JPII 14 (1) (2025) 93-101

Jurnal Pendidikan IPA Indonesia

https://journal.unnes.ac.id/journals/jpii

JUNIOR HIGH SCHOOL STUDENTS' SCIENCE LITERACY SKILLS BASED ON THE NATURE OF SCIENCE LITERACY TEST (NOSLiT)

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DOI: 10.15294/jpii.v14i1.15739

Accepted: February 11th, 2025. Approved: March 29th, 2025. Published: March 30th 2025

ABSTRACT

Science literacy is a fundamental competency for students to engage with scientific issues and make evidence-based decisions. However, Indonesian students consistently rank low in international assessments such as PISA, revealing major gaps in their ability to understand and apply scientific concepts. This study aims to measure the science literacy skills of junior high school students using the Nature of Science Literacy Test (NOSLiT), which focuses on students' understanding of the nature and processes of science rather than solely content mastery. A descriptive quantitative method was employed with 150 ninth-grade students from five public junior high schools in Bombana Regency, Indonesia. The NOSLiT instrument, adapted to the Indonesian context, consists of 35 multiple-choice items across five science literacy domains. Results indicated that students' overall performance was categorized as very poor, with an average score of 39.7%. Key weaknesses were found in scientific thinking, societal application of science, and scientific methodology. These findings highlight a mismatch between current teaching practices and the demands of 21st-century science education. The study underscores the importance of integrating inquiry-based and contextually relevant pedagogy to enhance students' scientific reasoning, curiosity, and literacy. This research provides a foundation for curriculum development and targeted interventions aligned with Sustainable Development Goal 4 on quality education.

Keywords: NOSLiT instrument; science literacy; science learning

INTRODUCTION

Science literacy is widely acknowledged as a foundational competency in modern education (Kolstø, 2001; Hidaayatullaah, 2022; Herianingtyas & Wafiqni, 2023). It plays a critical role in enabling individuals to make informed decisions, solve problems, and engage responsibly with scientific and technological issues in society (Roberts & Bybee, 2014; Kayumova & Tippins, 2016; Ibda et al., 2023). In today's rapidly changing world, science literacy is not only essential for those pursuing scientific careers but also for every citizen who must navigate daily life in a society increasingly shaped by science and technology (Fortus et al., 2022; Fadilah et al., 2020; Sun & Chan, 2024). Therefore, improving students' science literacy has become a global educational priority, as reflected in frameworks such as the Programme for International Student Assessment (PISA) (Dorfman & Fortus, 2019; Ustun et al., 2022; Gerondio et al.., 2023).

One of the studies on science literacy skills that is currently only used as a reference to determine the quality of education in world countries is through the Programme for International Student Assessment (PISA) organized by the Organization for Economic Cooperation and Development (OECD). More than 400,000 15-year-old students from 79 countries participated in

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PISA 2018. China became the country with the highest average achievement in this program for the science category, with an average score of 590, while Indonesia only ranked 72 with an average achievement of 396 (Forbes et al., 2020). This condition indicates that the science literacy of Indonesian students is still very low (Zulaiha & Mulyono, 2020; Pangestu & Karnadi, 2020; Nugroho et al., 2023; Raehang et al., 2025). Therefore, more efforts are needed to identify and solve the problem of low achievement of science literacy in order to compete with other nations.

Previous research shows that the science literacy of students in Indonesia is still at an alarming level. According to Narut and Supardi (2019), students' science literacy in Indonesia is still low, impacting their ability to understand and apply scientific concepts in everyday life. The Program for International Student Assessment (PISA) 2022 placed Indonesia 62nd out of 81 countries in science literacy, scoring 415. This score decreased by 21 points from PISA 2018, which reached 436, while the international average only decreased by 12 points.

An appropriate evaluation instrument is needed to measure and understand students' science literacy levels. One of the instruments used is the Nature of Science Literacy Test (NOSLiT), developed by Carl J. Wenning. It consists of 35 multiple-choice and true-false questions to assess students' understanding of the nature of science (Ariyanti et al., 2016). Furthermore, Narut and Supardi (2019) mentioned that the factors causing low science literacy in Indonesia are traditional learning methods, lack of learning facilities and resources, and lack of teacher training.

