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Science Literacy Profile of Junior High School Students on Context, Competencies, and Knowledge

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ABSTRACT

Objective: This study's preliminary goal is to describe junior high school students' proficiency in scientific literacy. It is based on exams that use questions that measure a student's proficiency in scientific literacy, adhering to the guidelines established by the Programme for International Student Assessment (PISA). **Method:** The research was a quantitative descriptive analysis. It used a list of 20 questions created to evaluate students' proficiency with scientific literacy using a set of predetermined indicators. Purposive sampling was used to gather the data, and 102 students were chosen as a sample from Junior High School 2 Sukorejo. **Results:** Based on research findings, 19 of the 102 students meet the criteria for scientific literacy skill level 4, the highest level. Additionally, 38 students meet the criteria for level 3 of scientific literacy, which needs to be improved. Furthermore, 45 students continue to meet the low criteria for level 2 scientific literacy skills. According to the findings of this study, future research efforts and increased attention from relevant teachers are required to concentrate more on improving students' scientific literacy skills**.** **Novelty:** The novelty of this research explores students' scientific literacy levels using a science literacy test focusing on context, competencies, and knowledge. It provides a comprehensive understanding of students' scientific literacy skills, moving beyond quantitative percentages. The detailed explanation will be valuable for future research and provide deeper insights into the subject matter.

INTRODUCTION

The ability to use language for reasoning is the current definition of literacy. One of the most critical educational concerns in the twenty-first century is literacy, as technology advances at a breakneck pace. High scientific literacy populations enable nations to make science, technology, and social policy decisions that are appropriate. PISA specifically addresses several dimensions or areas of measurement related to scientific literacy. Wahab (2023) stated that scientific literacy is considered an ability that students must have in the 21st era. Scientific literacy is essential in solving scientific problems (Pakpahan, 2022). This is because scientific literacy can help students understand and analyze problems, allowing them to find solutions using the scientific knowledge they have (Mellyzar, 2022). To solve problems in daily life, students need to be able to think critically, work with others, communicate their ideas clearly, and solve problems creatively. If students are scientifically literate, they can learn these skills (Hudha et al., 2023). Scientific literacy is critical to preparing the provision of skills that must be possessed by students from elementary school to university levels, which include critical thinking, creative, collaborative, and communication skills (Kurniasari et al., 2023). In addition, scientific literacy has the potential to form people who can compete competitively, can reason creatively. They can solve problems and master technology, which helps them adapt well to rapid changes and developments in the modern world (Nofiana & Julianto, 2018).

Context, knowledge, and competence shape scientific literacy. PISA 2018 defines this competency as the ability to design scientific investigations, evaluate phenomena, explain scientifically, and interpret data and evidence (Kemdikbud, 2019). To explain phenomena scientifically, students must have a strong understanding of scientific concepts and how these concepts impact society. They must also learn to design and evaluate scientific research using critical thinking (Sumarra et al., 2020). Students will be able to draw appropriate conclusions and analyze and evaluate information, statements, and arguments in various representations as part of interpreting data and evidence scientifically. In addition, students must be able to compile tables and display data in various formats (Widayoko, 2018). In short, to have scientific literacy competence, students must have content, procedural, and epistemic knowledge. This knowledge can be applied in various contexts, including personal, local, national, and global.

Currently, education is making more efforts to improve students' scientific literacy. Several countries have made scientific literacy a top priority in science education. Through scientific literacy training, science learning in schools aims to improve students' ability to respond to contemporary educational trends. Students must have scientific literacy skills, as reflected in the science education literature, which is increasingly recognized and valued by educators as a desired learning outcome. Scientific literacy is the ability to talk about scientific issues with others and think critically about science as a citizen. This is very important to understand the benefits of science and the challenges and threats of science. It is also essential to address the social and environmental problems faced by modern societies, especially those dependent on knowledge and technology (Indiana, 2018).

The results of the PISA study, which is conducted by the OECD every three years, show that the average scientific literacy ability of Indonesian students in 2000, 2003, 2006, 2009, 2012, 2015, 2018 and 2019 was 393, 395, 393, 385 respectively., 375, 403, and 396 (OECD, 2019). Because students’ achievement is below the PISA completion average, their scientific literacy results still need to be higher. This shows that students in Indonesia are not only unable to understand scientific concepts and processes, but they are also unable to use the knowledge they learn in everyday life (Sutrisna, 2021). However, educational evaluation systems such as the National Assessment and Minimum Competency Assessment have improved students’ scientific literacy abilities. The cognitive aspects of student learning outcomes are assessed through a system that refers to PISA standards and Trends in Mathematics and Science Studies (TIMSS) as assessment benchmarks (Herizal et al., 2020; Novita et al., 2021; Sherly et al., 2021).

