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Affective–Cognitive Disparity in Contextual Science Learning: Evidence from Baduy Local Wisdom

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Abstract: Environmental crises require science education to develop not only environmental awareness but also students' ability to reason about complex socio-ecological systems. This study aimed to analyze students' Socio-Ecological Reasoning (SER) and Environmental Attitudes (EA) within contextual science learning based on Baduy local wisdom. A descriptive correlational quantitative approach was employed involving 30 seventh-grade students selected through purposive sampling. Data were collected using an essay-based SER test and a Likert-scale EA questionnaire and analyzed descriptively and inferentially using SPSS. The findings showed that students' Environmental Attitudes were very high ($M = 4.40$), while Socio-Ecological Reasoning remained moderate ($M = 3.07$), indicating an affective–cognitive disparity. Pearson correlation analysis revealed a weak and non-significant relationship between both variables ($r = 0.12$; $p > 0.05$). This disparity suggests that contextual learning based on local wisdom effectively strengthens environmental values and awareness but has not fully facilitated systems thinking and higher-order reasoning skills, possibly because learning practices still emphasize value internalization more than analytical exploration. Therefore, science learning should integrate phenomenon-based and systems-oriented approaches that explicitly connect local wisdom with scientific inquiry to strengthen both affective and cognitive domains in sustainability-oriented education.

Keywords: Baduy community; Contextual science learning; Environmental attitudes; Local wisdom; Socio-ecological reasoning; Systems thinking

Introduction

The different global developments of the last decades point to the fact that environmental crises have evolved into systemic networked problems between human activities and ecosystems in simple words, their carrying capacity. Patterns of environmental degradation exemplified by deforestation and overexploitation of natural resources with an increasing pressure on ecological balance indicates that broader development paradigms have not encountered reforms to embed sustainability (Salvia et al., 2019). The globalization process has heightened everything economic and human and the scales of environmental impacts extend to local-global space (Parmin et al., 2016). As a reaction to this actual state of affairs, global initiatives like the Sustainable Development Goals (SDGs) stress that social, economic and environmental spheres must be addressed as interdependent processes (Barbier & Burgess, 2017). Thus, environmental crises need to be treated as complex problems, which point towards a complete change in the way humans view and treat the environment.

The transformation of students' ways of thinking and acting toward environmental issues through science education has become increasingly important in response to the growing complexity of environmental crises. Science education is not merely intended to transmit scientific knowledge, but also to promote scientific literacy that enables students to analyze environmental phenomena critically and based on scientific evidence (OECD, 2025). However, science

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teaching practices remain predominantly reductionist, characterized by fragmented instruction, memorization-oriented learning, and limited integration of authentic real-world contexts (Parmin et al., 2016). Such conditions hinder students from connecting scientific concepts with actual environmental problems and from developing a holistic understanding of human–environment interactions. Furthermore, the relatively low level of scientific literacy indicates that science instruction has not yet effectively fostered critical thinking and ecological awareness among students (Bodzin et al., 2010). Therefore, science education needs to be reoriented toward developing an ecological mindset and sustainability-oriented thinking to address increasingly complex environmental challenges (UNESCO, 2020).

To make sense of the connections between humans and the environment, we need non-linear and holistic approaches. The interactions of the social and ecological components create dynamic, interdependent socio-ecological systems (Scholz, 2011). And with environmental science literacy advocating for considering the consequences of human actions on ecological systems and evaluating them alongside scientific evidence in decision making (Colucci-Gray, 2013). Moreover, research on learning progression suggests that students' knowledge develops from prior intuitive reasoning to advanced systems thinking with respect to scientific concepts (Mohan et al., 2009). These perspectives imply that environmental issues cannot be understood in purely conceptual terms, but demand for integrated reasoning across socio-ecological dimensions.

Consequently, socio-ecological reasoning (despite being a rather more compex term) is understood as an ability to apply a systemic understanding of human environment relationships to engage in scientific reasoning for decision making towards sustainability. This construct is an amalgamation of environmental literacy, systems thinking, and evidence based argumentation (Kaiser & Fuhrer, 2003a). Drawing from socio ecological psychology, reasoning of individuals is contextualized because it takes place through an ongoing interaction with their social and ecological environments (Ali et al., 2025). Adding to this process, ethnoscience approaches bridge scientific classification with the local knowledge on plants as well as the social context in which these classifications are made (Dwijendra, 2020). Therefore, socio-ecological reasoning is an important cognitive and contextual but also transdisciplinary skill.

Environmental outcomes at the same time, environmental attitudes are an important affective element that links environmental knowledge to behavior (Araneo, 2024). These attitudes are more than just cognitive knowledge; they represent individuals values, perceptions and willingness to act responsibly on environmental matters. Environmental education also believes that information alone does not lead to behavior change, without corresponding attitudes (Otto & Pensini, 2017). Research has also indicated the importance of local values and cultural wisdom for improving environmental awareness (Frick et al., 2004) as well as ethnoscience-based learning to connect students more thoroughly with scientific knowledge, while contributing to their responsiveness and increasing positive environmental attitudes (Stevenson et al., 2013). Together these findings suggest that environmental attitudes develop through the interplay of cognitive, affective, and contextual influences.

Despite these advances, one major issue has however been neglected: the relationship between knowledge and environmental attitudes is often disconnected. Environmental literacy research suggests that students may demonstrate understanding of the concepts, but nevertheless have difficulty with applying these concepts in real-life decision-making contexts (Bamberg & Möser, 2007). Moreover, the poor ecology awareness and critical responsiveness to environmental problems are worsened by uncontextual science learning since students may learn science that is not directly related to their context (Guerrero & Sjöström, 2025). These conditions show that from theoretical and decontextualized instruction it results a disconnection of cognitive and affective domains.

Additionally, previous studies mainly focus on cognition and affect separately, providing little knowledge about how these two dimensions are interconnected. In contrast to this, socio-ecological psychology places equality on cognition and behaviours that are formed through the dynamic interplay of cognitive, social and environmental factors (Kaiser & Fuhrer, 2003). Nevertheless, there have been only few studies that examined socio-ecological reasoning and environmental attitudes in combination, particularly at contextualized learning environments based on local wisdom. Such a limitation indicates that integrative analyses are needed capturing both domains in conjunction.

