000	.246	.208
	Wilks' Lambda	.792	1.578[b]	2.000	12.000	.246	.208
	Hotelling's Trace	.263	1.578[b]	2.000	12.000	.246	.208
	Roy's Largest Root	.263	1.578[b]	2.000	12.000	.246	.208
K2	Pillai's Trace	.767	19.720[b]	2.000	12.000	.000	.767
	Wilks' Lambda	.233	19.720[b]	2.000	12.000	.000	.767
	Hotelling's Trace	3.287	19.720[b]	2.000	12.000	.000	.767
	Roy's Largest Root	3.287	19.720[b]	2.000	12.000	.000	.767
K1 * K2	Pillai's Trace	.071	.455[b]	2.000	12.000	.045	.071
	Wilks' Lambda	.929	.455[b]	2.000	12.000	.045	.071
	Hotelling's Trace	.076	.455[b]	2.000	12.000	.045	.071
	Roy's Largest Root	.076	.455[b]	2.000	12.000	.045	.071
a. Design: Intercept + K1 + K2 + K1 * K2							
b. Exact statistic							

Based on **Table 4**, the results of the MANOVA in the Multivariate Tests table showed that the interaction effect between coastal ethnoscience learning and ecological attitude categories (high vs. low) yielded a Pillai's Trace value of 0.071, with $F(2,12) = 0.455$ and Sig. = 0.045 (< 0.05). Thus, the interaction between the two factors was significant, indicating that the effect of instruction on students' critical thinking skills depended on their ecological attitude categories (high vs. low), although the magnitude of the interaction effect was classified as small (Partial $\eta^2 = 0.071$).

Discussion

This study was designed to examine how coastal ethnoscience-based learning, together with students' ecological attitudes, influences conceptual understanding and critical thinking skills at the elementary level. The research emerges from the need to move beyond abstract science instruction toward learning that is closely connected to students' real environments. The findings show that coastal ethnoscience learning has a clear positive effect on both conceptual understanding and critical thinking. This indicates that when students engage with scientific ideas through familiar environmental contexts, they are better able to construct meaning and retain knowledge. Such results are in line with constructivist views which emphasize that understanding develops through direct experience and active engagement (Kim et al., 2024; H. J. Park & Kim, 2024; Y. H. Park et al., 2022).

In addition, the improvement in students' critical thinking skills suggests that coastal ethnoscience learning provides space for deeper cognitive processes. Students are not only receiving information, but are also encouraged to observe, question, and evaluate environmental phenomena around them. This finding supports earlier research showing that contextual and ethnoscience-based approaches can strengthen higher-order thinking skill (Li et al., 2023; Mukti et al., 2026; Niwanggalih et al., 2023). For instance, when students examine changes in coastal ecosystems, they are prompted to connect observations with scientific explanations, which helps them develop reasoning skills. This shows that the integration of local context is not only relevant, but also effective in supporting meaningful science learning.

Another important result is the presence of an interaction between coastal ethnoscience learning and ecological attitudes. This suggests that the impact of the learning approach is not identical for all students, but is influenced by their level of environmental awareness. Students with stronger ecological attitudes tend to be more engaged and responsive during learning activities, which in turn supports better learning outcomes. However, the relatively small effect size indicates that ecological attitudes are not the only factor involved. Other elements such as teaching quality, classroom interaction, and school support likely contribute to the overall effectiveness of the learning process. This finding reflects the idea that learning outcomes are shaped by the interaction between instructional strategies and student characteristics.

From the perspective of educational management, this study highlights that the effectiveness of coastal ethnoscience learning depends not only on what happens in the classroom, but also on how schools organize and support the learning process. Schools play an important role in integrating local environmental resources into the curriculum, supporting teachers in designing contextual learning, and building a culture that values environmental awareness. These findings contribute to the field of educational management by showing that instructional innovation requires institutional support in order to produce consistent and meaningful learning outcomes. In this sense, school management becomes a key factor in connecting local potential, learning practices, and student development in a more systematic way.

CONCLUSION

This study concludes that coastal ethnoscience learning has a significant effect on elementary school students' conceptual understanding and critical thinking skills. The significant interaction between coastal ethnoscience learning and ecological attitudes indicates that the effectiveness of learning is influenced by students' affective characteristics, although the magnitude of the interaction effect is relatively small. From a school management perspective, these findings affirm the importance of school support in managing the coastal environment as a learning resource, building an ecological culture, and facilitating contextual learning in a well-planned manner. Future research needs to be conducted with a larger sample and across more diverse school contexts.

