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The Feasibility of A Science Literacy Assessment Instrument Based on Bengkulu Local Wisdom for Elementary School Students

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Abstract

This study evaluates the theoretical and empirical feasibility of a science literacy assessment instrument integrated with Bengkulu's local wisdom, *Rimbo Larangan*, for elementary students. Using the R&D approach with the ADDIE model, the instrument was designed to align scientific literacy dimensions (context, competence, knowledge, and attitude) with local ecological values. Data were collected via expert validation and trials with 30 students, then analyzed using Aiken's V and descriptive statistics. Results show high theoretical feasibility with an Aiken's V index of 0.88 and inter-rater reliability of 0.87. Empirically, the instrument demonstrated high reliability (Cronbach's Alpha 0.89) and valid item distribution across varying difficulty levels. Analysis of student profiles revealed that while the local context significantly boosted scientific attitudes (78%), scientific competence (58%) remains a challenge, particularly in evidence-based reasoning. This study concludes that the *Rimbo Larangan*-based instrument is a feasible and valid tool for measuring science literacy contextually. It bridges the gap between school science and indigenous ecological knowledge, fostering both environmental awareness and critical thinking in elementary education.

Keywords: Science Literacy; Ethnopedagogy; *Rimbo Larangan*; Assessment Instrument; Elementary School.

INTRODUCTION

The development of science and technology in the 21st century demands human resources equipped with essential competencies, such as critical thinking, creativity, collaboration, communication, and scientific problem-solving skills. These competencies have become the primary pillars of various educational policies in Indonesia, particularly within the *Kurikulum Merdeka* (Lubis et al., 2023). In science education, these demands are realized through the strengthening of scientific literacy, the individual capacity to use scientific knowledge, identify questions, and draw evidence-based conclusions to understand natural

phenomena (OECD, 2023a). Therefore, developing scientific literacy from the elementary school level is crucial to enable students to navigate various environmental, health, and technological issues surrounding modern society.

However, this grand vision still clashes with field realities. Various international studies confirm that the scientific literacy of Indonesian students remains low. Data from the 2022 Programme for International Student Assessment (PISA) shows that Indonesian students' scientific literacy scores stagnated at 383, significantly below the OECD average of 485 (OECD, 2023b). This condition is exacerbated by suboptimal evaluation mechanisms at the primary education level. A study by Izzah et al. (2025) revealed that assessment instruments in elementary schools tend to measure only low-level cognitive skills (C1–C2), providing little room for students to explore scientific reasoning. Similarly, Ariani et al. (2025) found that teachers still face difficulties in designing phenomenon-based assessment instruments, which are the core of scientific literacy.

This gap aligns with McCarthy's (2021) findings, stating that assessments focusing primarily on factual mastery still dominate evaluation practices in elementary schools. Meanwhile, Fariza et al. (2025) showed that students' scientific misconceptions are formed and rooted from an early age. This proves that shallow assessments not only fail to measure student ability but also fail to detect conceptual barriers existing since the beginning of their education. Consequently, most Indonesian students only reach basic competency levels. They can recognize simple scientific facts but are not yet skilled in applying scientific concepts to analyze daily problems. The PISA report (2023a) emphasizes that this low scientific literacy is driven by rote-oriented learning, the lack of real-world context, and limited assessment instruments capable of measuring Higher Order Thinking Skills (HOTS). Based on these realities, transforming the science assessment system has become an urgent necessity to systemically improve the quality of learning in Indonesia. Comprehensive efforts to increase scientific literacy require the support of assessment instruments that measure not only content mastery but also process competencies and scientific attitudes. Assessment serves a strategic function as a means to map critical thinking, logical reasoning, and students' capacity to link scientific concepts with real-life contexts (Purnawati & Yakin, 2025). From the perspective of Education for Sustainable Development (ESD), effective assessment must reflect students' awareness of the reciprocal relationship between natural systems and human activities (Haya et al, 2025). Integrating global environmental issues into assessment

instruments is crucial, as these materials provide complex real-world contexts as core elements of scientific literacy.

