



An Analysis of the Low Levels of Scientific Literacy and Environmental Concern Among Junior High School Students

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Abstract

Scientific literacy and environmental concern are essential for enabling students to understand scientific issues and engage in environmentally responsible practices. This study aimed to examine the profiles of scientific literacy and environmental concern among junior high school students, focusing on scientific competencies and affective-behavioral dimensions. A quantitative descriptive design was employed involving 32 purposively selected students from SMP Negeri 2 Subah, Indonesia. Data were collected using a scientific literacy test, scientific literacy observation sheet, environmental concern questionnaire, and environmental concern observation sheet. Descriptive statistics and exploratory correlation analyses were applied. The findings revealed a mean scientific literacy test score of 51.25, with 90.6% of students scoring below the minimum achievement criterion of 70. Observed scientific literacy was also low ($M = 1.83$), with interpreting scientific data and evidence representing the weakest dimension. Environmental concern was similarly low based on questionnaire responses ($M = 2.12$) and classroom observations ($M = 1.89$), particularly in behaviors involving environmental action, organization, and consistency. Scientific literacy test scores were not significantly associated with observed environmental concern (Spearman's $\rho = .32$, $p = .074$), whereas observed scientific literacy showed a strong positive association with observed environmental concern ($\rho = .72$, $p < .001$). These findings highlight differentiated cognitive and behavioral profiles and the importance of measurement approaches when examining both constructs. The results provide a context-specific foundation for developing science learning experiences that integrate evidence-based reasoning with environmental responsibility.

Keywords: Scientific literacy; Environmental concern; Scientific competencies; Environmental behavior; Junior high school students

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INTRODUCTION

Scientific literacy is a fundamental competency in twenty-first-century education because it enables individuals to understand scientific phenomena, evaluate evidence, make informed decisions, and respond critically to complex issues affecting society and the environment. Science education is therefore expected to develop not only students' conceptual knowledge but also their ability to apply scientific reasoning to authentic situations encountered in everyday life. Scientific literacy involves the capacity to engage with science-related issues as reflective citizens, evaluate the credibility of scientific information, and use evidence to support responsible decision-making (Osborne, 2023; Pratiwi et al., 2019; Yuliati, 2017). These competencies are particularly relevant to environmental challenges, including pollution, resource depletion, waste management, and ecosystem degradation, which require scientific understanding and responsible individual and collective action. Accordingly, scientific literacy represents an important educational foundation for preparing students to participate meaningfully in addressing environmental problems.

Despite its importance, the development of scientific literacy remains a substantial challenge in science education, particularly in Indonesia. The Programme for International Student Assessment (PISA) 2022 reported that Indonesian students achieved an average science score of 383, considerably below the OECD average of 485, indicating persistent difficulties in applying scientific knowledge and reasoning to real-world problems (OECD, 2023). Previous studies involving Indonesian secondary school students have similarly identified limitations in scientific literacy, including difficulties understanding scientific concepts, interpreting scientific information, and applying scientific reasoning in contextual situations (Anshar et al., 2023; Juwita et al., 2022; Ramli et al., 2022). Research focusing on ecosystem learning has also highlighted challenges in developing students' scientific competencies when learning activities require them to connect conceptual knowledge with environmental phenomena (Suhartinah et al., 2019). These findings emphasize the continuing need to understand scientific literacy beyond general achievement scores, particularly in relation to the competencies required for interpreting and responding to environmental issues.

Conceptually, scientific literacy encompasses interconnected competencies that extend beyond the acquisition of factual scientific knowledge. The PISA science framework emphasizes students' abilities to explain phenomena scientifically, evaluate and design scientific inquiry, and interpret data and evidence scientifically (OECD, 2023). Explaining phenomena scientifically requires students to apply scientific concepts and principles to understand natural events, whereas evaluating and designing scientific inquiry involves recognizing investigable questions, assessing research procedures, and understanding how scientific evidence is generated. Interpreting scientific data and evidence requires students to analyze information, identify patterns, evaluate conclusions, and distinguish evidence-based explanations from unsupported claims. These competencies are particularly important in environmental education because understanding environmental problems requires students to connect scientific explanations with observations, evidence, and practical decisions. However, scientific literacy should not be reduced to cognitive performance alone, as students' willingness to engage with scientific issues and consider their implications also contributes to meaningful participation in science-related contexts (Osborne, 2023; Yuliati, 2017).

Alongside scientific literacy, environmental concern constitutes an essential educational dimension associated with students' sensitivity, attitudes, values, and behaviors toward environmental protection. Environmental concern involves more than recognizing environmental problems; it also includes willingness to respond, commitment to environmental values, and the development of responsible practices in everyday life. The affective domain of educational objectives provides a useful conceptual perspective for understanding the progression from receiving environmental information and responding to environmental issues toward valuing, organizing, and internalizing environmentally responsible practices (Kratwohl et al., 1964). Social learning theory further suggests that environmental attitudes and behaviors may develop through observation, social interaction, modeling, and perceived behavioral capability. Within school settings, these processes are influenced by opportunities for participation, environmental routines, and interactions with teachers and peers. Previous studies have emphasized the importance of educational experiences, school environments, and family practices in fostering students' environmental awareness and responsible behavior (Herlina et al., 2021; Qodriyanti et al., 2022; Wattimena et al., 2022). Environmental concern can therefore be understood as a multidimensional educational construct involving affective engagement and behavioral expression.

Scientific literacy and environmental concern are conceptually connected because responsible environmental decision-making requires both scientific understanding and sensitivity to the consequences of human activities. Scientific literacy provides a cognitive foundation for recognizing environmental problems, evaluating evidence, and understanding the scientific implications of environmental practices, whereas environmental concern reflects

students' attitudes, values, and willingness to engage in environmentally responsible actions. Nevertheless, scientific understanding does not necessarily translate directly into environmental commitment or consistent behavior. Students may understand the causes and consequences of environmental degradation without demonstrating corresponding changes in everyday practices. Conversely, environmentally responsible behavior may emerge through social norms, habitual practices, or modeling without being accompanied by well-developed scientific reasoning. Previous research has examined associations between scientific literacy and environmental concern, while other studies have highlighted differences between environmental awareness and actual environmental behavior (Febriyanti & Rahmandani, 2024; Herlina et al., 2021; Suhartinah et al., 2019). These considerations suggest that cognitive scientific competencies and affective-behavioral environmental dimensions should be distinguished conceptually rather than assumed to develop at equivalent levels.