Contextual and phenomenon-based learning offers a promising approach to address this gap. By connecting scientific concepts with real life experiences, such approaches enhance the relevance of learning and support the development of critical and systems thinking skills (Ardoin et al., 2020). Moreover, integrating local wisdom into science learning has been shown to improve engagement and contextual understanding, although most studies still focus on developing learning media or models rather than examining students’ reasoning and attitudes (Sirait et al., 2024).

Indigenous communities such as the Baduy possess ecological practices that reflect harmonious relationships between humans and nature, representing valuable sources of indigenous ecological knowledge (Michie et al., 2023). However, the integration of local wisdom into science education remains limited and is frequently implemented in a normative rather than contextual manner (Ogegbo & Ramnarain, 2024). Furthermore, ethnoscience based learning has rarely been developed based on comprehensive analyses of students' learning needs, despite the importance of such analyses in designing effective and contextual science instruction (Wirama et al., 2023). Previous studies have mainly emphasized the development of learning media, literacy, or cognitive outcomes, while limited attention has been given to mapping students' socio-ecological reasoning and environmental attitudes as foundations for instructional design (Yasir et al., 2024).

Therefore, this study addresses these gaps by conducting a descriptive quantitative needs analysis to map students' socio-ecological reasoning and environmental attitudes within the context of science learning based on Baduy local wisdom. Importantly, the study identifies an affective cognitive disparity, where high environmental attitudes are not necessarily accompanied by equally strong socio-ecological reasoning. This finding provides a critical basis for developing science learning that integrates cognitive and affective domains to address sustainability challenges.

Method

This study employed a descriptive quantitative approach as part of the needs analysis stage within a Research and Development (R&D) framework. It aimed to identify the actual profile of students' Socio-Ecological Reasoning (SER) and Environmental Attitudes (EA) as a foundation for developing contextual science learning based on Baduy local wisdom (Sugiyono, 2013). The participants consisted of 30 seventh-grade students selected through purposive sampling, based on their involvement in environmental-based science learning. This sampling technique was applied because the study focuses on obtaining an in-depth profile rather than generalizing the findings (Cresswell, 2017).

Table 1. Dimensions and Indicators of Research Instruments

Variable	Dimension	Indicator	Item Code	Instrument Type	Scale
Socio-Ecological Reasoning (SER)	Explanation	Explains environmental phenomena	SER1–SER2	Essay	Rubric (1–4)
	Analysis	Identifies relationships between human and environment	SER3–SER4	Essay	Rubric (1–4)
	Interpretation	Interprets data within socio-ecological systems	SER5–SER6	Essay	Rubric (1–4)
	Evaluation	Evaluates and proposes sustainable solutions	SER7–SER8	Essay	Rubric (1–4)
Environmental Attitudes (EA)	Awareness	Awareness of environmental conditions	EA1–EA6	Questionnaire	Likert (1–5)
	Concern	Environmental concern	EA7–EA12	Questionnaire	Likert (1–5)
	Responsibility	Responsibility toward environment	EA13–EA18	Questionnaire	Likert (1–5)
	Behavior	Pro-environmental behavior	EA19–EA24	Questionnaire	Likert (1–5)

Table 2. Summary of Variables and Instruments

Variable	Dimensions	Instrument	Format	Number of Items	Scale
Socio-Ecological Reasoning (SER)	Explanation, Analysis, Interpretation, Evaluation	Test	Essay	8	Rubric (1–4)
Environmental Attitudes (EA)	Awareness, Concern, Responsibility, Behavior	Questionnaire	Likert	24	1–5

The research instruments consisted of an essay-based *Socio Ecological Reasoning* (SER) test and a Likert scale questionnaire measuring *Environmental Attitudes* (EA). The SER instrument was developed based on systems thinking indicators, including the ability to explain environmental phenomena, analyze relationships within socio ecological systems, interpret scientific data, and evaluate potential environmental solutions (Hmelo-Silver et al., 2007). Meanwhile, the EA questionnaire was adapted from the *New Ecological Paradigm* (NEP) framework, which encompasses key dimensions of environmental attitudes such as awareness of ecological crises, concern for environmental issues, responsibility toward environmentally damaging actions, and engagement in pro environmental behavior (Dunlap et al., 2000). To enhance contextual relevance, several indicators related to Baduy local wisdom and ecological practices were integrated into the instruments (Parmin et al., 2016).

Content validity was evaluated through expert judgment involving two science education experts, using Aiken's V index (Bell, 2016). Meanwhile, reliability was assessed using Cronbach's Alpha for the questionnaire and an analytic rubric for scoring the essay based SER instrument (Hays et al., 1983). Data collection was conducted in a controlled classroom setting, where students completed both instruments under teacher supervision.

Data analysis was conducted using both descriptive and inferential statistics with the support of IBM SPSS Statistics. Descriptive analysis involved calculating mean scores, percentages, and distribution categories to identify the overall profiles of Socio-Ecological Reasoning (SER) and Environmental Attitudes (EA). Inferential analysis was also carried out whereby Pearson correlation was used to assess for any relationship with socio ecological reasoning on environmental attitudes. The relationship between the variables was determined using two measures: the correlation coefficient (r) and significance level from t test (p-value).

Furthermore, a disparity analysis was carried out to examine the gap between the cognitive domain (SER) and the affective domain (EA). This involved comparing the average scores of both variables and calculating the difference to assess the extent of the gap between cognitive and affective aspects. This combined approach allows for a more comprehensive understanding of students' profiles by not only describing each variable independently but also examining their interrelationship within the context of socio-ecological learning.