The recent study that was done to characterize the domain and scientific literacy level of the students still demonstrates the need for more research and a higher level of scientific literacy among the students. In their research, Wumu et al. (2023), especially at the JHS 1 Kwandang education unit level, show that the literacy skills of students only get a score of 1.54, which is below the average national score of 1.7 with the definition of achievement of less than 50.0% of students achieving the minimum competency for literacy. Meanwhile, Shofawati et al. (2023) also found that teachers at Muhammadiyah Junior High School 2 Taman Sidoarjo stated that student learning outcomes on the Energy Flow material still needed to be higher. As many as 70% of students scored below the minimum completion criteria on the Energy Flow material. Fitriani (2023) Based on the results of observations at JSH 10 Magelang, students' scientific literacy skills are pretty low. Students' scientific literacy ability is limited to the tasks given by the teacher, according to the book, and has not been linked to environmental problems. Teaching materials commonly used by students in online learning activities are PPT, the material in PDF text, and student books, so there still needs to be more use of technology-based modules.

The AN 2022 public education report card can be accessed at raporpendidikan.kemdikbud.go.id/. It provides an overview of the quality of education in a particular area by using input, process, and output models to determine the performance or effectiveness of educational units. The 2022 AN results from the Junior High School (JHS) level in Indonesia show that literacy and numeracy skills are still below the minimum score. This is in line with previous research, which found that Indonesian students have low literacy and numeracy skills, which has an impact on their low critical thinking skills (Anisa et al., 2021; Sihaloho et al., 2019). One of the factors that contribute to poor learning outcomes is the literacy-based evaluation model used in learning (Wahab, 2023). Until now, AN only assessed students' abilities in literacy and numeracy. This also applies to the fields of language and mathematics. In science learning, teachers still use routine questions to evaluate students' understanding. However, literacy-based questions are now very much needed in science learning. Therefore, it is necessary to use questions based on scientific literacy to measure students' scientific literacy abilities.

RESEARCH METHOD

This preliminary study describes the findings made during the study's analytical phase without involving any hypothesis testing. To obtain the data, researchers need to address the issue adequately; preliminary research is carried out. No particular treatments, such as a control or experimental group, were used in this investigation. The findings of this study will act as a starting point for thinking about additional research goals aimed at improving junior high school students' scientific literacy abilities. As suggested by Saraswati et al. (2021), this strategy intends to improve the quality of following learning by creating efficient learning designs to increase students' scientific literacy.

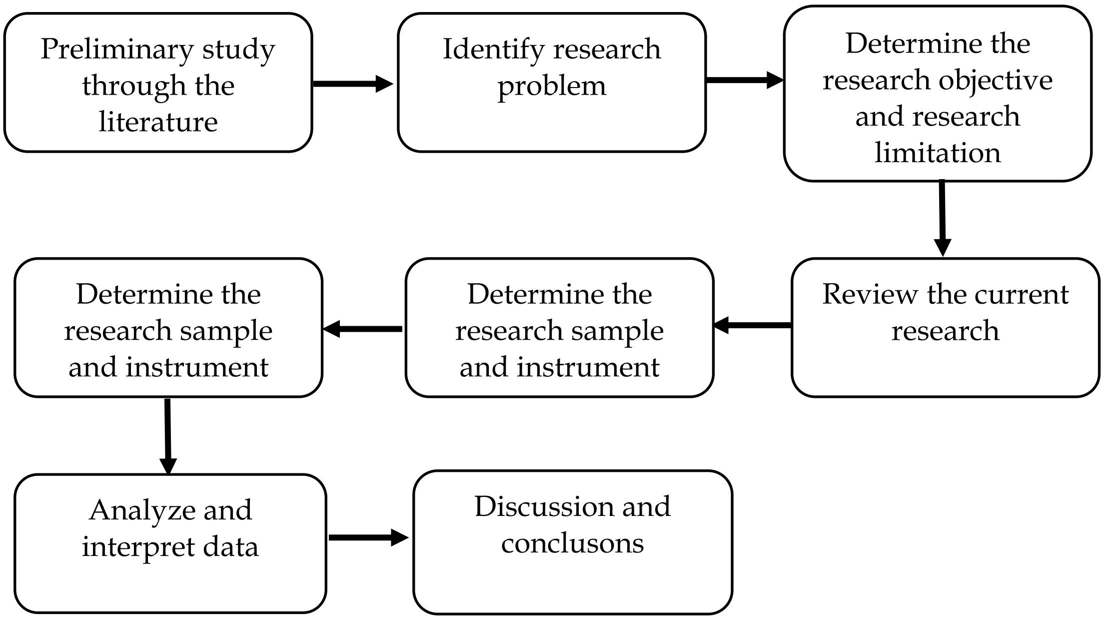

Figure 1. The research flowchart.