ACKNOWLEDGMENT

The authors express sincere gratitude to the Beasiswa Indonesia Bangkit (BIB-Kemenag) for providing comprehensive financial support that enabled this research. We acknowledge the Ministry of Religious Affairs of the Republic of Indonesia for its commitment to advancing Islamic education research through this scholarship program. Special appreciation is extended to the Ummi Foundation and the 127 participating educational institutions across Indonesia, whose cooperation and data access facilitated this systematic analysis of the effectiveness of Quranic education. This research contributes to national educational development goals and would not have been feasible without the institutional and financial support provided by BIB-Kemenag.

REFERENCES

Agnesti, Y., & Amelia, R. (2020). Penerapan Pendekatan Kontekstual dalam Menyelesaikan Soal Cerita pada Materi Perbandingan dan Skala terhadap Siswa SMP. *Mosharafa: Jurnal Pendidikan Matematika, 9*(2), 347–358. https://doi.org/10.31980/mosharafa.v9i2.748

Aji, L. P., Maas, D. L., Capriati, A., Ahmad, A., De Leeuw, C., & Becking, L. E. (2024). Shifts in Dominance of Benthic Communities along a Gradient of Water Temperature and Turbidity in Tropical Coastal Ecosystems. *PeerJ, 12*, e17132. https://doi.org/10.7717/peerj.17132

Akmal, A. U. (2021). Analisis Etnosains dalam Pembelajaran IPA di Sekolah Dasar (SD) Kota Padang dan Bukittinggi. *Jurnal Inovasi Pendidikan dan Pembelajaran Sekolah Dasar, 4*(2), 68. https://doi.org/10.24036/jippsd.v4i2.111385

Andriani, N., Saparini, S., Sudirman, S., Ismet, I., Jumalia, J., & Cahyati, N. (2020). The Potential of Coastal Areas Community Life as a Source of Contextual Learning of Temperature and Heat Materials. *Proceedings of the 4th Sriwijaya University Learning and Education International Conference (SULE-IC 2020)*. https://doi.org/10.2991/assehr.k.201230.193

Auliah, A., Jusniar, J., Fadly, D., & Samada, L. H. (2025). Descriptive Study of Students' Critical Thinking Skills on Controversial Environmental Issues through Student Worksheets. *Jurnal IPA & Pembelajaran IPA, 9*(2), 445–461. https://doi.org/10.24815/jipi.v9i2.45141

Baierl, T.-M., & Bogner, F. X. (2025). Cognitive Learning about Forests: The Key Role of Environmental Attitude. *International Journal of Science Education, 47*(3), 358–378. https://doi.org/10.1080/09500693.2024.2323917

Bhure, M., Welu, F., See, S., & Ota, M. K. (2021). The Effort to Enhance Pupils Cognitive Learning Achievement Using Contextual Teaching and Learning Approach. *Journal of Research in Instructional, 1*(1), 13–22. https://doi.org/10.30862/jri.v1i1.3

Calculli, C., D'Uggento, A. M., Labarile, A., & Ribecco, N. (2021). Evaluating People's Awareness about Climate Changes and Environmental Issues: A Case Study. *Journal of Cleaner Production, 324*, 129244. https://doi.org/10.1016/j.jclepro.2021.129244

Cotič, N., Plazar, J., Istenič Starčič, A., & Zuljan, D. (2020). The Effect of Outdoor Lessons in Natural Sciences on Students' Knowledge through Tablets and Experiential Learning. *Journal of Baltic Science Education, 19*(5), 747–763. https://doi.org/10.33225/jbse/20.19.747

Evendi, E., Arviani, V., Ezmar, E., & Rizki Aria, R. (2025). Analysis of Elementary School Students' Scientific Literacy Skills on the Topic of Animal Life Cycles. *Journal Informatic, Education and Management (JIEM), 7*(2), 350–356. https://doi.org/10.61992/jiem.v7i2.151

Friess, D. A., Yando, E. S., Wong, L.-W., & Bhatia, N. (2020). Indicators of Scientific Value: An Under-Recognised Ecosystem Service of Coastal and Marine Habitats. *Ecological Indicators, 113*, 106255. https://doi.org/10.1016/j.ecolind.2020.106255

Hadi, W. P., & Ahied, M. (2017). Kajian Etnosains Madura dalam Proses Produksi Garam sebagai Media Pembelajaran IPA Terpadu. *Rekayasa, 10*(2), 79. https://doi.org/10.21107/rys.v10i2.3608

Jia, Z. (2025). A MANOVA & ANOVA Based Investigation of Vehicle Class Differences in Occupant Injury Metrics. *American Journal of Student Research*, 283–289. https://doi.org/10.70251/hyjr2348.36283289