The validity of the instruments was established through content validation with the help of two experienced science teachers. They evaluated the relevance of the indicators, the clarity of the language used, and how well each item aligned with the intended constructs. The level of agreement among validators was analyzed using Aiken's V index, calculated using the formula:

$$V = \frac{\sum s}{n(c-1)} \quad (1)$$

Where s represents the score assigned by the validator minus the lowest score, n is the number of validators, and c is the number of rating categories. Reliability testing was conducted to ensure internal consistency. The reliability of the environmental attitudes questionnaire was measured using Cronbach's Alpha with the help of IBM SPSS Statistics. A coefficient value of 0.70 or higher was considered to indicate acceptable reliability. The socio-ecological reasoning test was assessed using an analytic scoring rubric to ensure consistency in evaluating students' responses. The data were collected by applying the socio-ecological reasoning test and environmental attitudes questionnaire under a controlled learning environment. Most participants were fully debriefed after the data collection and gave their consent for the study.

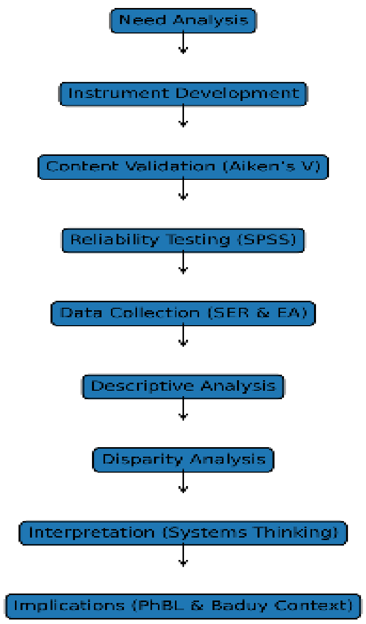

Figure 1. Research method flowchart

The collected data were analyzed using descriptive statistics with the support of IBM SPSS Statistics. This included calculating mean scores, percentages, and score distributions. To aid interpretation, the results were presented using various data visualization techniques such as bar charts, radar charts, and distribution graphs. In addition, the analysis focused on identifying the gap between the cognitive domain (SER) and the affective domain (EA) to highlight any potential imbalances in learning outcomes. This disparity analysis serves as an indicator of the gap between students' systems thinking abilities and their environmental attitudes within the context of science learning based on local wisdom.

Table 3. Score Interpretation Criteria

Score Range	Category
4.21 – 5.00	Very High
3.41 – 4.20	High
2.61 – 3.40	Moderate
1.81 – 2.60	Low
1.00 – 1.80	Very Low

Table 4. Data Analysis Techniques

Analysis Type	Purpose	Method
Content Validity	Assess item relevance and clarity	Aiken's V
Reliability Test	Assess internal consistency	Cronbach's Alpha (SPSS)
Descriptive Statistics	Identify mean and distribution	Mean, Percentage
Disparity Analysis	Identify gap between SER and EA	Mean Comparison

Result and Discussion

This juxtaposition was unequal, statistically significant and supports the affective domain but not the cognitive domain of student learning outcomes. High Environmental Attitudes (M = 4.40) and moderate Socio-Ecological Reasoning (M = 3.07) resulted in a mean difference of 1.33 points between the two scales. In addition, the Pearson Correlation analysis revealed a weak and non-statistically significant relationship between the two variables ($r = 0.12$; $p > 0.05$), meaning that students environmental awareness does not have an automatic relation to the ability of socio-ecological system analysis by them.

This, in turn, corresponds with the value action gap concept where people are aware of sustainability issues often at an emotional level but may find it difficult to convert their values into coherent actions. This is how it happens in science education: that students are very concerned about the environment yet lack systems thinking to recognize the complexity of human-environment interactions. Pedagogically, this gap suggests that current instructional practices remain primarily focused on internalizing values and limits the ability of students to engage in higher-order cognitive processes like causal analysis and evidence based reasoning.

Although integrating Baduy local wisdom has been effective in strengthening students' environmental attitudes, its potential to enhance analytical reasoning is still not fully utilized. It is frequently more utilized as a repository of values than as a foundation for the development of cognitive skills. Thus, learning science should be refocused toward practices that purposely combine the affective and cognitive domains. One such pedagogical strategy is phenomenon-based learning, an approach where students use systems thinking to study the environmental issue from real-world scenarios and knowing this technique bridges the gap between being aware of something and reasoning something.

In conclusion, the evidence supports a disjunction between affective and cognitive domains in which students attain significantly higher environmental attitudes as compared to socio-ecological reasoning skills. The non-significant correlation further indicates that these two constructs develop independently rather than simultaneously. This finding also aligns with theoretical concepts like the value–action gap, which acknowledges that people can emerge as highly valuing of the environment without possessing adequate cognitive mode of analyzing environmental deficits in a scientific manner. In this case students are aware and concerned, but do not have the skills of systems thinking needed to understand complex socio-ecological relationships.

Table 5. Descriptive Statistics and Disparity Analysis of Environmental Attitudes (EA) and Socio-Ecological Reasoning (SER)

Variable	Mean	Category
Environmental Attitudes (EA)	4.40	Very High
Socio-Ecological Reasoning (SER)	3.07	Moderate
Gap (EA – SER)	1.33	–

Table 6. Pearson Correlation Analysis between Socio-Ecological Reasoning (SER) and Environmental Attitudes (EA)

Variables	r-value	Sig. (p)	Interpretation
SER ↔ EA	0.12	> 0.05	Not Significant

This condition that is a structural issue in science learning where the encouraged instructional practices emphasising value internalisation over cognitive development. As a result, students can express concern about environmental issues, but often struggle to explain causal relationships, interactions, and the dynamics within systems. The gap highlighted by this study is not a simple descriptive point, but rather one that has statistical backing where simply improving attitudes towards the environment does not translate into gains in higher order thinking skills. Thus, the design of science learning should involve consensus that embeds affective and cognitive domains, including relative approaches to concepts like phenomenon-based learning that encourages students to bridge between their experiences in everyday life environmental problems with a more analytical systems-oriented one.

The scatter plot shows that the data points are widely separated from each other and do not show a clear linear relationship. In Environmental Attitudes, nearly all students score high, while their Socio-Ecological Reasoning scores tend to vary with a middle range. This pattern mirrors the results obtained from Pearson correlation, which suggested a weak and non-significant relationship between Environmental Attitudes and Socio-Ecological Reasoning. Thus, students who have more positive environmental attitudes do not automatically exhibit comparably strong socio-ecological reasoning skills.

