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Level of Scientific Literacy in Junior High School Students: Survey Research Based on Grade Level

Rotua Fetricia Silitonga[1], Nanang Winarno[2*], Lukman Hakim[3]

[1]PPG Prajabatan Bidang Studi IPA, Universitas Pendidikan Indonesia, Bandung, Indonesia

[2]Department of Science Education, Universitas Pendidikan Indonesia, Bandung, Indonesia

[3]Department of Physics Education, Universitas PGRI Palembang, Palembang, Indonesia

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*Corresponding author:
Nanang Winarno
Teuku Umar University
E-mail: nanang_winarno@upi.edu

Abstract

This research aimed to investigate the level of scientific literacy among junior high school students. The study used a quantitative approach with a survey design. A total of 152 participants, consisting of 90 female and 62 male students, were involved in the study conducted in Bandung City and Pekanbaru City. The instruments used in the research were adapted from the Scientific Literacy Test (SLT) and an open-ended question. Data analysis involved statistical tests supported by students' responses to the open-ended questions. The findings revealed that junior high school students' average scientific literacy level was 23.46, equivalent to 57.22% of the total SLT score, categorizing it as moderate. The average scientific literacy scores for students in grade 7, 8, and 9 were 23.00, 23.78, and 23.97, respectively. Statistical tests indicated no significant difference in junior high school students' average scientific literacy score ($p = 0.597$). The research noted lower scores on the Nature of Science (NOS) subscale (49.36%) compared to Scientific Concept Knowledge (SCK) subscale (67.30%). This highlights the need to enhance scientific literacy, particularly in NOS aspects, and suggests further investigation into factors influencing junior high school students' scientific literacy.

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INTRODUCTION

Education in the 21st century plays a crucial role in supporting the development of human resources quality, thus demanding education to prepare learners capable of facing global competition. There are 16 skills identified by the World Economic Forum (WEF) as essential in the 21st century, and scientific literacy is one of them (WEFUSA, 2015). The perspective that can be explored through scientific literacy skills is the importance of critical thinking and action, employing scientific thinking methods, and engaging in mastering critical thinking in addressing social issues. Scientific literacy is the scientific knowledge possessed by individuals and utilized to identify questions, acquire new knowledge, explain scientific phenomena, and draw conclusions based on evidence about issues related to science, understanding the characteristics of science as human knowledge and inquiry, awareness of how science, technology, culture, the environment, and the willingness to engage in science-related issues, and ideas. (Utami, et all ., 2022).

Investigating the scientific literacy abilities of junior high school students is crucial because scientific literacy plays a key role in a country's social, economic, and scientific development (National Research Council, 2012). Understanding the level of scientific literacy among junior high school students can provide valuable insights into the quality of science education and enable the development of more effective learning strategies (Osborne, 2007; Mintzes, 2005; Linder, 2007). By examining the level of scientific literacy among junior high school students, educators and researchers can understand the strengths and weaknesses within the science education system and design strategies to enhance it.

Based on previous research on the scientific literacy of junior high school students in various regions of Indonesia, there have been varying results regarding students' scientific literacy abilities. Research conducted by Ashari et al. (2023) showed that the scientific literacy abilities of junior high school students in Gresik Regency are relatively low, with an overall average of 55.15%. Similarly, students in grade 7 of junior high schools in Banjarmasin also exhibited low scientific literacy abilities, as measured by the instrument adapted from PISA questions (Wahab et al., 2023). Another study by Syarifuddin et al. (2023) indicated that the scientific literacy of junior high school students in Konawe Selatan Regency in terms of the Nature of Science (NOS) was categorized as low. Additionally, research on the scientific literacy abilities of junior high school students in Jambi Province by Jufrida et al. (2019) regarding Knowledge of Science and Competence of Science showed that the average scores were categorized as low. Another study by Siagian et al. (2021) investigating scientific literacy among grade 7 junior high school students in North Labuhan Batu Regency found that the level of scientific literacy was low. Furthermore, an analysis of scientific literacy among junior high school students in Mataram City in terms of science competence was conducted by Lestari et al. (2021), which also indicated low scientific literacy abilities. Similar results were reported by Fitriani et al. (2016) and Saidawati et al. (2022), showing that scientific literacy abilities of junior high school students in environmental pollution and material pressure were categorized as low.