Kevrekidis, T., Markos, A., Boubonari, T., Mogias, A., Malea, P., Apostoloumi, C., & Kevrekidou, A. (2024). Assessing the Impact of an Integrated Educational Program on Greek Students' Knowledge about Coastal Lagoons and Attitudes towards Marine Environment Conservation. *Marine Pollution Bulletin, 202*, 116297. https://doi.org/10.1016/j.marpolbul.2024.116297

Kim, S. H., Park, S., Lee, D. W., Park, H. S., Lew, D. H., & Song, S. Y. (2024). Early Experience of Direct-to-Implant Breast Reconstruction Using Acellular Dermal Matrix after Robot-Assisted Nipple-Sparing Mastectomy. *Plastic and Reconstructive Surgery, 154*(3), 512–520. https://doi.org/10.1097/PRS.0000000000011105

Kohan, N., Navabi, N., Motlagh, M. K., & Ahmadinia, F. (2024). Designing and Evaluating ECG Interpretation Software for Undergraduate Nursing Students in Iran: A Non-Equivalent Control Group Pretest-Posttest Design. *BMC Nursing, 23*(1). https://doi.org/10.1186/s12912-024-02472-0

Kuo, Y.-K., Batool, S., Devi, S., Tahir, T., & Yu, J. (2024). Exploring the Impact of Emotionalized Learning Experiences on the Affective Domain: A Comprehensive Analysis. *Heliyon, 10*(1), e23263. https://doi.org/10.1016/j.heliyon.2023.e23263

Kvia, A., Brønnick, K. K., Sagvaag, H., & Selbekk, A. S. (2025). Recovery Is up to You: Translation of a Peer-Led Group Intervention from Dutch to Norwegian Setting: A Quasi-Experimental Exploration of Attendance, Acceptability and Impact. *Social Work with Groups*. https://doi.org/10.1080/01609513.2025.2602200

Lestari, W. Y. (2025). Pembelajaran Potensi Lokal di Wilayah Garut dalam Pembelajaran IPA di SMP. *Science: Jurnal Inovasi Pendidikan Matematika dan IPA, 5*(3), 1351–1361. https://doi.org/10.51878/science.v5i3.6596

Li, W., Huang, J. Y., Liu, C. Y., Tseng, J. C. R., & Wang, S. P. (2023). A Study on the Relationship between Student Learning Engagements and Higher-Order Thinking Skills in Programming Learning. *Thinking Skills and Creativity, 49*. https://doi.org/10.1016/j.tsc.2023.101369

Lovren, V. O., & Jablanovic, M. M. (2023). Bridging the Gap: The Affective Dimension of Learning Outcomes in Environmental Primary and Secondary Education. *Sustainability, 15*(8), 6370. https://doi.org/10.3390/su15086370

Mentansan, G., Nauw, M., Awom, R., Ayorbaba, M., Lumi, J., Reeve, D., & Universitas Papua. (2023). Sasi Local Wisdom as a Cultural Capital for Sustainable Tourism Development in Raja Ampat Regency, West Papua. *International Journal of Green Tourism Research and Applications, 5*(1), 52–59. https://doi.org/10.31940/ijogtra.v5i1.52-59

Mohamad, F., Rashid, A. A., Roslan, D., Mohammad, Z., & Zulkefly, N. S. (2024). The Effectiveness of a Teddy Bear Hospital in Reducing Anxiety towards Healthcare Setting among Primary School Students: A Quasi-Experimental Study. *International Journal of Human and Health Sciences (IJHHS)*, S51. https://doi.org/10.31344/ijhhs.v8i20.695

Mohammadi, M., Abbasian, G. R., & Siyyari, M. (2022). Adaptation and Validation of a Critical Thinking Scale to Measure the 3D Critical Thinking Ability of EFL Readers. *Language Testing in Asia, 12*(1). https://doi.org/10.1186/s40468-022-00173-6

Muhammad, R. N. (2025). The Effectiveness of Coastal Environments Learning Media to Increase Elementary School Students' Cognitive Responses. *Didaktika: Jurnal Pemikiran Pendidikan, 31*(1), 28. https://doi.org/10.30587/didaktika.v31i1.9438

Mukti, H., Arnyana, I. B. P., Suma, K., & Margunayasa, I. G. (2026). The Effectiveness of Problem-Based Learning (PBL) Model Integrated with Ethnoscience in Improving Students' Higher-Order Thinking Skills and Scientific Literacy. *Multidisciplinary Science Journal, 8*(6). https://doi.org/10.31893/multiscience.2026355

Netto, M. P., Freire, P. L. S., Martins, G., Augusto, M., Abude, R. R. S., Cardoso, R. S., Miceli, B. S., & Cabrini, T. M. B. (2025). A Decade of Ecological Awareness on Marine Coastal Ecosystems: University Extension Engaging Basic Education Students in Brazil. *Marine Pollution Bulletin, 219*, 118315. https://doi.org/10.1016/j.marpolbul.2025.118315