Existing studies have contributed important evidence regarding the development of scientific literacy and environmental concern in educational settings. Research on scientific literacy has frequently emphasized achievement levels, learning difficulties, and instructional factors associated with students' scientific competencies (Anshar et al., 2023; Juwita et al., 2022; Ramli et al., 2022; Setyowati et al., 2022). Meanwhile, studies of environmental concern have examined students' environmental attitudes, environmental literacy, and the influence of school-based environmental education on responsible behavior (Herlina et al., 2021; Qodriyanti et al., 2022). Other research has explored relationships between scientific literacy and environmental attitudes, particularly in the context of ecosystem learning (Suhartinah et al., 2019). Although these studies provide valuable insights, their research emphases and conceptual approaches differ. Scientific literacy is frequently represented through aggregated achievement measures, while environmental concern is commonly discussed in terms of general attitudes or environmental behavior. Consequently, more differentiated conceptual attention is needed to clarify how particular scientific competencies and specific dimensions of environmental concern are characterized within science education.

An important research gap therefore concerns the limited integration of multidimensional perspectives on scientific literacy and environmental concern within a coherent educational framework. Existing evidence establishes the relevance of both constructs but does not eliminate the need for further investigation into their distinct dimensions, particularly scientific explanation, inquiry evaluation, evidence interpretation, affective responsiveness, environmental valuing, and the internalization of responsible practices. Understanding these dimensions is important because general classifications of scientific literacy or environmental concern may obscure differences among the competencies, attitudes, and behaviors that constitute each construct. Furthermore, contextual variations in students' educational experiences and environmental surroundings underscore the importance of examining these constructs within specific school environments. The contribution of the present study is positioned within this need for a more differentiated understanding of scientific literacy and environmental concern, rather than a claim that their relationship has not previously been investigated.

Accordingly, this study aims to examine the profiles of scientific literacy and environmental concern among junior high school students, with particular attention to scientific competencies and the affective and behavioral dimensions of environmental concern. Specifically, the study seeks to characterize students' scientific literacy across relevant competency dimensions, identify the dimensions of environmental concern reflected in students' attitudes and behaviors, and consider the two profiles within a common educational context. By addressing these objectives, the study is expected to contribute context-specific empirical evidence that can inform the identification of educational needs and provide a foundation for developing science learning experiences that connect scientific reasoning with environmental responsibility.

METHOD

Research Design

This study employed a quantitative descriptive research design to examine scientific literacy and environmental concern among junior high school students. The research focused on describing students' scientific competencies, environmental attitudes, and observable environmental behaviors without introducing instructional treatments or manipulating the research variables. Scientific literacy and environmental concern were assessed through complementary measurements to obtain information about their respective dimensions. In addition to descriptive analyses, exploratory correlation analyses were performed to examine associations among measurements that could be matched at the individual student level. These supplementary analyses were not intended to establish causal relationships.

Research Participants and Setting

The study was conducted in April 2026 at SMP Negeri 2 Subah, Batang Regency, Indonesia, during the 2025/2026 academic year. The research population comprised 454 students enrolled at the school. A total of 32 students were selected as research participants using purposive sampling. The selection criteria included students in Grades VIII and IX who had previously received science instruction on ecosystems and environmental conservation.

Instrument testing involved a separate group of 32 students from the same school population. These students had characteristics comparable to those of the main research participants but were not included in the primary data collection. The separation between the pilot-testing and main-study groups was intended to minimize potential bias associated with repeated exposure to the research instruments.

Research Instruments

Four instruments were used to assess scientific literacy and environmental concern: a scientific literacy test, a scientific literacy observation sheet, an environmental concern questionnaire, and an environmental concern observation sheet.

Scientific Literacy Test

The scientific literacy test was developed based on the scientific competency framework used in the Programme for International Student Assessment (PISA). The instrument addressed three competencies: explaining phenomena scientifically, evaluating and designing scientific inquiry, and interpreting scientific data and evidence (OECD, 2023). The initial instrument consisted of 20 multiple-choice items. Following empirical validity testing, 10 items met the established validity criteria and were retained for the main data collection. Students' test scores were expressed on a scale ranging from 0 to 100.

Scientific Literacy Observation Sheet

The scientific literacy observation sheet was used to assess students' scientific competencies during classroom learning activities. The instrument consisted of 10 indicators grouped into four dimensions: explaining phenomena scientifically (two indicators), evaluating and designing scientific inquiry (two indicators), interpreting scientific data and evidence (three indicators), and scientific attitudes (three indicators). The first three dimensions corresponded to the scientific competencies addressed in the PISA framework, while scientific attitudes constituted an additional observational dimension. Students' performance was assessed using a four-point rating scale, with higher scores indicating stronger observed performance.

Environmental Concern Questionnaire

The environmental concern questionnaire was developed with reference to Bandura's social learning theory, particularly observational learning and self-efficacy. The instrument was intended to examine students' self-reported environmental attitudes and behavioral tendencies. It consisted of 16 statements, including 13 positively worded statements and three negatively worded statements (Items 4, 8, and 14). Responses were recorded using a four-point

Likert scale consisting of Strongly Disagree, Disagree, Agree, and Strongly Agree. For positively worded statements, responses were scored from 1 to 4, respectively. Negatively worded statements were reverse-scored so that higher scores consistently represented greater environmental concern. The reverse-scoring procedure was calculated as 5 minus the original response score.

Environmental Concern Observation Sheet

The environmental concern observation sheet was developed based on the affective domain of educational objectives (Krathwohl et al., 1964). The instrument comprised five indicators representing receiving, responding, valuing, organizing, and characterizing. Receiving referred to students' attention to information about environmental pollution. Responding concerned students' participation in appropriate waste disposal practices. Valuing reflected students' concern for environmental cleanliness. Organizing assessed their ability to establish classroom cleaning responsibilities and encourage peer participation, while characterizing concerned the consistent and independent demonstration of environmentally responsible behavior. Each indicator was assessed using a four-point rating scale.