While many previous studies have relied on general PISA-based science literacy instruments or national assessments, these often focus heavily on the content aspect—evaluating what students know rather than how they understand the nature of science itself (Fortus & Touitou, 2021; Grabau et al., 2022; Alivernini & Manganelli, 2015; Cheema, 2019; Wan et al., 2024). In contrast, science literacy is a multifaceted construct that includes epistemological understanding, scientific reasoning, and socio-scientific decision-making (Drechsel et al., 2011; Manakul et al.., 2023; Hanfstingl et al., 2024; Ustun, 2024). Meanwhile, according to Laslo and Baram-Tsabari (2021), science literacy is the knowledge and understanding of scientific concepts and processes to make personal decisions, contribute to cultural and community activities, and increase economic productivity. To fill this gap, the Nature of Science Literacy Test (NOSLiT) offers a distinct and valuable approach (Altun & Kalkan, 2021; Hellman et al., 2024; Coulthart et al., 2024). The NOSLiT emphasizes students' understanding of how science works, including scientific postulates, methods of inquiry, rules of evidence, and dispositions toward scientific reasoning (Ozkale & Erdogan, 2022). Unlike conventional content-based assessments, NOSLiT is designed to reveal students' conceptual grasp of the *process and philosophy* of science—elements that are often underrepresented in curricula and teaching practices.

The urgency to use NOSLiT in this study stems from its ability to identify deep-rooted conceptual challenges that hinder students' development of science literacy (Hung & Wu, 2024). As observed in the Indonesian educational context, science teaching is still dominated by rote learning and textbook-based approaches, with limited emphasis on inquiry, experimentation, or reflective understanding of science as a human endeavor (Lee, 2018; Stahl et al., 2024). This has contributed to the persistence of misconceptions and fragmented knowledge not easily captured by conventional testing formats.

Furthermore, although several existing instruments, such as PISA science items or TIMSS frameworks, address literacy to some extent, they often emphasize cross-disciplinary applications or large-scale comparisons rather than probing the philosophical and methodological dimensions of science literacy (Kamelia et al., 2022; Agustin, 2023). For instance, PISA focuses on applying scientific knowledge in real-world contexts and evaluating evidence, but it does not comprehensively assess students' understanding of scientific norms, the tentative nature of scientific theories, or how science interacts with societal values (Takda et al., 2023). In contrast, NOSLiT's structure aligns more closely with the "Nature of Science" (NOS) dimension emphasized by many science education theorists (Shaw et al., 2014), making it an ideal tool for evaluating students' foundational scientific thinking.

The benefits of using NOSLiT are particularly relevant for junior high school students in Indonesia. Early adolescence is critical for shaping scientific reasoning skills and attitudes (Kurniawan et al., 2020). However, most previous studies have focused on high school or university-level students, with limited attention given to junior high school students. This study contributes by applying the NOSLiT instrument to ninth-grade students, providing insight into their baseline scientific understanding before transitioning to higher education or vocational tracks. Empirically, this study also addresses a specific research

gap: the lack of culturally adapted diagnostic assessment tools that can measure the NOS dimension of science literacy in Indonesian students. Although Wenning's original NOSLiT was developed for Western education systems, this study has adapted it to reflect local contexts and cognitive demands, ensuring its relevance and accessibility to Indonesian students.

Thus, this study aims: (1) to describe the current state of science literacy skills among junior high school students in Bombana Regency using the NOSLiT instrument, and (2) to examine the specific domains within science literacy—such as scientific reasoning, societal application, and the nature of scientific inquiry—that present the greatest challenges for students. The study employs a descriptive quantitative approach involving 150 Grade 9 students across five public schools, with data collected and analyzed across five NOSLiT domains.

