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Profile Analysis of Scientific Literacy Skills in Terms of Competencies, Knowledge, and Attitudes

Yudhistian[1], Tabitha Sri Hartati Wulandari[1*]

[1] Biology Education Department, Teacher Training and Education Faculty, Universitas PGRI Ronggolawe, Tuban, Indonesia.

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Corresponding Author:
Tabitha Sri Hartati Wulandari
tabithawulandari7@gmail.com

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Abstract: The study aims to describe scientific literacy skills in terms of competencies, knowledge, and attitudes. This is a descriptive quantitative study using a scientific literacy skills questionnaire with three components, using a five-point Likert scale that has undergone validity and reliability testing and has been declared valid and reliable. Data were collected from 165 subjects and analyzed descriptively for interpretation and categorization. The results indicate that scientific literacy skills in terms of competencies fall within the moderate category (74.15%), knowledge in the moderate category (73.97%), and attitudes in the high category (78.22%). The study concludes that the highest level of science literacy is in terms of attitude, while the lowest level is in terms of knowledge. Consequently, the implications for educators are suggested in developing students' science literacy knowledge through learning resources that are integrated with scientific reading materials.

Keywords: Attitudes; Competencies; Knowledge; Scientific literacy skills

Introduction

Scientific literacy skills is an important ability and factual knowledge about science that develops over time and involves holistic and dynamic understanding (Kilag et al., 2023; Syofyan et al., 2025). van Antwerpen et al. (2025) describe scientific literacy skills as an individual's ability to understand and apply scientific concepts and develop scientific skills, including critically analyzing scientific claims and the factors influencing their validity. Mastery of scientific literacy skills reflects students' ability to scientifically solve everyday problems at the individual and community levels (Bakar et al., 2023). Several factors influence scientific literacy skills, including reading habits, learning motivation, creativity, students' attitudes toward science, and students' reading interests (Jannah et al., 2020; Mayasari & Usmeldi, 2023).

According to Sartika et al. (2023), in scientific literacy skills, PISA focuses on several components or areas of measurement. The components of scientific literacy skills that are equally important to master are competencies, knowledge, and attitudes. Competencies are a complex combination of knowledge, skills, understanding, values, attitudes, and desires that lead to practical human actions to meet complex demands (Kipper et al., 2021; Redman et al., 2021). Knowledge combines contextual information, expert experience, and values that can generate innovation and be expressed in language with specific norms and meanings (Bag et al., 2021; Liu, 2023). On the other hand, attitude refers to an individual's overall assessment of an object, such as oneself, other individuals, objects, issues, abstract concepts, policies, and so on (Fishman et al., 2021; Mao et al., 2021). In the context of scientific literacy skills, competencies relate to the application of skills and their use in scientific research activities; knowledge is needed to understand scientific concepts, principles, and processes; while attitudes toward science reflect feelings, curiosity, awareness of science, and beliefs and values held toward science learning activities in school, as well as their impact and application in society

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(Lieskovský & Sunyík, 2022; Mao et al., 2021; Seema, 2024; Yulianti et al., 2022).

Recent decades, the importance of improving scientific literacy skills has been increasingly emphasized by various parties, including scientists, science educators, and education policymakers, as a benchmark and key objective of science education from elementary school to university, reflected in student achievement standards in the Indonesian education curriculum (Almeida et al., 2023; Coppi et al., 2023; Hariyadi et al., 2023; Ifdaniyah & Sukmawati, 2024; Sukmawati & Zulherman, 2023). Scientific literacy skills are essential in the 4th Industrial Revolution era (Hariyadi et al., 2023). However, the fact is that scientific literacy skills among Indonesian students are generally still low (Asiyah et al., 2024). Sukmawati et al. (2022) stated that based on the results of the PISA 2021 test, Indonesia ranked 62nd out of 70 countries, indicating that Indonesian students' scientific literacy skills are still lacking. The results of the TIMSS (Trends in International Mathematics and Science Study) 2019 also show that Indonesia achieved an average score of 396 compared to the international average of 489, indicating that the level of scientific literacy skills among students in Indonesia is at the lowest level (Putri et al., 2025). Fadlilah et al. (2024) also reported that the level of scientific literacy skills among Indonesian students remains low.