The questionnaire and observation sheet provided complementary perspectives on environmental concern. The questionnaire captured students' self-reported attitudes and behavioral tendencies, whereas the observation sheet assessed observable behaviors. Similarly, the scientific literacy test assessed students' performance on written tasks, while the scientific literacy observation sheet documented their demonstrated competencies during classroom activities.

Instrument Validity and Reliability

Before the main data collection, the research instruments were pilot-tested with 32 students who were not included in the main study. Item validity was examined using Pearson product-moment correlations between individual item scores and total instrument scores, with the assistance of IBM SPSS Statistics version 24. The original study applied a significance level of .05 and reported a critical correlation coefficient of .388 for the pilot-testing sample. Items were considered valid when their calculated correlation coefficients exceeded the specified critical value and their two-tailed significance values were below .05.

Based on the validity testing, 10 of the initial 20 scientific literacy test items were retained for the main data collection, while the remaining items were excluded. The validity results for the 10-item and five-item observation instruments were also reported using Pearson correlation coefficients and corresponding significance values.

Instrument reliability was evaluated using Cronbach's alpha, with a coefficient of at least .70 used as the criterion for acceptable internal consistency (Nunnally, 1978). The reported reliability coefficients were .937 for the 10-item instrument and .807 for the five-item instrument. In addition, the 16-item environmental concern questionnaire yielded Cronbach's alpha of .71 in the main-study data. Corrected item-total correlations were reported for the environmental concern questionnaire to provide additional information about individual item performance.

Research Procedures

The research was implemented through several sequential stages. Initially, permission was obtained from the school principal and science teachers to conduct the study. The research instruments were subsequently administered to the pilot-testing group to examine item validity and reliability. The results of these analyses were used to determine which items would be retained for the main data collection.

Following instrument testing, data were collected from the 32 research participants through the scientific literacy test, environmental concern questionnaire, and classroom observations. The observations were conducted by the researcher and/or observers using the prepared observation sheets. The scientific literacy test was used to obtain information about

students' scientific competencies, whereas the questionnaire and observation instruments provided information about environmental attitudes and observable behaviors. After data collection, the responses and observation scores were tabulated and analyzed statistically.

Data Analysis

The collected data were analyzed using descriptive statistics, including frequencies, percentages, means, standard deviations, and minimum and maximum scores. The analyses were conducted separately for the scientific literacy test, scientific literacy observation sheet, environmental concern questionnaire, and environmental concern observation sheet.

Scientific literacy test scores were converted to a scale of 0–100 and interpreted according to the school's Learning Objective Achievement Criteria (Kriteria Ketercapaian Tujuan Pembelajaran, KKTP). The minimum competency criterion was 70; therefore, students obtaining scores below 70 were classified as not yet meeting the expected learning achievement criterion.

Scores from the scientific literacy and environmental concern observation sheets were calculated using the four-point rating scale. Mean item scores were obtained by dividing the accumulated scores by the number of corresponding ratings. The scores were interpreted using the following intervals: 1.00–1.75 (very low), 1.76–2.50 (low), 2.51–3.25 (high), and 3.26–4.00 (very high), following the scoring interpretation attributed to Riduwan (2013). Scores were also expressed as percentages of the maximum possible score. Given the four-point scale, the minimum achievable percentage was 25%.

For the environmental concern questionnaire, response frequencies and percentages were calculated for each Likert-scale category. Positively and negatively worded statements were distinguished when interpreting the distribution of responses. Negatively worded items were reverse-scored before calculating the mean questionnaire scores. Item-level descriptive statistics and corrected item–total correlations were also examined.

Exploratory correlation analyses were conducted to examine associations among measures that could be linked at the individual student level. Spearman's rank-order correlation coefficients were calculated for the associations between scientific literacy test scores, observed scientific literacy, and observed environmental concern. Pearson correlation coefficients and their 95% confidence intervals were also reported as supplementary analyses. All correlations were examined using two-tailed significance tests. The environmental concern questionnaire was excluded from these analyses because the anonymous responses could not be matched with individual students' test and observation scores. Correlation findings were interpreted cautiously because of the limited sample size and the nonexperimental research design.

Ethical Considerations

The research was conducted with permission from the principal of SMP Negeri 2 Subah and with the cooperation of the participating teachers. Student participation was voluntary, and permission was also obtained from the students' homeroom teachers. Participants' identities were kept confidential, and the collected data were used exclusively for research purposes.

RESULTS AND DISCUSSION

Results

The scientific literacy and environmental concern profiles of junior high school students were examined through multiple-choice testing, classroom observations, and questionnaire responses. The findings encompass instrument validity and reliability, scientific literacy performance across competency dimensions, environmental concern reflected in students' attitudes and behaviors, and exploratory associations among the assessed measures. Descriptive and psychometric statistics are presented in tables, complemented by figures illustrating score distributions and differences across the measured dimensions.

Instrument Validity and Reliability

Item–total correlation analyses were reported for the 10-item scientific literacy observation instrument and the five-item environmental concern observation instrument. The item validity results are summarized in Tables 1 and 2. These results concern empirical item–total associations and do not independently establish content or construct validity.

Table 1. Item Validity Results for the Scientific Literacy Observation Instrument (n = 32)

Item	Pearson r	p-value	Status
1	.774	< .001	Valid
2	.515	.003	Valid
3	.817	< .001	Valid
4	.904	< .001	Valid
5	.770	< .001	Valid
6	.891	< .001	Valid
7	.871	< .001	Valid
8	.791	< .001	Valid
9	.819	< .001	Valid
10	.914	< .001	Valid

All 10 observation items showed significant positive item–total correlations ($r = .515-.914$; $p \leq .003$). Item 2 had the lowest reported correlation, and Item 10 the highest. Taken descriptively, the reported correlations were positive across the full set of indicators. The item-level correlations support the authors' item-retention decisions under the criterion used, but they should not be treated as evidence that all dimensions of the underlying construct have been validated.