The NOSLiT was designed to assess students' understanding of the nature of science, an aspect that is often under-represented in the curriculum. Previous studies, such as by Fauzi and Widjajanti (2018), have focused more on mastery of science content and problem-solving skills. This gap suggests that research with the NOSLiT fills a gap by highlighting the importance of philosophical and methodological understanding of science rather than just factual content. Much previous science literacy research has focused on high school or college students. For example, Susongko et al. (2024) evaluated science literacy in teacher education students. Research using the NOSLiT in junior high school students fills a gap by providing insight into the development of science literacy at an earlier stage of education, which is crucial for early intervention. Several studies in the past five years have explored the effectiveness of specific learning approaches in improving science literacy. For example, Gani et al. (2024) examined the impact of inquiry-based learning on students' science literacy. If research with NOSLiT does not link test results to specific instructional approaches, this suggests a gap that future research could fill by evaluating how specific instructional methods affect students' understanding of the nature of science.

This gap analysis shows that research using the NOSLiT instrument uniquely contributes by emphasizing junior high school students' understanding of the nature of science. However, there are opportunities to extend the research by considering specific learning approaches, socio-cultural contexts, and 21st-century skills. Thus, future research can provide a more comprehensive understanding of the factors influencing science literacy and how to improve this ability.

By focusing on the Nature of Science through the NOSLiT framework, this research complements existing studies that use PISA-based instruments and contributes novel insights into students' conceptual understanding of science. In doing so, it supports curriculum developers, educators, and policymakers in identifying specific areas for pedagogical improvement. These findings are particularly significant in the context of Sustainable Development Goal (SDG) 4, which emphasizes quality education and the development of relevant skills for lifelong learning—including critical thinking, problem-solving, and science literacy (Kaloga & Reno, 2022; Demirci et al., 2024).

This research addresses an urgent need for more nuanced and culturally responsive science literacy assessments among Indonesian students. By leveraging the advantages of the NOSLiT instrument, the study offers a more comprehensive evaluation of students' scientific understanding, going beyond factual recall to examine their epistemological and inquiry-based competencies. The findings are expected to inform future instructional design, teacher training, and educational policy to cultivate a scientifically literate generation capable of contributing to national development and global citizenship.

METHODS

The method used in this research is descriptive, and it was conducted in five junior high schools in Bombana in the odd semester of the 2021/2022 school year. Data were collected through written tests consisting of 35 multiple-choice questions. Data analysis was carried out on each indicator. This research on science literacy skills used grade 9 students of public junior high schools as samples. The research subjects amounted to 150 students.

The main instrument in this study is a set of science literacy questions developed by Wenning called the Nature of Science Literacy Test (NOSLiT), which was adapted into Indonesian by Syarifuddin et al. (2023). NOSLiT consists of 35 multiple-choice items. Students' answers were also analyzed based on the partition to obtain the data processing results as an average percentage of each aspect of science literacy.

The questions on the role of science are subdivided into the indicators of identifying questions that can be answered through science investigations, understanding the nature of scien-

tific endeavor/activity, and understanding generic science concepts, following the characteristics of the aspects of science literacy reviewed by Rahayu and Masykuri (2018). Questions from thinking and working scientifically are divided into indicators of explaining natural phenomena, recognizing patterns, identifying research variables, asking critical questions about research design, and obtaining/evaluating conclusions based on evidence. Similarly, questions from the aspects of science and society are divided into indicators of applying scientific conclusions in everyday life, identifying scientific issues that underlie policy decisions, understanding the role of science in making decisions, and developing questions to assess the validity of scientific reports and questioning the source of scientific reports. Mathematics and science questions are grouped into indicators of using mathematics in science and understanding the application of mathematics in science.

The raw scores were converted to a scale of 100, and the average was categorized into the predicates of very poor to very good, following Fadilah's (2024) rules.

86% - 100	= Very Good
76% - 85%	= Good
60% - 75%	= Enough
55% - 59%	= Poor
≤ 54%	= Very Poor

Table 1. Score of Each Factor in Grade 9

Factors	Indicators	Statement number	Answer		Score		% per indicator	Description
			True	False	max per indicator	Per indicator		
The Role of Science	identify questions that can be answered through science investigations	1	64	86	450	180	40	Very Poor
		7	56	94				
		25	60	90				
	Understand the nature of scientific endeavor/activity	2	43	107	600	258	43	Very Poor
		3	49	101				
		31	86	64				
		32	80	70				
	explain natural phenomena	10	48	102	300	126	42	Very Poor
		11	78	72				
Think and work Scientifically	recognize patterns	4	58	92	300	114	38	Very Poor
		23	56	94				
	identify research variables	5	48	102	450	174	38,666667	Very Poor
		6	75	75				
		27	51	99				
	ask critical questions about the research design	24	52	98	450	194	43,111111	Very Poor
		26	56	94				
		33	86	64				
	derive/evaluate conclusions based on evidence	14	50	100	750	348	46,4	Very Poor
		15	50	100				
		29	103	47				
		34	62	88				
		28	83	67				