Research has been conducted to analyze the level of scientific literacy skills in Indonesia, such as Agustya et al. (2023), who analyzed scientific literacy skills based on the competencies of high school students; Ashari et al. (2023), who analyzed the scientific literacy skills of junior high school students; Peni et al. (2022), who analyzed the scientific literacy skills of mathematics education students; and Suroso et al. (2021), who analyzed the scientific literacy skills of high school students. Based on the previous studies, it is evident that the analysis of scientific literacy skills levels in terms of competencies, knowledge, and attitudes, is still minimal. However, these three components need to be measured individually to determine the level of scientific literacy skills possessed by Indonesian students, which will be beneficial in daily life for making informed decisions and understanding global issues based on scientific evidence amid the rapid development of technology and information in the 21st-century. Therefore, this study is conducted with a novelty to analyzing the level of scientific literacy skills in terms of competencies, knowledge, and attitudes. The research question is: what is the level of scientific literacy skills in terms of competencies, knowledge, and attitudes? This study aims to describe the level of scientific literacy skills in terms of competencies, knowledge, and attitudes.

Method

The study is descriptive research using a quantitative approach that describes the level of scientific literacy skills in terms of competencies, knowledge, and attitudes. The research subjects were 165 eighth-grade students at SMP Negeri 4 Tuban who used scientific literacy skills in their daily science learning process. The research uses a questionnaire instrument comprising three main scientific literacy skills framework components: competencies, knowledge, and attitudes. These components were developed and adopted from PISA 2015 in Virtič (2022), as shown in Table 1.

Table 1. Components and Indicators for Measuring Scientific Literacy Skills

Component	Indicator	Indicator code
Competencies	Explaining phenomena scientifically	EPS
	Evaluating and designing scientific enquiry	EDS
	Interpreting data and evidence scientifically	IDS
Knowledge	Physical systems	PS
	Living systems	LS
	Earth and space systems	ESS
	Procedural knowledge	PK
	Epistemic knowledge	EK
Attitudes	Interest in science	IS
	Valuing scientific approaches to enquiry	VSA
	Environmental awareness	EA

Each indicator in the questionnaire contains three statements using a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree) (Ponsiglione et al., 2022). Each item in the statement was tested and refined before being used on the main research subjects. This was achieved by conducting a pilot study on 30 subjects separate from the main research subjects, which validated and assessed the reliability of the instrument using SPSS software. The validity test was conducted by comparing the calculated r value with the r value in the table and verifying the significance level obtained against the set significance level of 5%. In contrast, the

reliability test used Cronbach's Alpha, with a <0.5 (very bad) rating, 0.5-0. 6 (bad), 0.6–0.7 (medium), 0.7–0.8 (good), >0.8 (very good) (Noris et al., 2024). Table 2 shows that each statement item in the questionnaire is valid, while Table 3 shows that the statement items are reliable, making the instrument suitable for testing.

Table 2. Validity Test Results for Each Item on the Scientific Literacy Skills Questionnaire

Item code	Calculated r-value (table r-value = 0.361)	Sig. (2 tailed)	Interpretation
EPS1	.674	.000	Valid
EPS2	.638	.000	Valid
EPS3	.695	.000	Valid
EDS1	.796	.000	Valid
EDS2	.653	.000	Valid
EDS3	.627	.000	Valid
IDS1	.765	.000	Valid
IDS2	.747	.000	Valid
IDS3	.814	.000	Valid
PS1	.686	.000	Valid
PS2	.735	.000	Valid
PS3	.667	.000	Valid
LS1	.583	.001	Valid
LS2	.623	.000	Valid
LS3	.619	.000	Valid
ESS1	.746	.000	Valid
ESS2	.764	.000	Valid
ESS3	.669	.000	Valid
PK1	.762	.000	Valid
PK2	.646	.000	Valid
PK3	.686	.000	Valid
EK1	.725	.000	Valid
EK2	.657	.000	Valid
EK3	.592	.001	Valid
IS1	.393	.032	Valid
IS2	.499	.005	Valid
IS3	.451	.012	Valid
VSA1	.591	.001	Valid
VSA2	.555	.001	Valid
VSA3	.486	.006	Valid
EA1	.457	.011	Valid
EA2	.663	.000	Valid
EA3	.593	.002	Valid