The five-item environmental concern observation instrument was also examined for item validity. The correlation coefficients and significance levels for its individual indicators are reported in Table 2.

Table 2. Item Validity Results for the Environmental Concern Observation Instrument (n = 32)

Item	Pearson r	p-value	Status
1	.889	< .001	Valid
2	.481	.005	Valid
3	.867	< .001	Valid
4	.748	< .001	Valid
5	.815	< .001	Valid

All five reported correlations were positive and statistically significant ($r = .481-.889$; $p \leq .005$). These findings are consistent with the item selection criterion reported in the study.

The lowest coefficient was observed for Item 2, while Item 1 had the highest. No item in this five-item set was reported as failing the significance threshold, although the correlations do not address agreement between independent observers.

Following the item analyses, internal consistency was evaluated for the reported instruments. Table 3 presents the available Cronbach's alpha coefficients and the numbers of items to which they were assigned in the original Results.

Table 3. Reported Internal Consistency Coefficients

Instrument identified in original Results	Items	Cronbach's α
Scientific literacy observation instrument	10	.937
Environmental concern observation instrument	5	.807
Environmental concern questionnaire	16	.71

Table 3 reports alpha coefficients of .937 for the 10-item instrument and .807 for the five-item instrument, as labeled in the original Results. The environmental concern questionnaire was reported to have an alpha coefficient of .71 for its 16 items. Each coefficient exceeds .70, although item-level performance also requires consideration.

The observed item–total correlation evidence and reliability coefficients describe different aspects of instrument performance. The association of the .937 and .807 coefficients with specific instruments remains inconsistent across the source manuscript and requires confirmation from the original output.

Scientific Literacy Test Results

Scientific literacy test scores were interpreted against the school's Learning Objective Achievement Criteria (KKTP = 70). Table 4 presents the descriptive results and corresponding achievement frequencies.

Table 4. Descriptive Statistics of Scientific Literacy Test Scores (n = 32)

Test	Mean	SD	Min	Max	Below KKTP, n (%)	At/above KKTP, n (%)
Multiple choice (10 items)	51.25	12.38	20	80	29 (90.6)	3 (9.4)

Note. Scores are reported on a 0–100 scale; KKTP = 70.

The mean test score was 51.25 (SD = 12.38), with scores ranging from 20 to 80. Twenty-nine students (90.6%) scored below 70 and three students (9.4%) reached or exceeded the criterion. The mean was 18.75 points below the KKTP.

The difference of 18.75 points between the sample mean and the KKTP complements the student-level attainment frequencies. Thus, limited test performance was apparent in the group average as well as in the distribution of students meeting the criterion. The score distribution provides a complementary view of the descriptive results by showing how individual scores were spread around the KKTP threshold. Figure 1 displays the frequency of multiple-choice test scores at each reported score level.

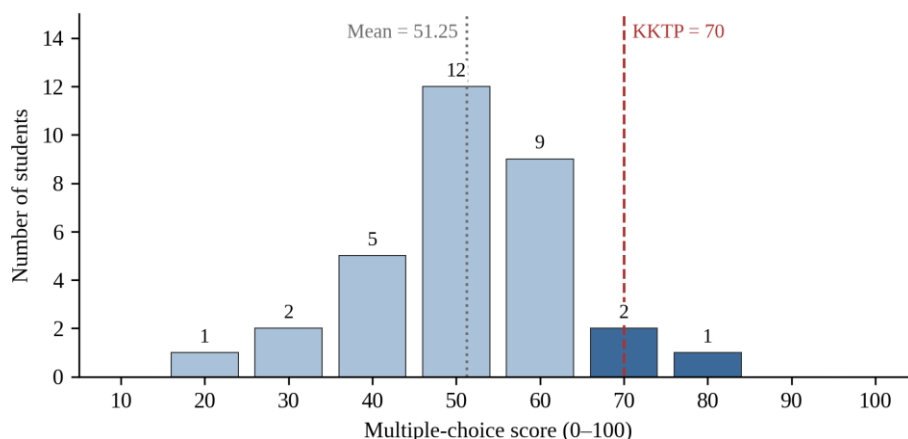


Figure 1. Distribution of Students' Multiple-Choice Scores Relative to the KKTP

Figure 1 displays the unequal distribution of students above and below the achievement criterion, with the larger group falling below the KKTP. The histogram also shows that attainment at the criterion was relatively uncommon in this sample. The figure is descriptive and does not establish the reasons for the students' score distribution.

Scientific Literacy Observation Results

Observed scientific literacy was summarized across four dimensions, comprising the three scientific competencies and an additional scientific attitudes domain. Table 5 presents the dimension-level results.

Table 5. Observed Scientific Literacy Performance Across Dimensions (n = 32)

Dimension	Mean (1–4)	% maximum	Category
Explaining phenomena scientifically (1–2)	2.19	54.69	Low
Evaluating and designing inquiry (3–4)	1.81	45.31	Low

Dimension	Mean (1–4)	% maximum	Category
Interpreting data and evidence (5–7)	1.67	41.67	Very low
Scientific attitudes (8–10)	1.76	44.01	Low
Overall (10 indicators)	1.83	45.70	Low

The overall observed mean was 1.83 (45.70% of the maximum). Explaining phenomena scientifically had the highest dimension mean (2.19), whereas interpreting data and evidence had the lowest (1.67). All four dimension means were below the scale midpoint of 2.50.

Across dimensions, the observed mean for explaining phenomena exceeded that for interpreting evidence by 0.52 points. All four dimension means were below 2.50, the midpoint used for interpretation of the four-point ratings. To illustrate the ranking of the four observed dimensions relative to the midpoint of the rating scale, Figure 2 presents the corresponding mean scores graphically.