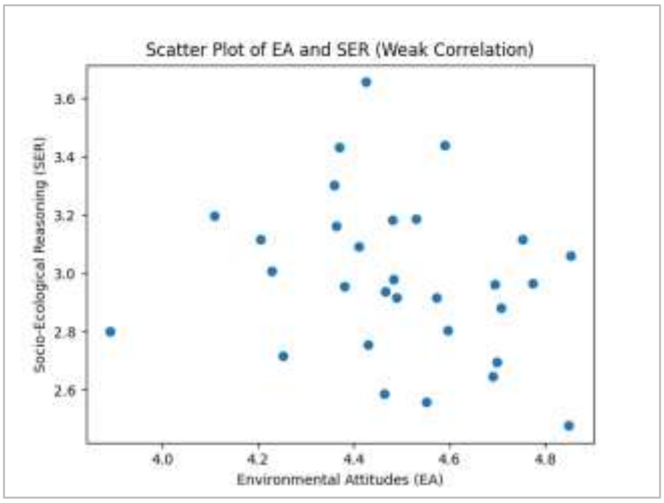

Figure 2. Scatter plot of environmental attitudes and socio-ecological reasoning

Students' Environmental Attitudes in Contextual Science Learning

The distribution of students' Environmental Attitudes (EA) across different indicators is shown in Table 4. The findings yield a total mean value of 4.40 falling within the very high grade therefore represents that students have a good prevalence of green environmental attitudes. These findings indicated that 87.78% of the students were classified into the high category, implying a well-developmentof environmental awareness and concern amongthe study group. Of the three dimensions, local wisdom appreciation shows the highest mean score (M = 4.75), followed by pro-environmental behavior (M = 4.64) and ecological awareness the lowest (M = 3.89), though still in the high-category.

The change across the dimensions demonstrates how students are getting beyond awareness of environmental issues to a growing sense of responsibility and desire to act. This appears to indicate that students are not only aware of environmental issues but also have the potential to act on their behavioral tendencies. However, the patterns in mean scores across dimensions suggests that environmental attitudes do not develop uniformly particularly between awareness and behavior.

To visualize these differences better, the distribution of Environmental Attitudes for indicators is showed in Fig. 2: Basic awareness as an indicator receive the lowest scores compared to local wisdom and behavioral practices which generally have a higher score than other variables.

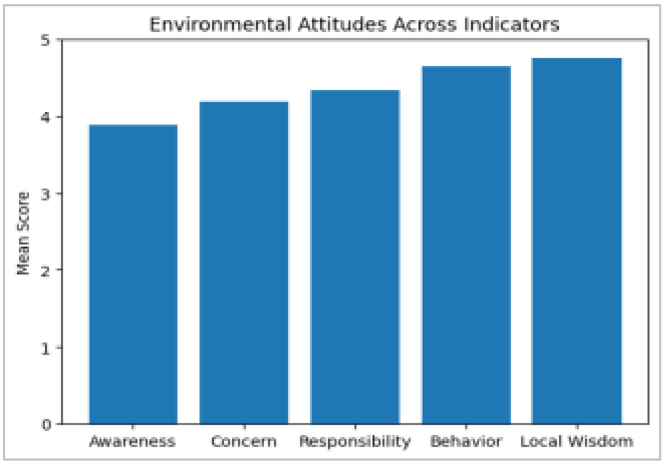

Figure 3. Environmental attitudes per indicator

Figure 3 shows a Venn diagram of components for environmental attitude, that is uses the overlap pattern in dimensions. Most students display some level of active awareness, concern, responsibility and pro-environmental behavior simultaneously (as represented by the overlapping ovals in the diagram). But only a portion of students are prepared to do so here, since they never reach beyond the awareness stage to the behavioral stage: such internalization of environmental values is not universal within the group.

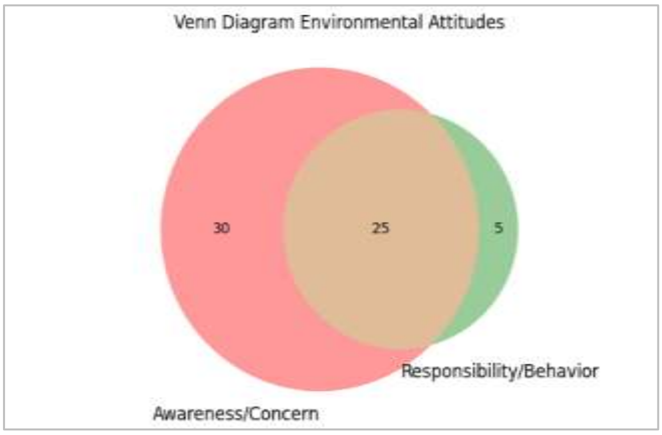

Figure 4. Overlapping distribution of environmental attitudes dimensions

Coming from a critical angle, this finding hints to the assumption that an actual behavior change from environmental awareness is by no means natural. Even if students are widely aware and worried, these views do not always lead to deeds. This represents a partially internalized process, where the affective part is stronger than the behavioral implementation. The findings also highlight the important role of contextual science learning based on Baduy local wisdom in shaping students' environmental attitudes. A high score in the local wisdom dimension implies that cultural values highly affect students' attention to environmental problems. By closely integrating scientific concepts with real life cultural practices, students can see the environment not only as a scientific object but also as a socio-cultural system that is imbued with meaning and values.

The variation across dimensions reflects a gradual and complex developmental process. Ecological awareness serves as the foundation, which then develops into concern, a sense of responsibility, and eventually leads to pro-environmental behavior. This progression does not occur in a linear manner but rather through interactions between learning experiences, social contexts, and internalized cultural values. This is in line with the studies which show that contextual learning affects students' motivation and relevance through science education (Dai et al., 2019). This link between the scientific idea works and genuine existence encounters features that even more powerful cognitive and emotive engagement enables students to build a greater understanding of your subject of study. In addition, by integrating local wisdom, it assists in forming ecological awareness and environmental ethics. Indigenous knowledge systems have built-in sustainability principles that preserve ecological balance (Rosa et al., 2025). These fundamental values guide the way students experience and interact with the local environment. Culturally contextualizing science also strengthens conceptual understanding and cultural identity (Sadeghian et al., 2022). This aligns with the view that scientific knowledge is closely related to its social and cultural context (Zidny & Eilks, 2018).