Table 3. Reliability Test Results for each Item on the Scientific Literacy Skills Questionnaire

Item code	Cronbach's alpha	Interpretation
EPS1	.953	Reliable, very good
EPS2	.954	Reliable, very good
EPS3	.953	Reliable, very good
EDS1	.952	Reliable, very good
EDS2	.953	Reliable, very good
EDS3	.954	Reliable, very good
IDS1	.952	Reliable, very good
IDS2	.953	Reliable, very good
IDS3	.952	Reliable, very good
PS1	.953	Reliable, very good
PS2	.953	Reliable, very good
PS3	.953	Reliable, very good
LS1	.954	Reliable, very good
LS2	.954	Reliable, very good
LS3	.954	Reliable, very good
ESS1	.953	Reliable, very good
ESS2	.953	Reliable, very good
ESS3	.953	Reliable, very good

Item code	Cronbach's alpha	Interpretation
PK1	.953	Reliable, very good
PK2	.953	Reliable, very good
PK3	.953	Reliable, very good
EK1	.953	Reliable, very good
EK2	.953	Reliable, very good
EK3	.954	Reliable, very good
IS1	.955	Reliable, very good
IS2	.955	Reliable, very good
IS3	.955	Reliable, very good
VSA1	.954	Reliable, very good
VSA2	.954	Reliable, very good
VSA3	.955	Reliable, very good
EA1	.955	Reliable, very good
EA2	.953	Reliable, very good
EA3	.954	Reliable, very good

Data collection techniques were employed during the final science lesson, which lasted one session, by administering a questionnaire to assess students' scientific literacy skills. The questionnaire was distributed online via Google Forms by the researchers. Data analysis was performed using descriptive quantitative techniques using Equation 1.

$$\text{Percentage of scientific literacy skills} = \frac{\sum \text{obtained score}}{\sum \text{maximum score}} \text{ x } 100\% \quad (1)$$

The results of scientific literacy skills percentages obtained were then interpreted in Table 3, which was developed and adapted from Sholikah & Pertiwi (2021). The interpretation was carried out to group students with very high to very low levels of scientific literacy in terms of competencies, knowledge, and attitudes.

Table 4. Interpretation of Scientific Literacy Skills Score

Percentage range (%)	Category
86-100	Very high
76-85	High
60-75	Moderate
55-59	Low
0-54	Very low

Result and Discussion

The study's results describe the profile analysis of scientific literacy skills possessed by students. One hundred sixty-five subjects completed scientific literacy skills questionnaires, which were reviewed in terms of competencies, knowledge, and attitudes.

Scientific Literacy Skills in Terms of Competencies

Figure 1 shows the percentage groups of scientific literacy skills in terms of the competencies acquired by students as a whole. Based on Figure 1, it is known that the highest percentage of scientific literacy skills in terms of competencies achieved by students is in the moderate category, which is 44.85%. Meanwhile, the remaining percentages are grouped into four categories, namely high (42.42%), very high (8.48%), low (2.42%), and very low (1.82%) (Figure 1). The group of scientific literacy skills, in terms of competencies that are still relatively low, can be improved by providing learning strategies or models that can develop in terms of competencies in scientific literacy skills (Amini & Sinaga, 2021).