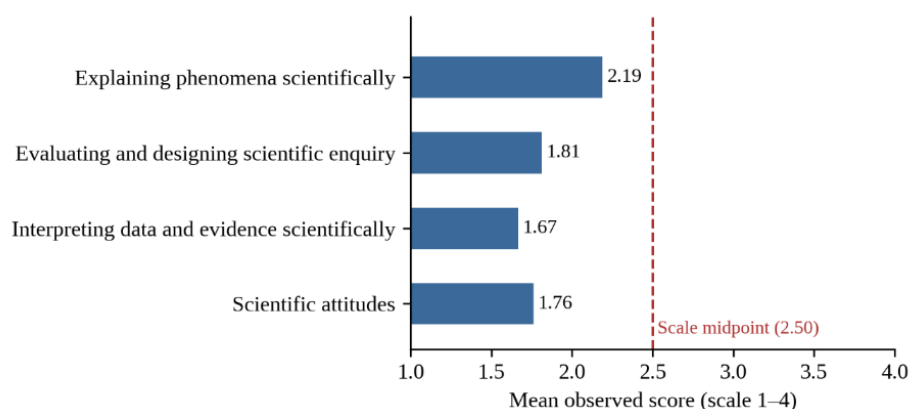


Figure 2. Mean Observed Scientific Literacy Score by Competency

Figure 2 illustrates the differences among observed dimensions. Interpreting data and evidence was the lowest-scoring dimension in this sample. The fourth domain, scientific attitudes, was included as a supplementary observation domain, while the other three dimensions aligned with the stated PISA scientific competencies. This distinction matters when interpreting the chart as a multidimensional classroom profile rather than a PISA subscale score.

Environmental Concern Questionnaire Results

The environmental concern questionnaire contained 16 items, including 13 positively and three negatively worded statements. Table 6 summarizes the 512 recorded responses according to wording direction.

Table 6. Distribution of Questionnaire Responses by Item Wording

Wording	Strongly disagree	Disagree	Agree	Strongly agree	Total
Positive (13 items)	12 (2.9%)	357 (85.8%)	33 (7.9%)	14 (3.4%)	416
Negative (3 items)	10 (10.4%)	10 (10.4%)	56 (58.3%)	20 (20.8%)	96
All items	22 (4.3%)	367 (71.7%)	89 (17.4%)	34 (6.6%)	512

Among positively worded items, 369 of 416 responses (88.7%) were Disagree or Strongly Disagree; among negatively worded items, 76 of 96 responses (79.2%) were Agree or Strongly Agree. Accounting for item wording, 445 of the 512 recorded responses (86.9%) were unfavorable. The questionnaire mean after reverse scoring was reported as 2.12 (SD = 0.24).

These counts refer to item-level responses, not the number or percentage of students classified as having low environmental concern. The predominance of unfavorable responses is consistent with the questionnaire mean below the scale midpoint. The contrast between positive and negative wording is displayed in Figure 3, which summarizes the proportional distribution of response categories before reversal of the negatively worded items.

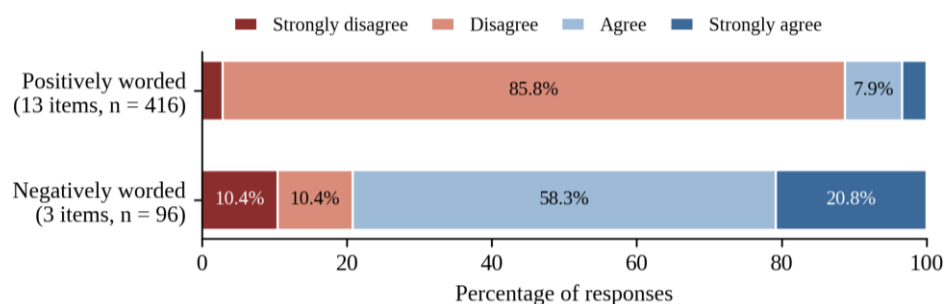


Figure 3. Distribution of Questionnaire Responses by Item Wording

Figure 3 illustrates the difference in unadjusted response frequencies between positive and negative wording. The item-level frequencies and psychometric results, previously in Appendix Table A1, are incorporated in Table 7.

The contrasting raw response directions underscore the need to account for statement wording before forming a total questionnaire score. The reported overall mean after reverse coding was 2.12 on the four-point scale.

To examine whether the aggregate response pattern was also evident across individual questionnaire statements, Table 7 provides the item-level frequencies, reverse-scored means, and corrected item–total correlations previously placed in Appendix Table A1.

Table 7. Item-Level Response Distribution and Psychometric Statistics of the Environmental Concern Questionnaire (n = 32)

Item	Wording	STS	TS	S	SS	Mean scored	Corrected item–total r
1	Positive	1	19	11	1	2.38	.22
2	Positive	2	23	3	4	2.28	.43
3	Positive	2	29	0	1	2.00	.66
4	Negative	2	1	25	4	2.03	.50
5	Positive	0	29	2	1	2.13	.02
6	Positive	3	27	1	1	2.00	.53
7	Positive	1	30	1	0	2.00	–.26
8	Negative	2	4	20	6	2.06	–.02
9	Positive	0	28	0	4	2.25	.28
10	Positive	0	26	6	0	2.19	.44
11	Positive	0	31	0	1	2.06	.72
12	Positive	1	30	1	0	2.00	.03
13	Positive	1	30	0	1	2.03	.72
14	Negative	6	5	11	10	2.22	.29
15	Positive	1	28	3	0	2.06	.28
16	Positive	0	27	5	0	2.16	.49

Note. STS = strongly disagree; TS = disagree; S = agree; SS = strongly agree. Items 4, 8, and 14 were reverse-scored. Overall $\alpha = .71$.

Item responses were concentrated in the Disagree category for many positively worded statements. Corrected item–total correlations varied from $-.26$ to $.72$. Items 7 and 8 had negative correlations ($-.26$ and $-.02$); Items 5 and 12 also had near-zero correlations ($.02$ and $.03$). These item-level results qualify the interpretation of the questionnaire's overall reliability.

For example, 31 of 32 students disagreed with Item 11, whereas 29 of 32 agreed or strongly agreed with the unfavorable statement in Item 4. These frequencies support the aggregated pattern but do not establish whether the statements capture distinct facets of environmental concern.

Environmental Concern Observation Results

Environmental concern observations covered five affective indicators. The score totals and means for each indicator are reported in Table 8.