Even with the very high environmental attitudes, this result should not be viewed as an ultimate measure of successful learning outcomes. Affective domain high scores may be due to internalization of values but not underpinned by a conceptual understanding. More specifically, students may express positive attitudes toward environmental problems and still not fully understand the fundamental scientific processes involved. Furthermore, with the self-report instruments there is a risk for social desirability bias: students may respond in ways consistent with normative expectations. Consequently, this scoring may identify a stronger tendency towards the behaviour than is the case in reality.

The Venn diagram shows that not all the students who demonstrate awareness and care actually make an action. This pattern suggests that there is an omission to the internalization process especially with regard to change in beliefs into behaviors. The findings also highlight possible imbalance in the affective versus cognitive compartments. Even if students have strong environmental attitudes, this does not lead to an ability to engage with the material from an interdisciplinary and systems perspective. It is also a condition in which the current practices of learning lend themselves more to influencing values than to building higher-order thinking skills.

This imbalance suggests that the integration of affective and cognitive domains in science learning is still not optimal. While contextual learning based on local wisdom has strong potential to shape environmental attitudes, it needs to be further developed to better support students’ cognitive growth. Consequently, local wisdom retention should not only be intended to develop values but also scientific reasoning. A potential solution to this problem comes in the form of phenomenon-based learning since it facilitates the systematic exploration of the science-society nexus by providing an integrative framework for students to develop inquiry competences that can then be applied within socio-ecological contexts. Such an approach could create environmentally literate learners who can critically engage with the problems surrounding the environment.

Students’ Socio-Ecological Reasoning in Contextual Science Learning

The distribution of students’ Socio-Ecological Reasoning (SER) across indicators is presented in Table 7.

Table 7. Distribution of Students’ Socio-Ecological Reasoning Across Indicators

Indicator	Cognitive Domain	Mean Score	Category
Explanation of phenomena	Scientific explanation	3.22	Moderate–High
Evaluation of investigation	Scientific inquiry	3.11	Moderate
Data interpretation	Evidence-based reasoning	3.06	Moderate
Socio-ecological connection	Contextual reasoning	3.11	Moderate
Solution evaluation	Decision making	3.17	Moderate
Systemic understanding	Systems thinking	2.97	Moderate
Biodiversity reasoning	Ecological complexity	2.94	Moderate
Program design	Problem-solving	2.97	Moderate
Overall Mean	-	3.07	Moderate

The overall mean score of 3.07 falls within the moderate category, suggesting that students’ reasoning abilities are still developing. The results show that students perform better on indicators related to descriptive reasoning, such as explaining scientific phenomena (M = 3.22), compared to those requiring higher-order thinking, particularly systems understanding (M = 2.97) and biodiversity reasoning (M = 2.94).

This pattern is clearer in Figure 5, which shows the SER per indicator. This trend illustrates a persistent divide between more descriptive and more analytic indicators, suggesting students are better able to identify and describe elements of a system than integrate them into complex systems.

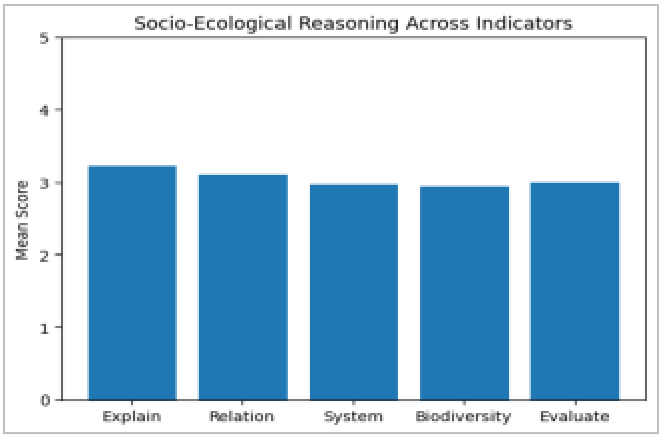

Figure 5. Socio-ecological reasoning per indicator

The distribution of students' reasoning levels is further illustrated in Figure 6, which shows that the majority of students are concentrated in the moderate category, with only a small proportion reaching higher levels of reasoning.

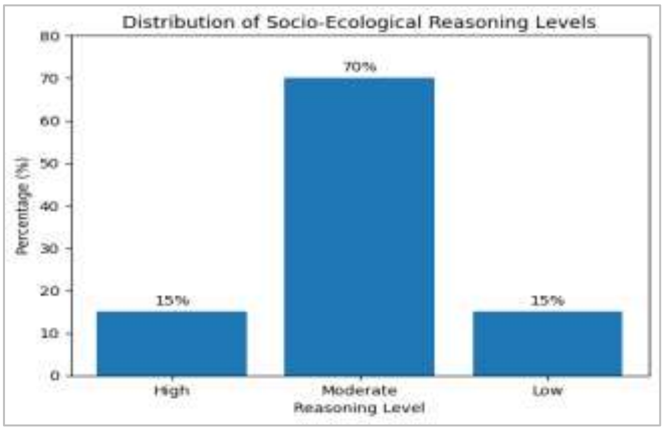

Figure 6. Distribution of socio-ecological reasoning levels

This trend indicates that students seem to have the basics of environmental systems but appear challenged in evaluating inter-relationships in more complex socio-ecological scenarios. Those descriptive indicators also indicate that while their ability to describe and elaborate a topic is stronger, they often are not able to adjust multiple variables or understand dynamic inter-relationships in a system. This finding, seen through an analytical lens, suggests how cognitive task complexity and student performance impact each other

From an analytical perspective, this finding reflects the influence of cognitive task complexity on student performance. Indicators requiring multidimensional analysis consistently show lower scores compared to those involving direct explanation. This indicates that students are still not used to accomplishing higher-order thinking processes, especially associated with systems thinking.