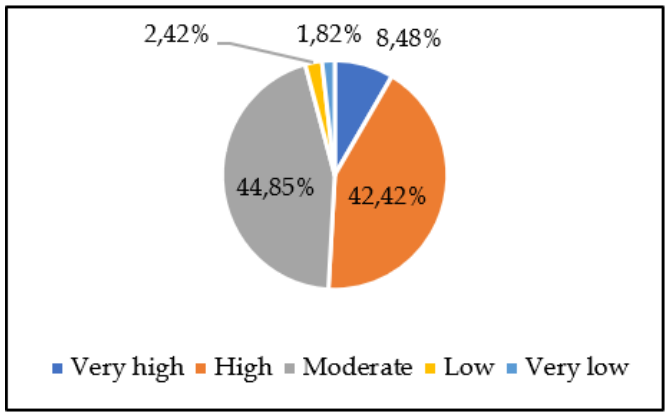

Figure 1. Scientific literacy skill percentage groups in terms of competency

Scientific literacy skills, as measured in terms of competencies, are assessed based on three indicators: explaining phenomena scientifically (EPS), evaluating and designing scientific inquiry (EDS), and interpreting data and evidence scientifically (IDS). Table 5 presents the level of scientific literacy skills, as measured in terms of competencies obtained by students.

Table 5 shows that the profile analysis results of students' scientific literacy skills in terms of competencies, are in the moderate category (74.15%). The standard deviation values obtained for all items in the competency review are also lower than the mean value per item, indicating that the data has a low level of variation and is homogeneous. All three indicators in the competency review fall into the moderate category.

Three items fall into the high category, while the remaining items fall into the moderate category. The moderate category achieved in scientific literacy skills in terms of competencies is due to the lack of practical activities and observation of natural phenomena in science learning. Most junior high school students only receive scientific theory rather than practical activities involving observing scientific phenomena, which results in a lack of skills in designing science experiments and interpreting observation data. Students who frequently memorize concepts rather than gain direct experience tend to poorly understand scientific principles (Rophi et al., 2024).

Table 5. Profile Analysis of Scientific Literacy Skills in Terms of Competencies

Indicator	Item	Mean	STDV.	Percentage (%)	Category
EPS	EPS1	3.91	0.71	78.18	High
	EPS2	3.75	0.74	75.03	Moderate
	EPS3	3.61	0.83	72.24	Moderate
			Mean	75.15	Moderate
EDS	EDS1	3.93	0.74	78.67	High
	EDS2	3.62	0.76	72.36	Moderate
	EDS3	3.81	0.78	76.12	High
			Mean	75.72	Moderate
IDS	IDS1	3.79	0.76	75.88	Moderate
	IDS2	3.44	0.82	68.85	Moderate
	IDS3	3.50	0.87	70.06	Moderate
			Mean	71.60	Moderate
		Overall mean		74.15	Moderate

The percentage score for the indicator explaining phenomena scientifically (EPS) is 75.15% (moderate), with the highest item percentage being EPS1 (78.18%) (Table 5). The moderate category for this indicator suggests that students face challenges and remain uncertain and confused when explaining natural phenomena based on relevant scientific principles and identifying factors that influence a scientific phenomenon. Students with misconceptions about natural phenomena may hinder their ability to accurately explain scientific concepts (Guerra-Reyes et al., 2024). In addition, students are still not entirely using scientific concepts to answer questions related to scientific phenomena in everyday life. Scientific uncertainty can stem from various factors, including cognitive barriers, misconceptions, and inadequate basic knowledge (Calvani et al., 2024). Furthermore, traditional teaching methods that often rely on memorization and lack of engagement with scientific uncertainty cause confusion among students (Chen et al., 2024; Zakwandi et al., 2024). Therefore, effective teaching is needed to encourage students to engage with scientific concepts through problem-based learning and reflection (Chen & Jordan, 2024).

The evaluating and designing scientific inquiry (EDS) indicator was used to measure scientific literacy skills, with an overall percentage of 75.72% (moderate) and two items falling into the high category (Table 5). However, the percentage obtained in the evaluating and designing scientific inquiry indicator shows that most students have doubts about designing valid experiments to test a hypothesis. Students are also confused in evaluating suitable research methods and identifying the control, independent, and dependent variables needed in scientific research. Variables are fundamental to scientific investigation and require proper definition for the success of research design and outcomes (Barillas, 2024). However, most students repeat scientific methods, confusing hypothesis testing and data interpretation (Vo & Simmie, 2025). Therefore, the scientific method can be applied as a learning approach to provide a structured approach to conducting investigations, emphasizing the importance of formulating and testing hypotheses (Campos & Pfister, 2023; Miller et al., 2023).