Table 8. Observed Environmental Concern Across Affective Indicators (n = 32)

Indicator	Total score	Mean (1–4)	% maximum	Category
Receiving	76	2.38	59.38	Low
Responding	55	1.72	42.97	Very low
Valuing	70	2.19	54.69	Low
Organizing	51	1.59	39.84	Very low
Characterizing	50	1.56	39.06	Very low
Overall	302	1.89	47.19	Low

Note. The maximum possible score per indicator is 128 (32 students $\times$ 4).

The overall mean was 1.89 (47.19% of the maximum possible score). Receiving had the highest observed mean (2.38), followed by valuing (2.19); characterizing had the lowest (1.56). Responding, organizing, and characterizing were in the very low category.

The observed mean was 0.82 points higher for receiving (2.38) than for characterizing (1.56). The three lowest indicators involved an explicit response, organizing activity, or independent continuity of environmental behavior. Figure 4 provides a graphical comparison of the five observed affective indicators and makes the differences between receptive and behavior-oriented indicators more visible.

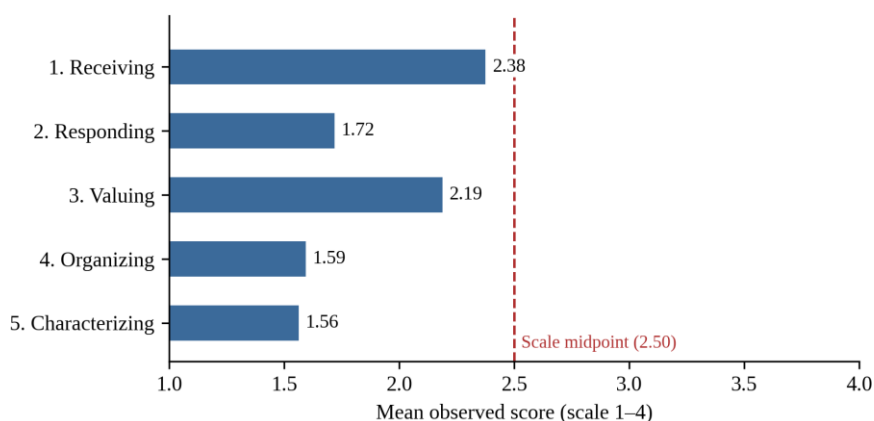
**Figure 4.** Mean Observed Environmental Concern Score by Indicator

Figure 4 shows higher mean ratings for receiving and valuing than for the indicators requiring environmental action, organization, or sustained practice.

All five indicators were scored on the same four-point range, so the ordering in Figure 4 reflects direct differences in their observed mean ratings. The diagram does not establish a developmental sequence for individual students.

Relationships Among the Measures

Three exploratory student-level correlation comparisons were reported for measures that could be linked for the same participants. Questionnaire responses were anonymous and were not included in these correlations. Table 9 reproduces the correlation values from Table 10 of the original manuscript.

Table 9. Exploratory Correlations Among Measures (n = 32)

Pair of measures	Spearman ρ	p	Pearson r [95% CI]	p
Multiple-choice – Observed environmental concern.	.32	.074	.20 [–.16, .51]	.267
Multiple-choice – Observed scientific literacy.	.62	< .001	.63 [.37, .81]	< .001
Observed scientific literacy – Observed environmental concern.	.72	< .001	.69 [.46, .84]	< .001

The correlation between multiple-choice scientific literacy scores and observed environmental concern was not statistically significant (Spearman ρ = .32, p = .074; Pearson r = .20, p = .267). Multiple-choice scores were positively correlated with observed scientific

literacy (Spearman $\rho = .62$, $p < .001$), while observed scientific literacy and observed environmental concern had a stronger positive association (Spearman $\rho = .72$, $p < .001$). The two correlations with $p < .001$ remained significant against a Bonferroni threshold of .0167 for three comparisons. The large association between the two observational scores requires caution because shared observation procedures or raters could contribute to their covariance.

The association between observed literacy and observed concern (Spearman $\rho = .72$, $p < .001$) was larger than that between the written literacy test and observed concern ($\rho = .32$, $p = .074$). Because observations of both constructs occurred in the same classroom context, the stronger correlation may partly reflect shared measurement conditions; this possibility cannot be quantified from the reported results.

DISCUSSION

The findings of this study provide evidence of limited scientific literacy and environmental concern among the participating junior high school students, while revealing differences across the competencies and behavioral dimensions assessed. The mean scientific literacy test score of 51.25, together with the finding that 90.6% of students did not meet the minimum learning achievement criterion, indicates substantial difficulties in demonstrating the scientific competencies represented by the assessment. The classroom observations similarly produced a low overall scientific literacy score, suggesting that limited performance was evident across both written assessment and observed learning activities. These findings are broadly consistent with previous studies reporting challenges in scientific literacy among Indonesian secondary school students, particularly in applying scientific knowledge to contextual problems (Anshar et al., 2023; Juwita et al., 2022; Ramli et al., 2022). International scholarship emphasizes that scientific literacy requires more than recalling scientific facts; it involves evaluating evidence, constructing explanations, and making informed judgments about issues involving science and society (Osborne, 2023; Sadler, 2004; Zeidler et al., 2005). However, the present findings should not be interpreted as evidence of the same proficiency levels measured by international large-scale assessments because the instruments and scoring procedures differ. Rather, they provide context-specific evidence that the participating students experienced difficulties with the scientific competencies represented in the study's assessment framework.

A more differentiated examination of scientific literacy revealed that explaining phenomena scientifically was the strongest observed dimension, whereas interpreting data and evidence scientifically was the weakest. This distinction is educationally important because explaining familiar phenomena and critically interpreting evidence require related but distinguishable forms of scientific reasoning. Scientific explanation involves applying conceptual knowledge to account for observable events, whereas evidence interpretation requires students to examine representations, identify relationships, evaluate the relevance of information, and draw defensible conclusions. The PISA scientific literacy framework explicitly recognizes data interpretation and evidence evaluation as central scientific competencies, emphasizing the ability to distinguish scientifically supported conclusions from unsupported claims (OECD, 2019). Research on socioscientific reasoning similarly demonstrates the importance of evaluating evidence, considering competing explanations, and justifying decisions when addressing complex scientific issues (Sadler, 2004; Sadler & Zeidler, 2005). In environmental contexts, these competencies become particularly relevant when students must interpret information about pollution, ecosystem changes, resource management, or the consequences of human activities. The lower observation score for evidence interpretation in the present study therefore identifies a dimension requiring closer educational attention. Nevertheless, the descriptive differences do not establish which instructional experiences produced the observed pattern, nor do they demonstrate statistically significant differences among the assessed dimensions.