Science and Society	Apply scientific inference in everyday life	12	41	109	600	204	34	Very Poor
		13	46	104				
		18	49	101				
		21	68	82				
	Identify the scientific issues underpinning policy decisions	16	44	106	450	131	29,111111	Very Poor
		17	41	109				
		35	46	104				
	Understand the role of science in making decisions	19	55	95	600	163	27,166667	Very Poor
		20	42	108				
		22	41	109				
		30	25	125				
Math and Science	Use maths in science	9	75	75	150	75	50	Poor
	Understand the application of maths in science	8	59	91	150	59	39,333333	Very Poor
	Total		2026	3224	5250	2026	38,590476	Very Poor

RESULTS AND DISCUSSION

Table 2 summarizes the research results on the science literacy achievement of junior high school students in Bombana Regency.

Table 2. Science Literacy of Junior High School Students in Bombana Regency

Aspects of Science Literacy	Research result	Percentage of Achievement
Scientific Thinking	Still relatively low	< 55%
Scientific Method	Not yet mastered well	< 55%
Math Ability	Low application of mathematical concepts in science	< 55%
Science and Society	The lowest indicator in science literacy	< 55%
Causes of Low Literacy	Learning methods do not support the science process	-

Table 2 illustrates that the achievement of science literacy of junior high school students in Bombana Regency is still low, especially in science and society. The main weaknesses are in the ability to think scientifically, the use of scientific methods, and the use of mathematics in science. One of the main causes of this condition is the learning method that does not empower students to apply the science process actively.

Based on a descriptive statistical analysis of 150 students, the average science literacy score was 38.6%, with a standard deviation of 13.7%. This shows that there is a fairly high spread of results among students in addition to the low average value. This variation in scores indicates an inequality in the mastery of science literacy, which internal student factors and the quality of learning received may influence. Furthermore, to determine whether there is a significant difference in science literacy skills between groups of students, a t-test was conducted on the two groups simulated based on the mean scores. The analysis showed that there was no statistically significant difference between the two groups ($t(148) = 1.31$, $p > 0.05$). This indicates that the low achievement of science literacy is evenly distributed among the observed groups, so learning improvements must be implemented as a whole.

A one-way ANOVA was conducted to examine differences in science literacy scores among students from five schools. The results revealed a statistically significant difference between the groups, $F(4, 145) = 2.87$, $p = .026$. Post hoc comparisons using Tukey's HSD indicated that students from School D scored significantly higher than those from School C ($p < .05$). These findings suggest that school-level factors such as teaching methods, learning resources, or teacher

competency may influence science literacy outcomes. Further investigation is needed to identify specific causes and address educational disparities across schools.

The role of science is to measure knowledge by identifying questions and understanding the nature of science. This aspect of the role of science needs to be mastered by students because it is universal. The aspect of the role of science consists of 2 indicators covering three items. It shows that in the aspect of the role of science, students who answer questions correctly are only 41.7%. Of the 150 students, 64 students answered question number 1, number 7 was answered by 56 students, and number 25 was answered by 60 students who answered the question correctly.

The above conditions arise because learning generally has not implemented inquiry-based learning, so students become unfamiliar with various science terms. In addition, the textbooks used as a reference for students are also still material-based, not based on experimental activities, so science terms are rarely found in them. According to Chen and Jordan (2024), the quality of learning, assessment, and textbooks will affect students' science literacy skills.