Environment-based and ESD materials are ideal for developing scientific literacy due to their multidisciplinary and problem-based characteristics. This forces students not only to use science knowledge in isolation but also to apply scientific methods to evaluate data and explain earth sustainability phenomena (OECD, 2023a). Within the *Kurikulum Merdeka* framework, such authentic and contextual assessments allow teachers to holistically describe students' abilities to solve environmental challenges at both local and global levels. Therefore, developing valid and reliable science literacy assessment instruments based on environmental issues is a strategic step toward supporting meaningful science learning in elementary schools.

The importance of appropriate instruments is closely related to natural resource conservation materials in elementary school. This topic requires not only a conceptual understanding of ecosystems and biodiversity but also the ability of students to understand the impact of human activities on the environment. Ideally, assessments on this material should encompass critical thinking and evidence-based decision-making. In practice, however, evaluations used in elementary schools still tend to be questions that merely measure memory and simple conceptual understanding (Savika & Zuhriyah, 2024). Although several previous studies have attempted to develop scientific literacy instruments for ecosystem topics (Amanda & Rahmi, 2024), energy (Munif, 2022), or general environmental contexts (Martinah et al., 2022), most have not deeply addressed local wisdom. In fact, integrating local wisdom into assessments can help students understand scientific concepts more contextually, as it relates directly to the cultural environment they experience daily.

An approach that integrates local cultural values into learning is known as ethnopedagogy. This approach positions local wisdom as a relevant learning source for building scientific understanding while instilling cultural identity (Arma, 2024). Various empirical studies show that integrating local knowledge into the science curriculum significantly increases cognitive retention and student motivation (Putra & Wahyuni, 2025; Putrayasa, Suparya, & Winangun, 2026; Pratiwi & Setiawan, 2025). Research by Fiqry (2025) also confirms that students learning through cultural contexts show a higher increase in critical thinking skills compared to those using standard, decontextualized science materials. Ethnopedagogy excels in bridging the epistemic gap between school science and community knowledge. While conventional methods tend to be textual and rigid, the

ethnopedagogical approach transforms abstract concepts into concrete phenomena experienced by students. In science learning, local wisdom is used as a socio-scientific lens to explain natural phenomena and conservation practices. Therefore, developing science literacy assessment instruments based on local wisdom not only has the potential to improve literacy skills empirically but also strengthens environmental awareness as part of global responsibility.

In Bengkulu Province, this potential is clearly reflected in the *Rimbo Larangan* tradition. This tradition is a form of customary forest management preserved through generations via customary rules that prohibit tree felling and wildlife hunting. This practice contains strong ecological values related to environmental responsibility and ecosystem balance. From an educational perspective, the integration of *Rimbo Larangan* is not merely a cultural preservation effort but an effective strategy to improve the understanding of basic science concepts through a contextual approach. Through this local context, students can construct scientific knowledge by connecting empirical observations in their environment with ecological theories learned in class.

The values in *Rimbo Larangan* have a direct link to the dimensions of scientific literacy, particularly in the competencies of explaining phenomena scientifically and evaluating inquiry designs. This tradition provides real data for students to analyze human impact on biodiversity and the hydrological cycle, in accordance with the PISA framework. Thus, *Rimbo Larangan* can serve as a "conceptual laboratory" for elementary students to practice evidence-based decision-making regarding sustainability issues. Therefore, the development of assessment instruments based on *Rimbo Larangan* is highly relevant for measuring the extent to which students can apply scientific principles to solve local environmental problems. Despite its great potential, the utilization of *Rimbo Larangan* in scientific literacy assessment instruments remains very limited. Most previous studies still focus on developing teaching materials or learning models, while studies on assessment instruments based on local culture are still scarce. Furthermore, existing instrument development research generally emphasizes only content validity, whereas construct validity, which ensures alignment between indicators, scientific literacy dimensions, and test items has not been studied in depth.