On the other hand, research conducted by Novili et al. (2017) reported that the scientific literacy abilities of grade 7 junior high school students in terms of competence and scientific knowledge were moderate. Furthermore, investigation into the scientific literacy of high school students was also conducted by Ozdem (2010), who found significant differences in the level of scientific literacy among different grades of students. However, so far, there has been no research analyzing the level of scientific literacy among junior high school students in each grade (7, 8, and 9) examining two aspects: NOS (Nature of Science) and SCK (Scientific Concept Knowledge). Moreover, the instrument used in this research is an adaptation of the Scientific Literacy Test instrument, which has not been previously

used in scientific literacy research among junior high school students in Indonesia. Therefore, further research is needed to investigate the level of scientific literacy among grade 7, 8, and 9 junior high school students in terms of NOS and SCK dimensions. The research questions guiding this study are as follows:

1. What is the scientific literacy level for the 7th, 8th and 9th-grade students?
2. Is there any significant difference in students' scientific literacy scores regarding grades?

METHOD

The approach used in this research is quantitative. A quantitative approach is a scientific method to obtain data with specific purposes and utilities based on numbers and statistics (Sugiyono, 2013). Furthermore, the method employed in this research is a survey method. According to Siyoto & Sodik (2015), the survey method is a research method that utilizes questionnaires as the primary instrument to collect data. The data are obtained by distributing questionnaires to respondents through an online questionnaire platform (Google Form).

The participants in this study are 152 junior high school students in the academic year 2023/2024, comprising 68 students from grade 7, 46 from grade 8, and 38 from grade 9. These students are distributed across 13 schools in two different cities: Bandung City and Pekanbaru City. The frequency distribution of the sample is presented in Table 1.

Table 1. Frequency Distribution of Samples

Grade	Gender	N	%
7	Male	29	43
	Female	39	57
	Total	68	100
8	Male	22	48
	Female	24	52
	Total	46	100
9	Male	11	29
	Female	27	71
	Total	38	100

The research instrument utilized was an online questionnaire consisting of two sections. The first section comprised respondent identification details, including full name, grade, school name, and city of the school's location. The second section consisted of 41 statement items divided into two subscales: Nature of Science (NOS) and Scientific Concept Knowledge (SCK), adapted from the Scientific Literacy Test (Ozdem, 2010), along with one open-ended question. The distribution of statements within each subscale is presented in Table 2.

Table 2. Subscales of the Scientific Literacy Test (SLT)

Subscale	Number of Items
Nature of Science (NOS)	22
Scientific Concepts Knowledge	19
Total	41

In the SLT, students can evaluate an item, which is a statement related to the subscales of scientific literacy covered in this scale, by choosing one of three options: "True", "False", or "Don't Know". The Cronbach's alpha coefficient is 0.74 for the SLT.

Data analysis was conducted descriptively and inferentially using SPSS software version 25. As for descriptive statistics, each class's scientific literacy level was presented. The students' scientific literacy level was expressed as mean ± standard deviation (SD). Scoring technique employed assigned a score of 1 for correct answers and 0 for wrong or "Don't Know" responses. The maximum scores obtainable from the SLT, NOS, and SCK were 41, 22, and 19, respectively. The analysis results were also presented by calculating the number of students who answered "True" divided by the total number of students and then converted into percentage form. The final scores were categorized based on levels of scientific literacy: (Very Low=0-20%, Low=21-40%, Moderate=41-60%, High=61-80%, and Very High=81-100%) (Hidayati & Sudarti, 2022). Furthermore, one-way ANOVA test was interpreted to determine if there were significant differences in scientific literacy levels among grades 7, 8, and 9.

RESULT AND DISCUSSION

Findings related to Research Question 1 "What is the scientific literacy level for the 6th, 7th and 8th-grade students?"

The overall average level of scientific literacy among students was 23.48, or 57.27% of the total SLT score. From these results, it can be concluded that junior high school students have a moderate literacy level. This indicates that students have adequate abilities to understand scientific concepts and characteristics. These findings contradict the research reported by Alam et al. (2015), Ramadhani (2022), Sujudi (2022), and Ashari et al. (2023), which stated that the scientific literacy level of junior high school students is still relatively low. This discrepancy may be due to the use of different measurement instruments to assess scientific literacy, which can lead to differing results. Furthermore, according to Boujaoude (2002), teaching methods, assessment practices, the quality of textbooks used, participation in extracurricular scientific activities, and experiences with science in non-school contexts are important factors influencing students' scientific literacy levels.