The interpretation of socio-ecological reasoning is directly associated with systems thinking, which includes understanding relationships between components of a system: interactions between components, feedback loops and time-varying behaviour from the dynamics system (Rahman et al., 2025). The relatively low performance in systemic indicators indicates that students' understanding remains fragmented, where concepts are learned in isolation rather than as interconnected elements within a system.

Results indicate that existing pedagogies do not support the development of systems thinking skills. A heavy focus on conceptual knowledge and rote memorisation leads students to only have a surface-level understanding of what they learn, preventing them from being able to apply it effectively in real-world situations. This indicates a pedagogical environment that is largely teacher-centric, which focuses on simple delivery of knowledge instead of engaging students in the knowledge building processes.

Contextual learning referring to the local wisdom has a very promising implication in developing socio-ecological reasoning, however its implementation seems only capable of affecting cognitive and affective instead of psychomotor. Indigenous knowledge provides authentic examples of relationships between humans and the environment. However, this potential has not been fully utilized to support analytical reasoning processes (Fanzo et al., 2024).

The moderate overall score suggests that students' socio-ecological reasoning skills are still not fully developed. This indicates that the learning experiences provided may not be sufficient to help students analyze complex environmental issues. The stronger performance in descriptive indicators also shows that students are more accustomed to answering direct questions than engaging in tasks that require deeper analysis.

Disparity Between Environmental Attitudes and Socio-Ecological Reasoning

Table 8 presents a comparison between Environmental Attitudes (EA) and Socio-Ecological

Reasoning (SER). The two variables were both found to be extremely disproportionate, LEA (M = 4.40) being in the very high and SER (M = 3.07) in moderate range of description The result is even more apparent in the figure 7, which depicts a difference between the mean scores of EA and SER.

Table 8. Comparison Between Environmental Attitudes and Socio-Ecological Reasoning

Variable	Mean Score	Category
Environmental Attitudes	4.40	Very High
Socio-Ecological Reasoning	3.07	Moderate

This disparity is more clearly illustrated in Figure 7, which shows the difference in mean scores between EA and SER.

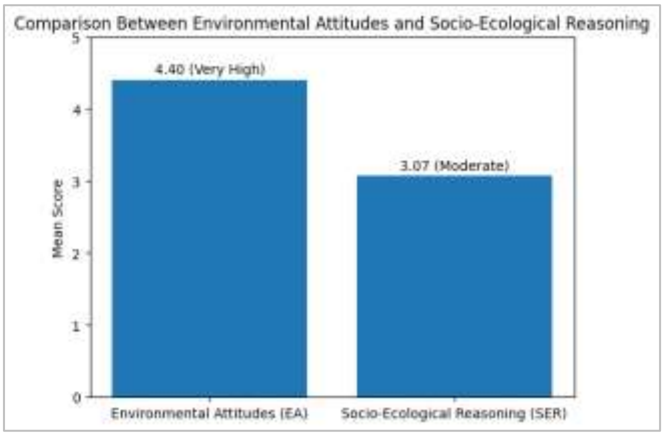

Figure 7. Comparison between environmental attitudes and socio-ecological reasoning

As further illustrated in Figure 8, the categories are distributed such that most students are classified as high for EA but still fall within a moderate category for SER.

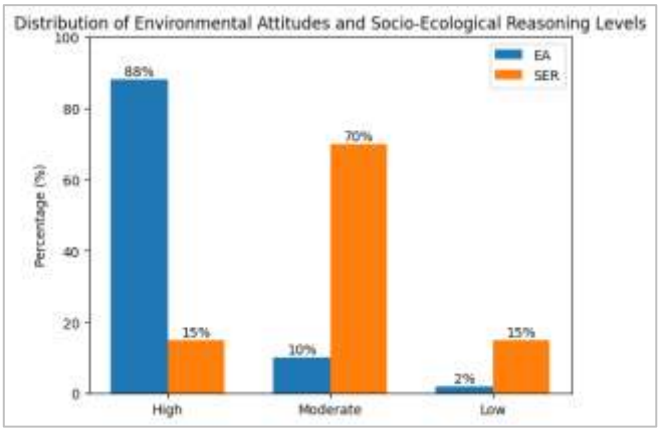

Figure 8. Distribution of EA and SER levels (%)

These findings confirm a gap between the affective and cognitive domains, where students' strong environmental attitudes are not matched by their reasoning abilities. They are aware and concerned but cannot yet analyze the complexities of human and environmental systems. From a critical perspective, this disparity reflects a structural issue in science learning. The internalization of environmental values does not necessarily lead to the development of analytical reasoning skills. Students were unaware of the scientific mechanisms involved, and gave hollow concern for environmental issues

This state indicates a detachment between the Emotional and Cognitive domains involved in learning. Norms-based approaches to instruction can, by themselves, create a positive disposition, but not necessarily greater cognitive complexity. In science education literature, this gap is often associated with the lack of integration between learning experiences and cognitive processes. Systems thinking involves both an understanding of the concepts and providing students with opportunities to practice solving complex problems. In the absence of these opportunities, students may understand more simply.

Findings indicate that science learning cannot be pure concept-based, but rather must go with phenomena. Instruction should analyze and implement real-world environmental topics for students which improved their capability to think in systems. Moreover, the embedding of local wisdom concept should not only be to attract value formation but also can even take advantage as analytical reasoning development. Local wisdom serves as a connecting part of scientific concepts as it relates to the students real-life context which allows them to construct deeper and more meaningful understanding.

Interpreting the Gap: A Systems Thinking Perspective

Figure 9 Conceptual model of imbalanced Environmental Attitudes Socio-Ecological Reasoning And for what it goes to show, that students exhibit good affective engagement but limited analytical power. Systems thinking, a major bridge connecting environmental awareness with the capacity to interrogate complex socio-ecological relations. Without addressing systems thinking specifically in learning, environmental attitudes might stay at the normative level and not progress to a higher-order reasoning skill (Rahman et al., 2025).