Based on the descriptions above, the development of a science literacy assessment instrument based on local wisdom has become an urgent matter. The developed instrument is expected to measure students' abilities more contextually by linking natural resource

conservation with local cultural practices. The novelty of this research lies in the integration of Bengkulu's local wisdom, *Rimbo Larangan*, into an assessment instrument that covers the dimensions of context, competence, knowledge (content, procedural, and epistemic), and scientific attitudes according to the PISA framework. Additionally, this study conducts a comprehensive validation, both theoretically through experts (logical validity) and empirically through student trials.

Thus, this study aims to identify and describe the feasibility of a science literacy assessment instrument based on the Bengkulu local wisdom of "*Rimbo Larangan*" for fifth-grade elementary school students, reviewed from both logical and empirical validity. The results of this study are expected to provide a significant contribution to the availability of contextual, authentic science assessment instruments rooted in local values, supporting the improvement of students' scientific literacy while fostering concern for culture and the environment.

RESEARCH METHOD

This study is a Research and Development (R&D) project employing the ADDIE model, aimed at determining the feasibility of a science literacy assessment instrument based on the Bengkulu local wisdom of *Rimbo Larangan* for elementary school students. The feasibility of the instrument in this study is reviewed through two main aspects: logical (theoretical) validity and empirical validity. Logical validity was obtained through an expert judgment process, while empirical validity was derived from instrument trials with students. This approach is commonly used in educational instrument development research to ensure that the resulting tools possess high quality before being utilized to measure student performance. The instrument developed in this study consists of a science literacy test in the form of 10 essay items, structured according to the PISA science literacy framework, which includes the dimensions of context, scientific competence, knowledge (content, procedural, and epistemic), and attitudes toward science. All test items were developed by integrating the context of Bengkulu local wisdom, specifically the practice of preserving the *Rimbo Larangan* customary fores which is relevant to the topic of natural resource conservation in elementary school science education.

Logical or theoretical validity was obtained through a validation process by two experts who are lecturers in the Elementary School Teacher Education Study Program at the University of Bengkulu. The validators assessed the instrument's feasibility based on three

main criteria: material, language, and construct. The material aspect covers the alignment of questions with learning competencies, science literacy indicators, and the accuracy of the scientific concepts used. The language aspect evaluates sentence clarity, suitability for the linguistic development level of elementary students, and the correct use of the Indonesian language. Meanwhile, the construct aspect pertains to the alignment of the question format with science literacy indicators and the clarity of the stimulus and instructions. Validator assessments were conducted using a specific rating scale and subsequently analyzed using the Aiken's V index and Inter-rater Reliability. The Aiken's V index was used to determine the level of expert agreement on the feasibility of each instrument item (Aiken, 1985). Meanwhile, Inter-rater Reliability was employed to measure the level of agreement between evaluators in scoring the validated instrument. A higher inter-rater reliability value indicates a higher level of assessment consistency among the validators regarding the developed instrument.

After undergoing expert validation and being declared theoretically feasible, the instrument was then tested to determine its empirical feasibility. The instrument trial was conducted with 30 sixth-grade students at SD Negeri 05 Kota Bengkulu. The selection of sixth-grade students as trial subjects was based on the consideration that they had already studied the material on natural resource conservation, thus enabling them to understand the context of the questions. The data from the trial were then analyzed to determine the empirical quality of the items, including item validity, test reliability, discriminating power, and difficulty levels.

Items that met the criteria for validity, reliability, discriminating power, and appropriate difficulty levels were declared empirically feasible and could be used to identify the students' science literacy profiles. The scores obtained by each student were then converted into percentages using the following formula:

$$Score = \frac{Total\ Student\ Scores}{Total\ Maximum\ Scores} \times 100$$

(Ngalim, 2007).

The resulting values were categorized to determine the students' level of science literacy. The categories of science literacy abilities are shown in the following table 1.