Environmental concern demonstrated a similarly differentiated pattern across self-

reported responses and classroom observations. The questionnaire results indicated that 86.9% of recorded item responses reflected unfavorable environmental attitudes or behavioral tendencies after accounting for statement wording. The overall questionnaire mean of 2.12 was below the scale midpoint, while the observation instrument produced an even lower mean of 1.89. These results suggest that environmentally responsible attitudes and practices were not strongly represented within the measured domains. Previous studies have emphasized that environmental concern encompasses knowledge, attitudes, intentions, and behavior, which are related but conceptually distinct dimensions (Herlina et al., 2021; Qodriyanti et al., 2022). A meta-analysis involving children and adolescents demonstrated that environmental education can improve environmental knowledge, attitudes, intentions, and behavior, although the magnitude of improvement differs across these outcomes (van de Wetering et al., 2022). Research synthesizing environmental education outcomes has likewise emphasized that cognitive and affective achievements cannot automatically be equated with observable conservation behavior (Ardoin et al., 2018; Ardoin et al., 2020). The agreement between the questionnaire and observation results in their general classification is noteworthy, but the instruments did not provide directly interchangeable measurements. Consequently, their findings should be interpreted as complementary descriptions of environmental concern rather than evidence of precise agreement between individual students' reported attitudes and actual behaviors.

The environmental concern observations further showed that receiving and valuing were stronger than responding, organizing, and characterizing. This pattern is consistent with the conceptual distinction between recognizing environmental information and demonstrating sustained commitment through action. Within the affective domain, receiving concerns attention to relevant information, while valuing reflects the importance individuals assign to particular principles or practices. Organizing and characterizing involve the incorporation of values into priorities and the demonstration of relatively consistent behavior (Krathwohl et al., 1964). The relatively low scores for responding, organizing, and characterizing suggest that observable environmentally responsible practices were less evident than attention to and recognition of environmental issues. Environmental psychology provides a useful perspective on this distinction. Pro-environmental behavior depends not only on environmental awareness but also on perceived responsibility, behavioral opportunities, social expectations, and individuals' capacities to act (Bamberg & Möser, 2007; Hines et al., 1987; Kollmuss & Agyeman, 2002). Research focusing on young people's environmental engagement additionally emphasizes the importance of developing personal and collective competence through meaningful opportunities to participate in environmental action (Chawla & Cushing, 2007). These theoretical perspectives help contextualize the observed pattern, although the present study did not measure the psychological or social mechanisms necessary to determine why some affective indicators were lower than others.

The relationship between scientific literacy and environmental concern was more complex than the descriptive classifications of both constructs might initially suggest. Scientific literacy test performance was not significantly associated with observed environmental concern (Spearman $\rho = .32$, $p = .074$), whereas observed scientific literacy and observed environmental concern demonstrated a stronger positive correlation ($\rho = .72$, $p < .001$). This contrast indicates that conclusions about the relationship between the constructs depend partly on how they are operationalized and measured. Research on environmental behavior has consistently challenged the assumption that scientific or environmental knowledge independently produces environmentally responsible action. Environmental knowledge may contribute to behavior, but its relationship with action depends on the kinds of knowledge involved and on additional motivational, social, and situational conditions (Frick et al., 2004; Kaiser & Fuhrer, 2003; Steg & Vlek, 2009). Meta-analytic evidence further indicates that environmental attitudes, responsibility, and perceived behavioral control are relevant to

understanding environmentally responsible practices (Bamberg & Möser, 2007). Accordingly, the nonsignificant association between written scientific literacy performance and observed environmental concern should not be interpreted as evidence that the constructs are unrelated. Equally, the stronger correlation between observational measurements does not establish that scientific literacy promotes environmental concern, particularly because shared observation conditions or rater-related influences may contribute to the observed association (Podsakoff et al., 2003).

The differences among the assessment results also highlight the importance of measurement quality when interpreting multidimensional educational constructs. Written tests, self-report questionnaires, and classroom observations capture different forms of evidence and are subject to different sources of measurement error. Written assessments primarily reflect students' performance on specified cognitive tasks, whereas observation instruments are influenced by the opportunities available for demonstrating particular behaviors and by the criteria used by observers. Self-report instruments introduce additional concerns related to response interpretation, social desirability, and the correspondence between reported tendencies and actual behavior. In the present study, the environmental concern questionnaire yielded acceptable overall internal consistency (Cronbach's $\alpha = .71$), but several items demonstrated very low or negative corrected item-total correlations. These item-level findings suggest that the reported reliability coefficient should not be interpreted as evidence that every questionnaire statement functioned satisfactorily. The predominance of similar responses across several items also raises questions about the ability of the instrument to discriminate among participants with different levels of environmental concern. Moreover, the comparatively strong correlation between the two observation measures may partly reflect shared assessment conditions. Methodological research has demonstrated that common measurement sources can influence observed relationships between variables, making it important to distinguish substantive associations from measurement-related covariance (Podsakoff et al., 2003). The present findings therefore reinforce the need to interpret scientific literacy and environmental concern through their individual measurement characteristics rather than relying exclusively on composite scores.