Furthermore, the scientific literacy levels of students were identified for each grade level. Average scores for overall scientific literacy and for the sub-scales of scientific literacy are presented. The overall average SLT scores for junior high school students are provided in Table 3.

Table 3. Average Scores of Scientific Literacy for Junior High School Students

Class	N	$\bar{X}$	SD
7	68	23.00	5.93
8	46	23.78	5.06
9	38	23.97	4.28
Total	152	23.48	5.28

Based on Table 3, the highest average score is 23.97, obtained from grade 9 students, followed by grade 8 students at 23.78, and grade 7 students at 23. Meanwhile, the highest standard deviation is 5.93, obtained from grade 7 students, followed by grade 8 students at 5.06 and grade 9 students at 4.28. This study indicates that students at the highest level, grade 9, achieve the highest scientific literacy scores. This could be attributed to several factors, such as cumulative learning experiences (Lee, 2012), cognitive maturity level (Piaget, 2008), and changes in curriculum and teaching methods (Bybee, 1997).

The average SLT scores of junior high school students, as assessed by two subscales, namely NOS and SCK, are provided in Table 4.

Table 4. Average Level of Scientific Literacy Reviewed from Two Subscales

Subscale	Class	N	$\bar{X}$	SD
NOS	7	68	10.65	3.21
	8	46	10.73	3.58
	9	38	11.20	2.34
	Total	152	10.86	3.04
SCK	7	68	12.35	3.43
	8	46	13.22	3.43
	9	38	12.79	2.34
	Total	152	12.79	3.07

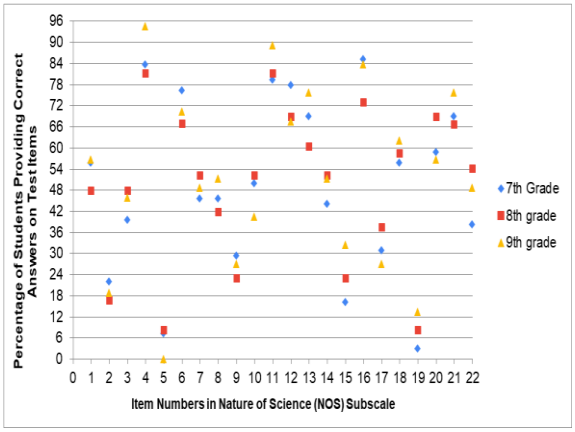
In the SLT, there are 22 items related to the NOS subscale. According to Table 4, the average score of junior high school students on this subscale ($\bar{x}$ = 10.86) is 49.36% of the maximum score obtained. In the SLT, there are 19 items related to the SCK subscale. According to Table 4, the average score of junior high school students on this subscale ($\bar{x}$ = 12.79) is 67.30% of the maximum score obtained from this subscale. From these results, it can be concluded that the literacy outcomes of junior high school students have relatively lower values on the NOS subscale compared to the SCK subscale.

Studies related to the nature of science have shown similar results, indicating that students lack adequate understanding of NOS (Doğan & Abd-El-Khalick, 2008; Doğan Bora et al., 2006; Ebenezer & Zoller, 1993; Kang et al., 2005). Several factors that can influence students' lack of understanding in the aspect of NOS include the curriculum (Meichtry, 1993), teaching approaches (Lederman & Antink, 2013), and experiences with laboratory activities and science experiments in schools (Hofstein, 2017). Therefore, the aspect of NOS requires special emphasis in science education programs in Indonesia.

Furthermore, when the average scores of each class are analyzed in the NOS subscale, it

is found that grade 7 students ($\bar{x}$ = 10.65) achieve 48.41% of the maximum score that can be obtained from this subscale, while grade 8 students ($\bar{x}$ = 10.73) achieve 48.77% of the maximum score, and grade 9 students ($\bar{x}$ = 11.20) achieve 50.91% of the maximum score. The results of the item analysis for this subscale are presented in Figure 1.