Interpreting data and evidence scientifically (IDS) is the indicator with the lowest percentage value in the competencies component for measuring scientific literacy skills, at 71.60% (moderate) (Table 5). Similar studies also demonstrate that students' ability to interpret data consistently yields relatively low results and requires intervention (Agustya & Jauhariyah, 2023; Ashari et al., 2023; Indasa & Jauhariyah, 2024). The lowest scores indicate that students still make errors in systematically reading and analyzing data from experimental results. Most students struggle to develop the critical analysis skills needed to interpret scientific data due to the lack of emphasis on the importance of data literacy in the current educational curriculum (Nugraha, 2023). Students also compare and draw conclusions based on available data with uncertainty. This is because students were found to use scientific evidence sparingly to support research findings. Data interpretation and concluding are related to higher-order thinking skills, so students require advanced analytical thinking skills and extensive knowledge of the concepts being studied to interpret readings and data (Yusnaeni et al., 2024).

Scientific Literacy Skills in Terms of Knowledge

Figure 2 presents the percentage groups of scientific literacy skills regarding students' in terms of knowledge. The largest group of students' scientific literacy skills in terms of knowledge is moderate, at 47.27% (Figure 2). Next is the high category, at 35.76%; very high, at 12.12%; very low, at 3.64%; and the low category, at 1.21% (Figure 2).

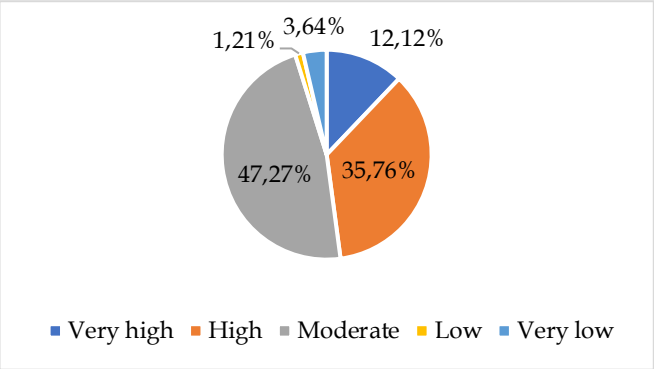

Figure 2. Scientific literacy skill percentage groups in terms of knowledge

Five indicators, including physical systems (PS), living systems (LS), earth and space systems (ESS), procedural knowledge (PK), and epistemic knowledge (EK), were used to measure scientific literacy skills in terms of knowledge. Table 6 presents data on measuring scientific literacy skills in terms of knowledge.

Table 6. Profile Analysis of Scientific Literacy Skills in Terms of Knowledge

Indicator	Item	Mean	STDV.	Percentage (%)	Category
PS	PS1	3.87	0.77	77.45	High
	PS2	3.73	0.71	74.55	Moderate
	PS3	3.64	0.88	72.73	Moderate
			Mean	74.91	Moderate
LS	LS1	3.88	0.81	77.70	High
	LS2	3.70	0.82	73.94	Moderate
	LS3	3.75	0.89	74.91	Moderate
			Mean	75.52	Moderate
ES	ESS1	3.90	0.72	77.94	High
	ESS2	3.83	0.73	76.61	High
	ESS3	3.72	0.82	74.42	Moderate
			Mean	76.32	High
PK	PK1	3.47	0.77	69.45	Moderate
	PK2	3.47	0.88	69.45	Moderate
	PK3	3.93	0.77	78.67	High
			Mean	72.53	Moderate
EK	EK1	3.52	0.87	70.42	Moderate
	EK2	3.55	0.81	70.91	Moderate
	EK3	3.52	0.79	70.42	Moderate
			Mean	70.59	Moderate
			Overall mean	73.97	Moderate

Students' scientific literacy skills in terms of knowledge were categorized as moderate (73.97%) (Table 6). Homogeneous data and low levels of variation were also evidenced by the standard deviation values of all items in the knowledge review, which were lower than the mean value per item. Four of the five indicators used to measure scientific literacy skills in terms of knowledge were categorized as moderate: physical systems, living systems, procedural knowledge, and epistemic knowledge. Meanwhile, one indicator falls into the high category, namely earth and space systems, making it the indicator with the highest percentage value in the knowledge review. The rarity of conducting practical activities or observing natural phenomena among junior high school students also directly impacts their limited procedural and epistemic knowledge. This causes a low level of scientific literacy skills in terms of knowledge, resulting in a moderate category. Students who are confused and unable to distinguish between epistemic and procedural knowledge indicate that their level of scientific literacy is unclear (Zetterqvist & Bach, 2023).