From an educational perspective, the findings suggest the relevance of learning experiences that connect scientific reasoning with opportunities to examine and respond to environmental problems. The lower performance in interpreting scientific evidence points to the importance of activities in which students analyze environmental data, evaluate competing explanations, and justify decisions using scientific information. Meanwhile, the relatively weaker behavioral indicators of environmental concern suggest the value of providing opportunities for students to participate in planning, implementing, and evaluating environmentally responsible practices. Research on socioscientific issues education supports the integration of scientific evidence, ethical considerations, and reflective decision-making into learning experiences involving authentic societal problems (Sadler, 2004; Zeidler et al., 2005). Systematic reviews of environmental education also indicate that locally relevant issues, meaningful participation, and opportunities for action are important considerations when designing educational programs (Ardoin et al., 2020; Monroe et al., 2019). Evidence from meta-analyses further supports the potential of environmental education to improve students' environmental outcomes, while showing variation in effectiveness across educational contexts and outcome domains (van de Wetering et al., 2022). These findings provide a rationale for considering contextual, inquiry-oriented, and participatory environmental learning in future instructional development. Nevertheless, because the present study did not implement or evaluate a learning intervention, the effectiveness of such approaches cannot be inferred from its results.

The principal contribution of this study lies in presenting a differentiated profile of scientific literacy and environmental concern within the same junior high school context and

demonstrating the importance of distinguishing assessment modalities when interpreting their relationship. Rather than relying exclusively on overall achievement classifications, the findings identify specific areas in which students demonstrated comparatively weaker performance, particularly scientific evidence interpretation and behavioral dimensions requiring environmental action, organization, and consistency. The contrast between written-test and observation-based correlations also underscores the importance of separating cognitive performance from observed behavioral engagement. These findings extend the descriptive evidence available for understanding how scientific competencies and environmental dispositions are represented in school-based assessments, while remaining consistent with broader research recognizing the multidimensional nature of environmental learning (Ardoin et al., 2018; Kollmuss & Agyeman, 2002; van de Wetering et al., 2022). In the context of SMP Negeri 2 Subah, the resulting profile provides an empirical starting point for considering the development of science learning materials that connect evidence-based reasoning with environmental responsibility. The potential integration of environmental issues and local cultural practices in Batang Regency is conceptually relevant to this direction, but its educational value must be established through subsequent development and evaluation rather than assumed from the present descriptive findings.

CONCLUSION

This study examined the profiles of scientific literacy and environmental concern among junior high school students, revealing relatively low performance across the assessed cognitive, affective, and behavioral dimensions. The scientific literacy test produced a mean score of 51.25, with 90.6% of students failing to achieve the school's minimum learning achievement criterion (KKTP = 70). Classroom observations similarly indicated low scientific literacy ($M = 1.83$), with interpreting scientific data and evidence emerging as the weakest competency compared with explaining scientific phenomena. Environmental concern was also classified as low based on questionnaire responses ($M = 2.12$) and classroom observations ($M = 1.89$). Among the observed affective indicators, receiving and valuing demonstrated relatively higher scores than responding, organizing, and characterizing. These findings identify specific dimensions of scientific literacy and environmental concern that require educational attention within the participating school context.

The exploratory correlation analyses revealed that the association between scientific literacy and environmental concern differed according to the assessment approach. Scientific literacy test scores were not significantly associated with observed environmental concern (Spearman's $\rho = .32$, $p = .074$), whereas observed scientific literacy demonstrated a strong positive association with observed environmental concern ($\rho = .72$, $p < .001$). These differences emphasize the importance of distinguishing written scientific competency assessments from observational measures when interpreting relationships between cognitive performance and environmental behavior. The stronger association between observational measures may partly reflect shared assessment conditions, and neither correlation provides evidence of a causal relationship. Consequently, the findings do not establish that higher scientific literacy necessarily results in greater environmental concern.

The principal contribution of this study is the identification of differentiated scientific literacy and environmental concern profiles that extend beyond overall achievement classifications. The findings highlight the importance of examining scientific evidence interpretation alongside environmental attitudes and observable responsible behaviors within science education. In the context of SMP Negeri 2 Subah, these profiles provide an empirical basis for identifying learning needs and informing the development of contextual science learning materials that integrate evidence-based reasoning with environmental responsibility. However, the educational effectiveness of such materials remains to be investigated through subsequent research.

LIMITATION

Several limitations should be considered when interpreting the findings. First, the study involved only 32 purposively selected students from a single junior high school, limiting the generalizability of the results to broader student populations. Second, the scientific literacy test retained only 10 of the original 20 items following validity screening, potentially restricting coverage of the scientific competencies being assessed. Third, the observation instruments did not include reported inter-rater agreement estimates, making it difficult to establish the consistency of behavioral assessments across observers. Fourth, the environmental concern questionnaire exhibited highly concentrated response distributions, and several statements demonstrated weak or negative corrected item–total correlations, indicating potential limitations in item discrimination and measurement quality. In addition, the questionnaire was administered anonymously and could not be linked to individual test and observation scores, preventing its inclusion in student-level correlation analyses. The relatively strong association between the two observational measures may also have been influenced by shared measurement conditions. Finally, the descriptive, cross-sectional design did not examine potential explanatory factors or causal mechanisms; therefore, the results cannot establish why the observed competency and behavioral patterns occurred.

RECOMMENDATION

Future research should involve larger and more diverse student samples and employ scientific literacy and environmental concern instruments with stronger evidence of validity, internal consistency, and inter-rater reliability. Particular attention should be given to evaluating and refining questionnaire items with weak discrimination and ensuring that different assessment measures can be linked at the individual student level when appropriate ethical and confidentiality safeguards are maintained. In educational practice, the findings support consideration of contextual learning activities that strengthen scientific evidence interpretation while providing opportunities for students to engage in environmentally responsible actions, collaborative environmental planning, and sustained conservation practices. Integrating local environmental issues and cultural practices from Batang Regency into science learning materials represents a potentially relevant direction for instructional development. Subsequent studies should systematically develop, validate, and evaluate such materials to determine their effectiveness in improving scientific literacy and environmental concern rather than assuming their benefits from the present descriptive findings.

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AUTHOR CONTRIBUTIONS STATEMENT

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Restianingsih	✓	✓	✓	✓	✓	✓		✓	✓	✓			✓	
Sigit Ristanto		✓				✓		✓	✓	✓	✓	✓		
Muhammad Syaipul Hayat	✓		✓	✓			✓			✓	✓		✓	✓

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

INFORMED CONSENT

We have obtained informed consent from all individuals included in this study.

DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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