Environmental Attitudes (EA) and Socio-Ecological Reasoning (SER) are two constructs that express imbalance between the affective and cognitive domains in science learning. The average score of Environmental Attitudes (M = 4.40) indicates a high level of internalization environmental values by the students. The mean for Socio-Ecological Reasoning those in the lower Developmental range (M = 3.07) indicated that students can still make very limited sense of socio-ecological systems interconnections. This gap shows that,while students were able to voice concern about the environments, they did not yet have the analytical skills support needed in order to acquire a complete understanding of the systems involved.

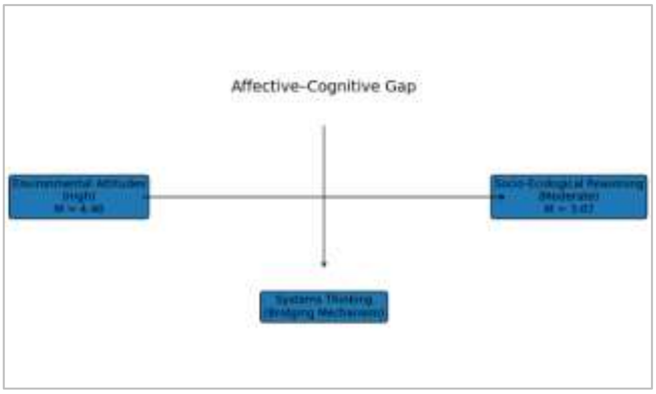

Figure 9. Overlap between environmental attitudes and socio-ecological reasoning

From a theoretical standpoint, systems thinking offers an interpretive framework regarding this gap. Systems thinking focuses on recognizing relationships between system components, interactions feedback loops and dynamic changes. The ability to not just understand individual concepts, but to integrate those within complex contexts. Students' relatively stronger performance in explaining environmental phenomena suggests that they have developed a basic conceptual foundation. But their performance on systemic indicators is worse indicating that they still struggle to link these concepts through cause-and-effect pathways. In fact, it indicates that learners are still in a naive partial understanding phase where the concepts have been learned independently of each other, but not synthesized into a coherent whole.

The findings suggest that current learning practices have not yet explicitly facilitated the development of systems thinking skills. Instructional approaches that primarily emphasize conceptual knowledge often result in fragmented knowledge structures, making it difficult for students to connect scientific concepts with real-world environmental phenomena characterized by complex and dynamic interactions. Previous studies in science education have shown that systems thinking does not develop automatically through traditional instruction but requires learning experiences that engage students in analyzing relationships, feedback loops, and interactions within complex systems. Experiential and contextual learning environments provide opportunities for students to explore authentic socio-ecological issues and construct a more integrated understanding of human–environment relationships. In this regard, local wisdom offers meaningful contextual examples that illustrate how ecological sustainability is embedded within everyday cultural practices, thereby supporting the development of systems-oriented thinking (Rahman et al., 2025).

The observed disparity between Environmental Attitudes and Socio-Ecological Reasoning further indicates that the learning process may be more effective in shaping environmental values than in fostering higher-order cognitive skills. While students demonstrate strong environmental concern and awareness, they appear to experience difficulties in explaining the scientific mechanisms underlying environmental problems and socio-ecological interactions. This pattern suggests that instructional practices continue to prioritize the internalization of environmental values without providing sufficient opportunities for analytical inquiry and cognitive exploration. Consequently, students may develop normative understandings of environmental responsibility without acquiring the systems thinking skills required to analyze complex environmental challenges. The relatively consistent pattern of moderate reasoning scores across participants also suggests that these limitations may be associated with instructional design rather than solely with individual learner characteristics.

These findings highlight the importance of integrating affective and cognitive domains more effectively within sustainability-oriented science education. Contextual and phenomenon-based learning approaches offer considerable potential to bridge this gap by engaging students in authentic environmental issues that require evidence-based reasoning, systems analysis, and decision-making. Furthermore, local wisdom should not only function as a source of environmental values but also serve as a contextual foundation for scientific investigation and reasoning. By connecting scientific concepts with culturally meaningful environmental practices, science learning can support the development of both environmental attitudes and socio-ecological reasoning. Strengthening systems thinking through such approaches is essential for preparing students to understand environmental issues critically, holistically, and sustainably.

The Role of Baduy Local Wisdom in Science Learning

Local wisdom in Baduy is also flourishing well (M = 4.75) which was the highest means score and has the most powerful affect on cultural values as shape one of environmental attitudes. The significance of the score is greater than those on ecological awareness and environmental concern, indicating that cultural context has a greater impact on attitude formation rather than purely conceptual. In overall this pattern has certain to follow up with regards to integration of local wisdom that would not only make the learning contextually relevant but it also empowers students emotionally. The relationship between cultural values and learning experiences allows students to develop higher-level meaning about the environment.

Baduy local wisdom serves as an authentic context that reflects sustainable practices in everyday life. Values of ecological sustainability, restraint in resource consumption and respect for nature have become a system that is understood by the Baduy community. Incorporating this context into science learning helps students develop scientific knowledge as practices with direct relevance to people, rather than abstract or classroom-only concepts. This allows students to make cultural links to scientific concepts, thus reinforcing the affective domain.

As an ethnoscience, local knowledge not only represents a descriptive component but also offers perspective in terms of creating a holistic approach to understanding. Research in the area of science education indicates that when students are exposed to indigenous knowledge, it increases their awareness towards ecological issues and relates them with a better concept on bank-full condition (Rahman et al., 2025). This point of view emphasizes that scientific knowledge is entangled with social and cultural contexts. Moreover, it has been reported that contextual learning aligns with the provision of genuine experiences to develop student engagement and engage more favourable attitudes related to science (Fanzo et al., 2024).

However, the dominance of the local wisdom dimension also reveals a limitation. While cultural values strongly influence environmental attitudes, they do not correspond to a significant improvement in socio-ecological reasoning. This suggests that, in learning, local wisdom is often used more as a source of values than as a tool for developing analytical skills. If used in this manner without analytical processes as a backbone it might lead you to more superficial understandings. Such that students know that Baduy practices are environmentally friendly without understanding the scientific form.