The percentage value obtained by the physical systems (PS) indicator falls into the moderate category (74.91%), with two items falling into the moderate category (PS2 and PS3) and one item falling into the high category (PS1) (Table 6). The results indicate that most students have not fully understood everyday physics concepts like Newton's laws. This adjusts to the discoveries of Mustofa et al. (2024), who famous that most understudies misconstrue Newton's laws, emphasizing the significance of getting a handle on essential material science concepts. Understudies are still questionable in clarifying vitality standards, its exchange in physical frameworks, and how sound and light waves work in different media. Most educators apply traditional teaching methods, often failing to foster a deep understanding of physics concepts, leading to ongoing difficulties even at advanced levels (Brundage et al., 2023). Therefore, knowledge of the physical systems indicator needs to be strengthened by educators. One approach that educators can take is to incorporate everyday examples and discussions about energy principles and improve understanding and retention of physical laws (Weber et al., 2024).

Similar to the previous indicator, the living systems (LS) indicator for measuring scientific literacy skills, as assessed by knowledge, achieved a moderate percentage score (75.52%), with two items classified as moderate (LS2 and LS3) and one item classified as high (LS1) (Table 6). The direct category demonstrates that most understudies require encouraging information to clarify how biological systems work and are connected with the environment. Effectively including understudies within the learning preparation environments can cultivate a more profound understanding of complex frameworks, making it imperative to address emerging natural issues (Gladwin & Ellis, 2024). Furthermore, the natural impacts caused by the life forms of living life forms, such as photosynthesis and distinguishing variables affecting the development and improvement of living beings, require enhancement. One step toward consolidating natural education into instruction is joining STEM into the learning demonstration, which has been demonstrated to improve students' understanding and states of mind toward the environment (Ramulumo &

Shabalala, 2024). Furthermore, students with higher species knowledge demonstrate increased environmental awareness, which impacts their understanding of ecological interactions and ecosystems (Härtel et al., 2023).

Unlike the previous two indicators on scientific literacy skills in terms of knowledge, the overall percentage of the earth and space systems (ESS) indicator reached the high category (76.32%), with two items reaching the high category (ESS1 and ESS2) and one item reaching the moderate category (ESS3) (Table 6). The achievement of the high category in the earth and space systems indicator shows a significant level of scientific literacy skills in terms of knowledge. Most students could explain how climate change occurs and the factors that influence it. Strong science standards in K-12 education are necessary to improve students' ability to engage critically with climate-related topics (Beaver et al., 2024). Students also demonstrated that they could explain the water cycle and its role in ecosystem balance well. Students' capability to clarify the water cycle illustrates their understanding of its vital part in adjusting the environment, which is also significant for advancing natural administration (Holt et al., 2024). Furthermore, accomplishing the tall category demonstrates that understudies have accurately caught on to how the development of firmament bodies influences life on the soil. The student's ability to explain how the movement of celestial bodies affects life on earth reflects a comprehensive understanding of scientific literacy (Islamiyah et al., 2024).

The measurement of scientific literacy skills in terms of PK or procedural knowledge reached the moderate category (72.53%), with two items in the moderate category and one in the high category (PK3) (Table 6). The moderate category achieved by the procedural knowledge indicator shows that most students still have difficulty using laboratory equipment safely and according to the procedure, following experimental procedures correctly to obtain valid results. Experimental equipment with an emphasis on safety is important to be done effectively. In any case, Kranz et al. (2023) famous that understudies frequently come up short of taking after-test methods precisely, driving them to invalid comes about. This highlights a hole in their procedural information. Understudies, moreover, stay reluctant to clarify the significance of controls in logical tests, underscoring the requirement for teachers to fortify information in procedural information markers. Uncertainty in explaining the role of controls in experiments indicates a lack of important foundations for scientific reasoning (Pedersen et al., 2025). The need for curriculum development that emphasizes procedural skills and provides hands-on experience to build confidence and competencies is an important educational implication to address the lack of procedural understanding (Kodikara et al., 2024).