Figure 1. Analysis of NOS Subscale Items



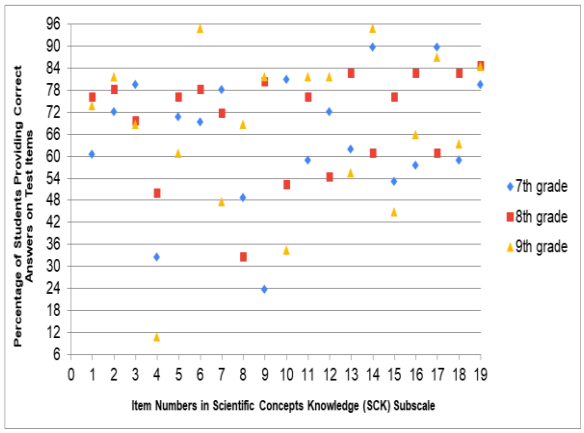
Item analysis indicates differences between grade levels regarding the percentage of correct answers on the NOS subscale (Figure 1). According to Figure 1, grade 9 students have a higher percentage of correct answers than grade 7 and 8 students.

Item analysis reveals lower percentages of correct answers on some items in the NOS subscale for grade 9 students as observed in Figure 1. Grade 9 students experienced invalid conclusions on items 5, 10, 17, 20, and 22 of the NOS subscale. Concerning this, compared to grade 7 and 8 students, many grade 9 students encountered difficulties in responding to statements such as "There are fixed steps always followed by scientists to guide them toward scientific knowledge" (Item 5 - False), "Scientific theories should explain additional observations not used in theory" (Item 10 - True), "Scientific fields like biology have limitations" (Item 17 - False), "Scientific ethics are related to the potential harm caused by scientific experiments" (Item 20 - True), and "Scientists rarely provide final answers to issues that are subjects of public debate (e.g., nuclear energy or environmental conservation)" (Item 22 - True).

The particular highlight among 9th-grade students in the NOS subscale is Item 5: "There are fixed steps always followed by scientists to guide them toward scientific knowledge." In this item, the statement "Wrong" obtained a percentage of 0%, indicating that none of the 9th-grade students answered correctly and tended to state "Correct." This result suggests that students understand that there are fixed and structured steps that every scientist always follows in every situation. However, the scientific process is often flexible and depends on context, research questions, and methods. This may occur because students may not yet understand that scientists can use various methods and approaches depending on the field of study, research questions, or research objectives. Therefore, teaching methods emphasizing science's dynamic and contextual nature are needed to help students understand the diversity of scientific methods (Garcia-Camona, 2018).

In the SLT, there are 19 items related to SCK. Based on Table 3, the average score of SMP students on this subscale ($\bar{x}$ = 12.79) is 67.30% of the maximum score obtained from this subscale. When the average score of each grade is analyzed on the SCK subscale, it can be seen that 7th-grade students ($\bar{x}$ = 12.35) achieve 69.58% of the maximum score on this subscale, while 8th-grade students ($\bar{x}$ = 13.22) obtain a maximum score of 65% of the maximum score, and 9th-grade students ($\bar{x}$ = 12.79) achieve a maximum score of 67.32% of the maximum score. The results of the item analysis for this subscale are presented in Figure 2.

Figure 2. Analysis of SCK Subscale Items



Item analysis reveals differences in the percentage of correct answers between grade levels on the SCK subscale (Figure 2). In the SCK subscale, grade 8 students have more correct answers than grade 7 and 9 students. Item analysis indicates lower percentages of correct answers on some items in the SCK

subscale for grade 8 to consider. As seen in Figure 2, grade 8 students have invalid conclusions on items 8, 12, 14, and 17 in the SCK subscale. With reference to this, compared to grade 7 and 9, some grade 8 students encountered difficulties in responding to statements such as "Only some life on Earth depends on solar energy" (Item 8 - False), "Nothing in the universe (from atoms, living organisms, to stars) is stationary, but always moves relative to something else" (Item 12 - True), "Although humans differ in body structure and skin color, all humans are the same species" (Item 14 - True), and "Any newborn animal shows certain behavioral patterns without needing to be taught. For example Some animals can suckle their mother without being told to" (Item 17 - True).

A particular highlight for grade 8 students on the SCK subscale is Item 8: "Only some life on Earth depends on solar energy." This statement is marked as "False," with 32.61% of grade 8 students answering correctly, while the rest selected "True" and "Don't Know" responses. This indicates a lack of understanding among students about ecosystems, specifically regarding the role of solar energy in food chains and ecosystems. They may not realize that nearly all life on Earth, directly or indirectly, depends on solar energy for photosynthesis and providing energy sources for living organisms (Leegod et all., 2006).

In the open-ended question of the study, the students provided statements regarding their understanding of scientific concepts.

Question: "Write down some things you can do to maintain air quality."