Table 1. The categories of science literacy abilities

Percentage (%)	Category
86 – 100	Very High
76 – 85	High
60 – 75	Moderate
55 – 59	Low
≤ 54	Very Low

(Purwanto, 2019).

Through this categorization, students' science literacy skills can be analyzed systematically, providing an overview of their mastery levels in understanding natural resource conservation concepts contextualized through the *Rimbo Larangan* local wisdom.

RESULTS AND DISCUSSION

This study aims to develop and test the feasibility of a science literacy assessment instrument based on the Bengkulu local wisdom of *Rimbo Larangan* regarding natural resource conservation in elementary schools. The science literacy measured in this study refers to the PISA framework, which encompasses four main aspects: scientific attitude, context, knowledge, and scientific competence. The developed instrument consists of 20 items designed to measure students' ability to understand, analyze, and evaluate scientific phenomena related to environmental preservation through a local cultural context.

The instrument blueprint was prepared based on science literacy indicators including scientific attitudes, local contexts, types of knowledge (content, procedural, and epistemic), and science literacy competencies. Each item was designed using operational verbs from the Revised Bloom's Taxonomy at the cognitive levels of C4 (Analyzing), C5 (Evaluating), and C6 (Creating). Thus, the instrument is expected to measure Higher Order Thinking Skills (HOTS). The developed items also feature instrument attributes consisting of knowledge types, science literacy competencies, context, and cognitive demands. These four components are integrated so that each question measures not only the understanding of science concepts but also the students' ability to link those concepts with real-world phenomena. Examples of these attributes can be seen in Table 2, which displays a sample question based on the *Rimbo Larangan* context along with its solution and assessment rubric.

Table 2. Attributes of the Developed Assessment Instrument

Category Framework	Question (Reading and Item)	Solution	Assessment Rubric	
			Answer Criteria	Score
Knowledge Type: Content	DOES RIMBO LARANGAN HELP REDUCE THE IMPACT OF CLIMATE CHANGE?	<i>Rimbo Larangan</i> helps reduce climate change because forests absorb carbon dioxide from the air through photosynthesis. By reducing carbon dioxide in the atmosphere, the greenhouse effect is mitigated, preventing drastic increases in earth's temperature.	Explaining the forest's function in absorbing carbon dioxide	1
Science Literacy: Competence- Interpreting evidence and data scientifically	In several areas of Bengkulu, there are customary forests called <i>Rimbo Larangan</i> . People are prohibited from logging indiscriminately in these areas. This forest is protected by customary rules to remain sustainable. Forests have many functions for the environment, including maintaining water sources, providing habitats for various living things, and absorbing carbon dioxide from the air.	Additionally, the forest maintains ecosystem balance, water availability, and prevents environmental damage such as landslides and floods.	Explaining the relationship between forest conservation and climate change	1
Context: Local- Environmental and cultural preservation	Carbon dioxide is a greenhouse gas that causes global warming. If the forest is damaged by illegal logging, environmental temperatures may rise, soil becomes prone to landslides, and water availability decreases.		Explaining the impact of forest destruction on the environment	1
Cognitive Demand: High (HOTS)	Question: Based on the text, explain how <i>Rimbo Larangan</i> can help reduce the impact of climate change!		Linking the preservation of <i>Rimbo Larangan</i> with climate change mitigation efforts	1
			Maximum Score	4

The developed science literacy assessment instrument underwent a logical (theoretical) validity test. This validation was conducted by two experts, lecturers from the Elementary School Teacher Education Program at the University of Bengkulu. The process aimed to assess the instrument's alignment with material, construction, and language aspects. The experts' assessments were analyzed using the Aiken's V index to determine the level of agreement on feasibility. Additionally, an inter-rater reliability analysis was performed to measure assessment consistency between validators. The results are presented in Table 3.