METHODS

Purposive sampling was used in this investigation to gather the necessary data. Specific factors define the methodology known as "purposeful sampling" (Sugiyono, 2017). A total of 102 eighth-grade students from State JHS 2 Sukorejo. In this study, students' scientific literacy levels were evaluated using questions about scientific literacy. Based on the PISA scientific literacy indicators, which include the following: Context, Competencies, and Knowledge. Twenty questions were used, with four different conversation topics that complemented the school's science curriculum and the PISA scientific literacy setting. Additionally, the questions were developed to fall inside the PISA's defined parameters, which included the personal, local/national, and Global context, explaining phenomena scientifically, evaluating and designing scientific inquiry And interpreting data and evidence scientifically on competencies, then aspect content, procedural and epistemic on knowledge. Students who have studied these subjects were the ones who were included in the study's sample. After gathering the information, it is then processed to calculate the students' scientific literacy score and proficiency level. Students' levels of scientific literacy are measured by 1) assigning a value or score to each question at a distinct level, which is done through the analysis of scientific literacy tests. The value score is adapted from PISA, then 2) Use the scoring system shown below to calculate the achievement score for each level.

$$Score = \Sigma \frac{Bi \ x \ bi}{St} \ x \ 100\%$$

Description :
B_i = the number of items answered correctly
b_i = the value of each item (adapted from PISA)
S_t = theoretical score

(Pravitasari et al., 2015)

Table 1 shows the range of scores and degrees of scientific literacy skills for the 20 questions after converting the PISA scores and the research findings.

Table 1. Student scientific literacy level criteria.

Score Range	Scientific Literacy Level	Criteria
93.0 -100.0	6	Very Good
73.0 – 92.0	5	Good
55.0 – 72.0	4	Enough
40.0 – 54.0	3	Deficient
14.0 – 39.0	2	Low
7.0 – 13.0	1.a	Very Low
1.0 – 6.0	1.b	Very Low

Assess each student's answer sheet after calculating the score to establish the category of the student's scientific literacy ability. After that, use Table 1 to determine the degree of scientific literacy the pupils have attained. There are distinct skills for each level. The author will use the PISA's explanation of each level's abilities to ascertain the boundaries of students' abilities at each level in order to provide more precise data.

RESULTS AND DISCUSSION

Results

This study employed 20 essay questions designed by the PISA (Program for International Student Assessment) scientific literacy skill indicators, which include 1) Contexts, 2) Knowledge, and 3) Competencies (OECD, 2018). Subsequently, student responses were analyzed to assess their proficiency in scientific literacy skills. Students scored 5 for entirely correct answers, 2.5 for partially correct responses, and 0 for incorrect or non-responsive answers. The test results on Blood system knowledge indicate that the average score for science literacy skills falls within the low category. The results of the descriptive analysis of science literacy skills for eighth-grade students at JHS 2 Sukorejo are shown in Table 2.

Table 2. Descriptive analysis of science literacy skills.

Indicator	Aspect	Highest Score	Lowest Score	Average score
Context	Personal	70.0	30.0	60.0
	Local/National	65.0	40.0	45.0
	Global	60.0	20.0	37.5
Competencies	Explaining phenomena scientifically	70.0	30.0	65.0
	Evaluating and designing scientific inquiry	65.0	25.0	35.0
	Interpreting data and evidence scientifically	50.0	20.0	45.0
Knowledge	Content	67.5	35.0	55.0
	Procedural	65.0	20.0	47.5
	Epistemic	60.0	25.0	25.0