Epistemic knowledge is an indicator for measuring scientific literacy skills with the lowest percentage value compared to other indicators, at 70.59%, and is classified as moderate (Table 6). Epistemic knowledge is important for students to master because it can foster critical thinking to understand the nature of scientific inquiry and the justification of scientific claims and enable students to evaluate the credibility of sources (Lee et al., 2024; Osborne & Allchin, 2024). The moderate category is further supported by the percentage scores of the three items under the epistemic knowledge indicator, all of which also fall into the moderate category (EK1, EK2, and EK3) (Table 6). The low percentage scores on the epistemic knowledge indicator indicate that most students have not fully understood and require further reinforcement of knowledge to explain how science develops based on empirical evidence, distinguish between theories and hypotheses in science, and explain how the scientific method is used to test scientific statements correctly. One improvement strategy that can be implemented is to emphasize science-based investigative and argumentative aspects in daily learning processes, focusing on the development of research-based thinking as the foundation of scientific thinking and implementing a curriculum that encourages independent scientific experimentation so that students can engage in experiment design, data collection, and analysis (Lee et al., 2024; McIntosh & Johnston, 2024; Salmento & Murtonen, 2019).

Scientific Literacy Skills in Terms of Attitudes

Scientific literacy skills in terms of attitudes obtained by students are grouped according to percentage and presented in Figure 3. Most scientific literacy skills in terms of attitudes obtained by students are in the high category (43.03%) (Figure 3). The remaining percentages are grouped into four categories: moderate (33.33%), very high (21.82%), very low (1.21%), and the smallest category, low (0.61%) (Figure 3).

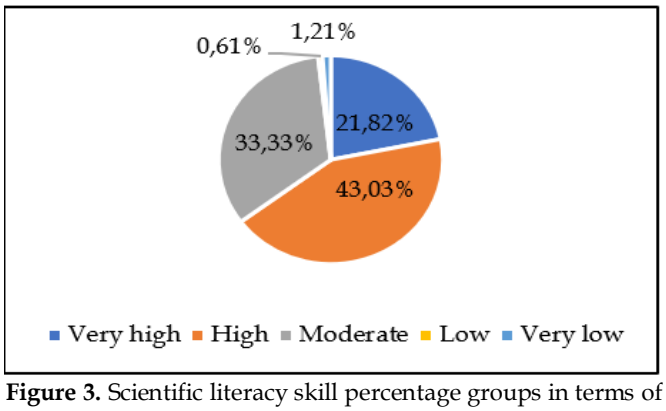

Figure 3. Scientific literacy skill percentage groups in terms of attitudes

Table 7 presents data on scientific literacy skills measured in terms of attitudes using three indicators, namely interest in science (IS), valuing scientific approaches to inquiry (VSA), and environmental awareness (EA).

Table 7. Profile Analysis of Scientific Literacy Skills in Terms of Attitudes

Indicator	Item	Mean	STDV.	Percentage (%)	Category
IS	IS1	3.76	0.83	75.27	Moderate
	IS2	3.83	0.82	76.61	High
	IS3	4.04	0.76	80.85	High
			Mean	77.58	High
VSA	VSA1	3.85	0.66	76.97	High
	VSA2	3.99	0.78	79.76	High
	VSA3	3.84	0.76	76.73	High
			Mean	77.82	High
EA	EA1	4.19	0.76	83.88	High
	EA2	3.76	0.77	75.15	Moderate
	EA3	3.94	0.76	78.79	High
			Mean	79.27	High
		Overall mean		78.22	High