Table 3. Results of Logical Validity

Assessment Aspect	Aiken's V Value	Category
Material	0.89	Very Valid
Construction	0.87	Very Valid
Language	0.90	Very Valid

The analysis shows that all aspects obtained an Aiken's V value above 0.80, placing them in the "Very Valid" category. This indicates that the instrument meets the feasibility criteria for material suitability, item construction, and language use. Furthermore, the inter-rater reliability analysis showed a coefficient of 0.86, categorized as High Reliability. This value signifies a high level of agreement between the two validators, suggesting that the assessments are consistent and reliable. Despite being declared very valid, the validators provided several suggestions for improvement. Regarding material, validators suggested enriching question stimuli with more engaging visuals, such as images, graphs, or simple data related to the condition of the *Rimbo Larangan* forest. They also recommended emphasizing the link between forest conservation and climate change to clarify the scientific context. In terms of construction, validators suggested a neater, more systematic layout to help students read and understand questions. Some items were also revised to clarify instructions and avoid ambiguity. Regarding language, validators suggested simplifying sentences to align with the linguistic development of elementary students and ensuring proper punctuation to prevent misunderstandings. Following the revisions, the instrument was tested on 30 sixth-grade students. Empirical analysis using Pearson Correlation showed that 19 items were valid, while 1 item was invalid and excluded from further analysis. Reliability testing using Cronbach's Alpha yielded a value of 0.89 (High Reliability), indicating strong internal consistency. Discriminating power analysis showed 6 items were "Very Good," 8 were "Good," 4 were "Fair," and 2 were "Poor." The difficulty level analysis revealed 5 "Easy" items, 10 "Medium" items, and 5 "Hard" items. This distribution shows a good variety of difficulty levels for comprehensive measurement.

The empirically feasible items were then used to analyze the science literacy profiles of 28 fifth-grade students. The results are shown in Figure 1.

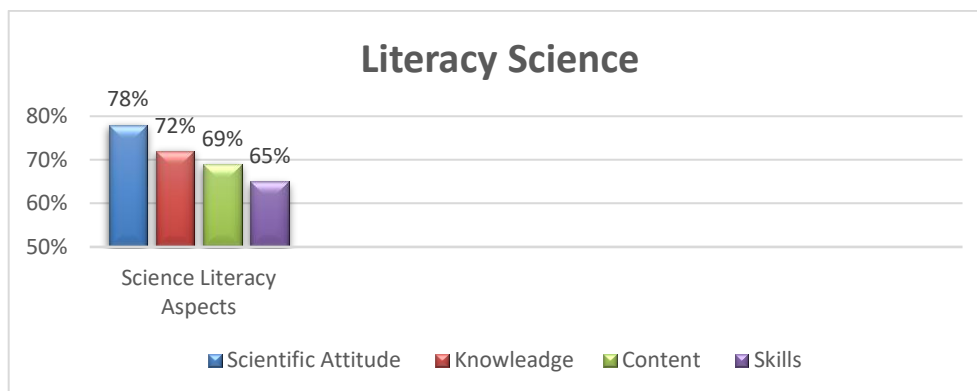


Figure 1. Percentage Diagram of Science Literacy Results

The results of the students' scientific literacy profiles (Figure 1) reveal a contrasting distribution between affective and cognitive aspects. The highest achievement in the scientific attitude (78%) dimension indicates that the use of the "Rimbo Larangan" local context successfully resonated with the students' emotional and environmental ethics. This integration of local wisdom is not merely a decorative element of the assessment but plays a vital role in building character and environmental awareness from an early age (Arma, 2024). When students are presented with traditional values they recognize, a sense of belonging emerges, triggering natural curiosity. This aligns with the views of Septina et al. (2025), who suggest that cultural attachment strengthens students' intrinsic motivation in learning science. Furthermore, local wisdom serves as an "epistemological bridge" that minimizes student resistance to scientific concepts often perceived as foreign or overly theoretical (Fiqry, 2025), thereby providing a clearer contextual understanding of the natural phenomena in their surroundings (Putrayasa et al., 2026).