The observed gap between environmental attitudes and socio-ecological reasoning can therefore be partially explained by the dominant affective role of local wisdom. While it is effective in shaping values and attitudes, it has not yet been fully utilized to develop systems thinking skills. This suggests that the integration of local wisdom in learning is still partial, as it does not fully connect cultural values with scientific analysis.

To address this limitation, the role of local wisdom in learning needs to be strategically reoriented. Cultural values should not only serve as a foundation for attitude formation but also as a basis for developing higher-order thinking skills. This is shown in the use of Baduy practices as case studies so that students are able to analyse relationships between human activities and impacts on the environment within a system. This way, students can cultivate a more holistic understanding of socio-ecological systems.

Implications for Phenomenon-Based Science Learning

The findings of this study indicate an imbalance between affective and cognitive domains in science learning, where Environmental Attitudes are very high ($M = 4.40$) while Socio-Ecological Reasoning remains moderate ($M = 3.07$). This pattern suggests that current learning practices are more effective at shaping values than at developing higher-order thinking skills. As a result, strengthening students' analytical and systems thinking abilities should become a key priority in science education.

A possible framework for bridging this gap is phenomenon-based learning. Such method keeps the real world phenomenon in the heart of learning, where students connect and put together different concepts through a singular context. These features can be classified into three: interdisciplinary learning, a focus on complex issues and student engagement. By using this approach, students are confronted with situations that foster the relationships between different components of a system and contribute to developing their systems thinking skills.

SDE reasoning limitations indicate that students had not yet developed socio-ecological systems understanding. Such ability can be cultivated through the use of phenomenon based learning, which involves having students investigate real world environmental issues. Complex phenomena, such as human ecosystem interactions, provide natural settings in which students can use identifying the cause-and-effect relationships and interdependencies to explore the dynamic nature of systems.

Baduy local wisdom has significant potential as a source of phenomena in learning. Specifically, the Baduy community practices are examples of hvordan sustainable practices can be relatable and real-world contexts for science. Local wisdom is incorporated into phenomenon-based learning and students can relate between cultural values and scientific analysis. Not only does this support their environmental attitudes but it allows them be able to understand the concepts on a deeper level in meaningful ways.

The findings suggest that science learning design needs to shift from concept-based approaches toward phenomenon-based approaches. Focusing on concepts alone is not enough to develop systems thinking skills. Learning experiences are required to learn higher-order cognitive abilities which include exploration, analysis &

post-analysis of real-world scenarios. Therefore, the learning activities should be planned in such a way that students are motivated to identify problems linked to variables and that Scientific Principles will work toward solutions based on evidence.

A crucial implication from this study concerns the need for science learning to address both affective and cognitive domains. Learning must do more than shape attitudes, it should also develop critical and systemic thinking. Combining phenomenon-based learning with Baduy local wisdom offers a potential way for achieving that goal.

Contribution to Socio-Ecological Education Research

This study provides empirical evidence of a gap between Environmental Attitudes and Socio-Ecological Reasoning within the context of science learning. Although students demonstrated really excessive Environmental Attitudes indicators that, they do internalize values as a part of their belief systems; Socio-Ecological Reasoning continues to be average in order suggesting limitations in methods considering. These findings are consistent with research in science education, indicating that understanding scientific literacy is multidimensional.

This impression can reinforce theoretical frameworks that stress the integration of affective and cognitive domains when students encounter scientific learning. Examining the discrepancy between affective and cognitive domains provides a new lens of understanding through which to view student conceptualization of environmental problems. An analytical lens for systems thinking allows a deeper understanding of the complexities students face in synthesizing ideas within intricate socio-ecological systems.

If properly integrated local wisdom broadens the ethnoscience research field which shows that indigenous knowledge can not only orient attitudes but also support the quality development of analytical skills. This study contributes to the empirical literature methodologically, by using a prescriptive quantitative needs analysis integrating cognitive and affective variables. Testing students through a combination of essay-based tests and Likert-scale questionnaires provides a well-rounded perspective. Consequently, this method provides a more comprehensive perspective in contrast to studies that also address only one domain.

The study also contributes contextually by integrating Baduy local wisdom into science learning. The results highlight the notion that making education culturally relevant adds depth and meaning to learning. Local context here is not only an illustration but also a robust learning resource rooted in the way students process their vision of human-environment dynamics.

This novelty of this study is due to the way of integrating socio-ecological reasoning, environmental attitudes and local wisdom in one single framework for analysis. Previous studies have often concentrated on elements of learning individually, but this research combines these awareness times to find where the gaps in learning happen. This two-pronged approach contributes to a new avenue of socio-ecological education research by asserting that productive science learning must cultivate both environmental awareness and systems thinking concurrently.

Conclusion

This study identified a disparity between students' Environmental Attitudes (EA) and Socio-Ecological Reasoning (SER) within contextual science learning based on Baduy local wisdom. Students demonstrated very high Environmental Attitudes (M = 4.40), indicating strong environmental awareness and concern, while their Socio-Ecological Reasoning remained at a moderate level (M = 3.07), suggesting that systems thinking abilities are still developing and not yet optimally integrated with the affective domain. These findings indicate that current instructional practices may be more effective in strengthening environmental values than in facilitating analytical and systems-oriented reasoning. The high EA scores are also likely influenced by sociocultural and contextual exposure to Baduy local wisdom; however, the findings suggest that local wisdom has predominantly been integrated as a source of environmental values and norms rather than as a basis for scientific inquiry and systems analysis. Therefore, the observed gap may reflect limitations in instructional design rather than limitations of the local wisdom itself. This study contributes to socio-ecological education research by emphasizing the importance of balancing affective and cognitive dimensions in sustainability-oriented science learning. Future research is recommended to investigate instructional approaches that more effectively integrate local wisdom with systems thinking and higher-order reasoning skills through experimental or longitudinal research designs.

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Author Contributions

Conceptualization, E.Y.R., A.W., and I.F.N.; methodology, E.Y.R., A.W., and I.F.N.; validation, A.W. and I.F.N.; formal analysis, E.Y.R.; investigation, E.Y.R.; data curation, E.Y.R.; writing—original draft preparation, E.Y.R.; writing—review and editing, A.W. and I.F.N. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

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