Aspects of scientific thinking and working are important observational and experimental skills that will be learned when science is taught and orientated towards inquiry in teaching and laboratory methods (Eaton et al., 2018; Babalola et al., 2023). Furthermore, it was explained that in the aspect of thinking and working scientifically, only 42.4% of students could answer correctly. The analysis conducted by the author still shows that students do not have good science literacy related to the ability to work scientifically or practically. The practicum carried out still cannot provide a thorough understanding of students. Students carried out the practicum only to complete the task without knowing each step's function.

Achievement in the aspect of science and society by Murti et al. (2018) only reached 30.1%. Some knowledge has not been acquired by students in terms of identifying, drawing a scientific conclusion, and understanding science. Several aspects of science literacy need to be improved regarding science and society, namely, students' ability to observe, analyze, and draw conclusions from data (Ayers, 2024).

Mathematics and science aspects are aspects related to the ability of students to accept evidence or facts that exist in the scientific process. The results obtained show that students can answer 44.6% of the questions. Some students have realized that truth in science needs to be believed if there is valid evidence. Murti et al. (2018) got pretty good results, around 56.65%. This indicator has the highest achievement among other indicators. Students in the 21st century understand several principles and knowledge regarding scientific claims that correlate cause and effect to form a scientific conclusion by testing and verifying all matters relating to the claim (Šmida et al., 2023). The more unconventional a claim is, the greater its requirement for supporting evidence; anecdotal evidence is inadequate evidence of any scientific claim (Scholes et al., 2021; Thomas & Drew, 2022).

Overall, several student achievements are still classified as very poor. The results are classified as very poor because the average score is less than 55% (Ariyanti et al., 2016). Unsatisfactory results can occur because the learning methods used do not follow the 21st century. In the 21st century, it is challenged to create education that can participate in producing thinking resources that can participate in building a knowledge-conscious social and economic order as befits citizens of the world in the 21st century (Wijaya et al., 2016; Çelik, 2018; Tamronglak, 2020; Kadir et al., 2024). Several learning methods can train students to use the scientific method in solving problems and performing science literacy during classroom learning (Wenning, 2006). Inquiry learning focuses on students as the center of learning. Students will ask questions, search for answers, and design research. This is done to answer the questions so that there is a discussion between students and teachers.

Through asking questions and seeking literacy, students will have more and more questions related to facts or phenomena experienced by students. The curiosity that arises will lead to efforts and ideas to prove that existing phenomena can be proven using the scientific method. The application of science literacy will be following the needs of students by sticking to the principles of science literacy, namely finding problems, seeking information and literacy, concluding problems, and deciding the best steps in dealing with problems (Muhammad et al., 2018).

The study's results on the low scientific literacy of junior high school students in Bombana Regency are closely related to quality education as one of the sustainable development goals (SDGs). These results indicate that the quality of science education is still not optimal, in line with the challenges in SDG 4 in ensuring that all students acquire relevant skills for the future, including critical thinking skills and science-based

problem-solving (Bello, 2020; Bertone et al., 2024). Less interactive learning methods are the main factor. Therefore, reinforcement is needed in inquiry-based learning strategies, experiments, and STEM (Science, Technology, Engineering, and Mathematics) approaches.

CONCLUSION

This study concludes that the science literacy skills of junior high school students in Bombana Regency are critically low, with an average NOSLiT score of 39.7%, indicating a "very poor" category. The lowest achievements were found in *science and society* and *scientific thinking*, highlighting students' limited understanding of how science operates within social contexts and their inability to engage in evidence-based reasoning. These findings underscore the urgent need for educational reform that moves beyond content memorization to promote a deeper epistemological understanding of science.

The Nature of Science Literacy Test (NOSLiT) provides significant insight into students' conceptual difficulties, particularly in interpreting scientific phenomena, understanding inquiry processes, and recognizing the role of science in everyday life. Unlike conventional assessments such as PISA, NOSLiT captures fundamental misconceptions and gaps in students' understanding of the nature and purpose of science—areas essential to 21st-century science literacy.

Therefore, to improve student outcomes, it is necessary to implement inquiry-based learning models that emphasize scientific reasoning, reflective thinking, and socio-scientific relevance. This research also demonstrates the importance of adopting diagnostic instruments like NOSLiT for curriculum evaluation and instructional improvement in alignment with the objectives of Sustainable Development Goal 4 (Quality Education).

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