As viewed from attitudes, scientific literacy skills have the highest percentage value compared to the other two components, 78.22%, reaching the high category (Table 7). This is also supported by the three indicators used to measure scientific literacy skills in terms of attitudes, all of which reached the high category (Table 7). Overall, the mean value obtained per item is also higher than the standard deviation value per item, indicating that the data obtained is homogeneous and has a low level of variation. The high level of scientific literacy skills in terms of attitude among junior high school students, which is 78.22% (Table 7), is because most of them have become accustomed to applying positive awareness and habits toward the environment, which has increased their interest in science and their appreciation of the scientific approach to observation. This is in line with Mohamad (2024), who state students who enjoy science learning and participate in direct investigation show a higher appreciation of the scientific method.

The high category with a percentage value of 77.58% was achieved by the interest in science (IS) indicator, with two items reaching the high category (IS2 and IS3) and one item reaching the moderate category (IS1) (Table 7). The high category achieved indicates that most students have shown a positive attitude toward science, such as being interested in learning more about the field of science, enjoying reading, and following the latest developments in science. Hunaepi et al. (2021) mention that a positive attitudes toward science is driven by curiosity, which motivates students, leading to increased attention and memory encoding, significantly impacting increased engagement and learning outcomes in science. Additionally, a scientific attitude that includes curiosity significantly influences academic success in various subjects (Mr & Gangrade, 2024). Students also demonstrate their enthusiasm for science by frequently asking questions about natural phenomena around them. A positive attitude toward science driven by curiosity can support initiatives to promote societal progress and knowledge toward a better and more beneficial perspective (Delugas et al., 2025; Sturgis et al., 2024).

The second indicator for measuring scientific literacy skills in terms of attitudes, is valuing scientific approaches to inquiry (VSA), which achieved a high category with a percentage score of 77.82% (Table 7). The high category achieved in this indicator is also supported by the three items, which also reached the high category (Table 7). The three items with a high category indicate that most students have a positive attitude, believing that the scientific method is the best way to understand the natural phenomena around them. A positive scientific attitude includes belief in the scientific method and viewing science as a social process and force that helps understand natural phenomena (Grinnell, 2019). This conviction is impacted by individuals' fundamental introduction to science and their recognition of scientists' validity (Wintterlin et al., 2021). Understudies have moreover demonstrated competencies in esteeming the significance of valid logical proof in making choices or drawing conclusions approximately an issue, subsequently maintaining a strategic distance from conclusions without a solid logical premise. This adjusts with Nasution & Chastanti (2023), who emphasize the significance of solid proof and a solid logical establishment in problem-solving and decision-making to maintain a strategic distance from unwarranted conclusions. A solid logical demeanor makes a difference in people recognizing sound logical claims from deception and empowers more enlightening open talk (Schweizer, 2023).

Environmental awareness (EA) was the indicator used to measure scientific literacy skills in terms of attitudes, with the highest percentage value compared to the other two indicators, at 79.27% and reaching the high category (Table 7). The environmental awareness indicator obtained two items that reached the high category (EA1 and EA3) and one that reached the moderate category (EA2) (Table 7). The highest percentage value achieved by the environmental awareness indicator proves that most students understand the importance of preserving the environment and ecosystems. Students also have environmental awareness by trying to reduce negative impacts on the environment in their daily lives. Students who actively participate in environmentally friendly activities demonstrate their understanding of

sustainable practices (Gupta et al., 2024). In addition, students also show a positive attitude by being interested in science-based solutions to overcome environmental problems. The findings of Mustofa & Sueb (2023) state that students who care about environmental awareness show a high commitment to overcoming environmental problems. Environmental understanding and awareness among students also directly influence school sustainability efforts, highlighting the importance of integrating environmental awareness into the educational curriculum (Hakim & Endangsih, 2023).

Conclusion

The study concludes that the highest level of science literacy is in terms of attitude, while the lowest level is in terms of knowledge. The study's findings indicate that students need a learning approach to improve and accommodate scientific literacy skills, especially regarding knowledge. The study implies for educators are suggested in developing students' science literacy knowledge through learning resources that are integrated with scientific reading materials.

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The authors declare no conflict of interest.

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