Conversely, the lowest score in scientific literacy competence (58%), particularly in the indicator of interpreting data and evidence scientifically, uncovers a serious cognitive gap. Students remain trapped at a factual understanding level and struggle when required to engage in Higher Order Thinking Skills (HOTS). The students' difficulty in linking scientific variables, such as the correlation between tree density and the stability of the hydrological cycle, suggests that scientific cause-and-effect logic has not yet been established as strongly as their cultural intuition. This condition is often exacerbated by persistent misconceptions regarding basic science concepts, which require structured remediation strategies to avoid hindering understanding at subsequent educational levels

(Amrullah et al., 2025; Fariza et al., 2025). This low competence also serves as a "yellow flag" for the education sector, confirming that classroom practices are still dominated by one-way information transfer or teacher-centered approaches, which provide insufficient space for students to practice science process skills (Purnawati & Yakin, 2025).

In the knowledge dimension, the fact that mastery of content knowledge outperformed epistemic knowledge indicates that students are more familiar with "what" is known than "how" that knowledge was acquired. Students may know that forests produce oxygen, yet they falter when asked to explain the inquiry process or the validity of a scientific claim. Therefore, an epistemological reconstruction of scientific literacy is required; science education must not only teach products but must be based on inquiry processes rooted in local culture (Fiqry, 2025). To overcome classroom rigidity, the use of outdoor learning methods in areas like Rimbo Larangan can be an effective solution. Learning directly within a real ecosystem allows students to experience scientific phenomena firsthand, which is empirically proven to improve scientific literacy in ecosystem materials compared to merely reading texts (Amanda & Rahmi, 2024).

The integration of Rimbo Larangan into this instrument tangibly proves that ecosystem topics framed within local wisdom can significantly enhance students' conservation awareness (Haya et al., 2025). In the modern era, learning innovations based on local wisdom are becoming crucial. This approach not only equips students with technical knowledge but also with 21st-century skills relevant to global demands (Pratiwi & Setiawan, 2025; Lubis et al., 2023). This is consistent with global scientific literacy research trends, which are shifting from rote memorization toward real-world application capabilities as standardized by PISA (Ariani et al., 2025; OECD, 2023b).

Furthermore, the development of local context-based assessment items is a concrete response to the needs of teachers for evaluation instruments that support Education for Sustainable Development (ESD). Teachers require tools that do not merely test memory but also evaluate students' readiness to maintain the sustainability of the Earth (Ardellea & Hamdu, 2022; Rakhmayani & Hamdu, 2021). By highlighting the potential of customary forests as a subject of study, this instrument provides a more authentic portrait of scientific literacy (Astari et al., 2025). Such authentic assessment excels in detecting students' ability to apply scientific logic to solve real-world problems in their environment (McCarthy, 2021). In conclusion, the Rimbo Larangan-based instrument is not only statistically proven through high validity and reliability but also functions as a cognitive framework that unites cultural

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ethics with scientific rationality. Integrating local wisdom into science learning is not just an effort to preserve culture; it is a strategic key to fostering a future generation of Indonesians who are scientifically literate, critical thinkers, and environmentally wise (Putra & Wahyuni, 2025).

CONCLUSION

The development of the *Rimbo Larangan*-based science literacy instrument proves that ethnopedagogy is a vital bridge for connecting abstract scientific concepts with the tangible socio-cultural realities of elementary students. While the instrument achieved high logical and empirical validity (Aiken's V 0.88; Alpha 0.89), the findings offer a deeper reflection on the current state of science education: students possess a high emotional affinity and ethical concern for their local environment, yet they still struggle with the cognitive rigors of scientific reasoning and data interpretation. This disparity suggests that while local wisdom successfully fosters a "scientific attitude," it must be paired with more robust inquiry-based learning models to elevate "scientific competence." Therefore, the transformation of assessment must be followed by a pedagogical shift toward contextualized, phenomenon-based instruction. Future research should focus on developing digital-based adaptive assessments and longitudinal studies to examine how diverse cultural backgrounds influence the development of higher-order thinking skills across different regions.

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