Student 1 : "Reducing the use of private transportation and switching from gasoline-fueled transportation to electric vehicles."

Student 2 : "Planting trees, reducing emissions, using environmentally friendly energy sources, limiting vehicle pollution, and promoting sustainable practices."

From the responses of both students, it is evident that they have a good understanding of scientific concepts, particularly within the context of scientific literacy regarding the Scientific Concept Knowledge (SCK) subscale. Student 1 mentions reducing the use of private transportation and transitioning to electric vehicles. This reflects an understanding that fossil fuel transportation contributes to air pollution, and using electric vehicles can reduce greenhouse gas emissions. Student 2 also emphasizes the importance of reducing emissions and limiting vehicle pollution. This indicates an understanding the connection between motor vehicles and air pollution and efforts to mitigate their negative impact. Additionally, Student 2 highlights the importance of planting trees as one way to maintain air quality. Both students underline the importance of using environmentally friendly energy sources. This demonstrates an understanding of the role of energy sources in shaping air quality and their impact on the environment.

In conclusion, both students show a good understanding of scientific concepts in the context of maintaining air quality. They are aware of the impact of human activities on the environment and outline tangible actions that can be taken to improve the situation. The students' understanding encompasses aspects such as the role of transportation, vegetation, vehicle emissions, and sustainable practices, indicating that they have an adequate understanding of scientific concepts related to air quality, which aligns with important components of scientific literacy (Yamin et al., 2019).

Findings Related to Research Question 2 "Is there any significant difference in students' scientific literacy scores regarding grades?"

The results of the one-way ANOVA among groups are interpreted to determine if there is a significant difference in the level of scientific literacy for grades 7, 8, and 9. One-way analysis of variance between groups is conducted to explore the impact of the level of scientific literacy scores of junior high school students measured by the SLT. The results are presented in Table 4.

Table 4. Influence of Grade Level on Junior High School Students' Scientific Literacy Level

Variable	Category	N	$\bar{x}$	SD
	7th grade	68	23.00	5.93
	8th grade	48	23.40	5.06
	9th grade	37	23.97	4.28

Grade level	Source of Variation	Sum of Squares	*df*	Mean Square	F	p	Sig.
	Between Groups	29.14	2	14.57	0.52	0.6	0.597
	Within Groups	4188.8	149	28.11			
	Total	4217.94	151				

Subjects were divided into three groups according to their grade levels (Group 1: Grade 7; Group 2: Grade 8; Group 3: Grade 9). There was no statistically significant difference in scientific literacy scores among the three grade levels [$F(2, 149) = 0.597$, $p > 0.05$]. This result may indicate that, overall, the three grade levels have similar levels of scientific literacy. This finding could prompt further questions or additional research to understand why grade levels have no significant difference. Consistency in teaching or instructional approaches across grades 7, 8, and 9 may be an important factor in this result. If scientific literacy levels are similar, it may indicate that the curriculum or teaching methods applied in all classes are relatively consistent. Other factors such as teaching methods, learning resources, or classroom environment could be subjects of research to gain further insights into students' scientific literacy.

In a previous study by Genc (2015), it was also found that there was no significant difference in scientific literacy scores among grade levels 6, 7, and 8 ($p = 0.972$). However, this result differs from the study conducted by Ozdem et al. (2010), which found a significant difference in scientific literacy scores among grade levels, specifically between grade 6 ($\bar{x} = 20.32$) and grade 8 ($\bar{x} = 21.92$), and also between grade 7 ($\bar{x} = 19.59$) and grade 8 ($\bar{x} = 21.92$).

CONCLUSION

This study found that the scientific literacy level of junior high school students was categorized as moderate, with an average score of 23.48. Furthermore, junior high school students had relatively lower scores on the Nature of Science (NOS) subscale at 49.36% compared to the Scientific Concept Knowledge (SCK) subscale at 67.30%. This finding was also supported by the responses to the open-ended question, which demonstrated a fairly good understanding of scientific concepts, particularly in the SCK subscale. Statistically, the study reported no significant difference in the average scientific literacy scores among students in grades 7, 8, and 9, which were 23.00, 23.40, and 23.97, respectively.

This research relied on quantitative data to assess the scientific literacy levels of junior high school students. In the future, researchers could conduct qualitative research to provide more comprehensive insights into the scientific literacy levels of each student. Further research is also needed to investigate the influence of various variables on students' scientific literacy levels.

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