Niwanggalih, P., Subchan, W., & Wahyuni, S. (2023). Preliminary Stage: Student Worksheets Oriented to Higher Order Thinking Skills Based on Learning Styles. *Thinking Skills and Creativity Journal, 6*(2), 160–167. https://doi.org/10.23887/tscj.v6i2.62574

Park, H. J., & Kim, J. (2024). Perceived Social Position, Active Engagement with Life, and Depressive Symptoms among Older Adults. *Social Science and Medicine, 345*. https://doi.org/10.1016/j.socscimed.2024.116716

Park, Y. H., Kim, H. S., Kim, H., Park, J., Kim, S., & Choi, Y. E. (2022). Direct Removal of Harmful Cyanobacterial Species by Adsorption Process and Their Potential Use as a Lipid Source. *Chemical Engineering Journal, 427*. https://doi.org/10.1016/j.cej.2021.131727

Putri, A. N. L., Sutarto, S., & Wahyuni, D. (2024). Meta Analisis Kemampuan Berpikir Kritis Siswa SMP dalam Pembelajaran IPA. *Jurnal Penelitian Pembelajaran Fisika, 15*(1), 43–48. https://doi.org/10.26877/jp2f.v15i1.15580

Ramdani, A., Jufri, A. W., Jamaluddin, J., & Setiadi, D. (2020). Kemampuan Berpikir Kritis dan Penguasaan Konsep Dasar IPA Peserta Didik. *Jurnal Penelitian Pendidikan IPA, 6*(1), 119–124. https://doi.org/10.29303/jppipa.v6i1.388

Saedi, A. M., Isa, Z., & Salleh, S. S. B. (2023). An Empirical Study of Workers' Knowledge, Attitudes, and Practices (KAP) Regarding Safety Risk across Demographic Factors and Active BBS Organizations: A Factorial MANOVA Approach. *Sains Malaysiana, 52*(8), 2453–2469. https://doi.org/10.17576/jsm-2023-5208-20

Sari, S. N., Zulkarnaen, Z., Hakim, A., Efwinda, S., & Takebayashi, T. (2025). The Effectiveness of Problem-Based Learning in Enhancing Students' Explaining Competence on the Thermodynamics Topic. *Jurnal Pendidikan MIPA, 26*(3), 1594–1609. https://doi.org/10.23960/jpmipa.v26i3.pp1594-1609

Scippo, S. (2024). Montessori Primary Schools' Effectiveness: A Quasi-Experimental Study on Schooling Outcomes. *School Effectiveness and School Improvement, 35*(2), 193–213. https://doi.org/10.1080/09243453.2024.2349537

Sekaringtyas, T., Suyono, S., & Hadi, W. (2024). The Influence of Understanding Science Concepts, Critical Thinking Skills, and Scientific Literacy on Scientific Attitudes Class IV Primary School Students. *Journal of Ecohumanism, 3*(8). https://doi.org/10.62754/joe.v3i8.5228

Song, Y., Ying, H., Hu, P., Fang, W., & Chen, S. (2025). Clinical Decision Support for Whole-Course Management of Tumors: A Quasi-Experimental, Pre-Post Design with a Non-Equivalent Control Group. *Psycho-Oncologie, 19*(4), 4438. https://doi.org/10.18282/po4438

Surya, Y. F., Atmoko, A., Nusantara, T., Masfufha, A., & Sumianto, S. (2025). The Effectiveness of Problem-Based Learning in Enhancing Reflective-Critical Thinking Skills of Elementary School Students in Science Learning. *Journal of Integrated Elementary Education, 5*(2), 323–338. https://doi.org/10.21580/jieed.v5i2.28077

Telegin, M., & Mt-Kltyik, A. (2025). The Impact of Conceptual versus Memorization-Based Teaching Methods on Student Performance. *Journal of Emerging Investigators*. https://doi.org/10.59720/24-254

Ud Din, I., & Hayat, Y. (2021). ANOVA or MANOVA for Correlated Traits in Agricultural Experiments. *Sarhad Journal of Agriculture, 37*(4), 1250–1259. https://doi.org/10.17582/JOURNAL.SJA/2021/37.4.1250.1259

X, R. (2022). A Quasi Experimental Non-Equivalent Control Group Pre Test-Post Test Design Study Was Conducted to Assess the Effectiveness of Information Booklet in Terms of Knowledge and Attitude Regarding PPIUCD among Primigravida Mothers Residing in Selected Rural Area at Moradabad. *International Journal of Science and Research (IJSR), 11*(1), 1383–1386. https://doi.org/10.21275/sr22124180712