After summarizing the scores obtained on aspects of scientific literacy, it can be seen that the highest score achieved by each student was 70.0, while the lowest score obtained was 30.0, with the average score for all students being 60.0. In the local/national context, the highest value is 65.0, and the lowest is 40.0, with an average value of 45.0. In a global context, the highest value is 60.0. The lowest value is 20.0, with an average value of 37.0, while in Scientific competencies, including Explaining phenomena scientifically, the highest score was 70.0; the lowest score was 30.0, with an average of 65.0 in Evaluating and designing scientific inquiries. The highest score was 65.0, the lowest score was 25.0. The average score was 35.0; for Interpreting data and evidence scientifically, the highest value was 50.0, the lowest value was 20.0, and the average value was 35.0. Meanwhile, in Scientific Knowledge, the content aspect obtained the highest score of 67.5, the lowest score was 35.0, and the average score was 55.0; in the procedural aspect, the highest score was 65.0, and the lowest score was 20.0 and the average score was 47.5 while in the epistemic aspect the highest value is 60.0, the lowest value is 25,00, with an average value of 25, .0. The next step involves assessing the level of scientific literacy skills among students. Student scores are then categorized into score ranges as specified in Table 1. The results of this categorization are presented in Figure 2.

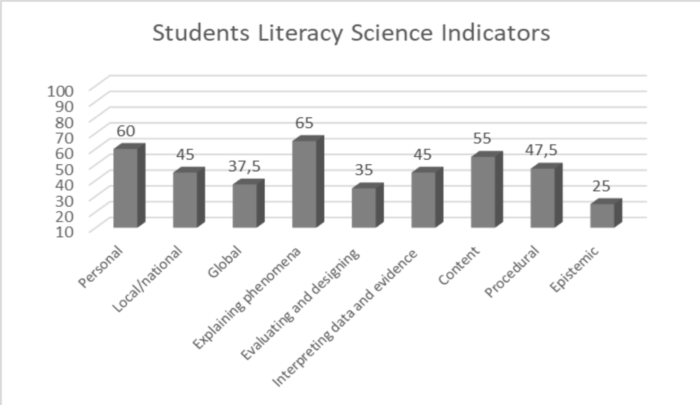

Figure 2. Student literacy science indicators.

Based on data grouping based on scientific literacy indicators and students' scientific literacy abilities on local context indicators, we obtained an average value of 60.0. On local/national indicators, it was 40.0, and on global indicators, 37.5. Meanwhile, the data obtained for the scientific literacy competency indicators were Explaining phenomena, Evaluating and designing, and Interpreting data and evidence, respectively, at 65.0, 35.0, and 45.0. In the knowledge indicator, the following data was obtained: Content was 55.0, the Procedural aspect was 47.5, and the Epistemic aspect was 25.00.

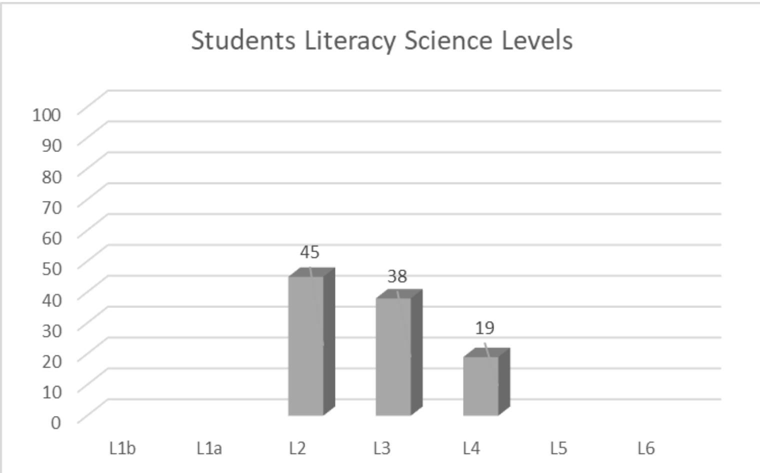

Figure 3. Student literacy science levels.

Based on the results of grouping students according to their scientific literacy skill levels, as depicted in Figure 3, it is evident that 45 students are still at level 2, 38 students are at level 3, and 19 students have reached level 4. It is evident from the data that efforts are required to increase the science literacy of the school's students. We can use the PISA-provided descriptions of the skills related to each level of scientific literacy for a more in-depth analysis.

Discussion

We can learn more specifics about the student's scientific literacy from the results after grouping the students' levels. The scientific literacy skills of students are already explained by PISA, specifically at each level. It can be used to determine the limitations of each level's students' abilities. It is shown in Table 3.

Table 3. Scientific literacy level.

Scientific Literacy Level	Description
Level 1b	Students can utilize basic scientific knowledge to identify familiar aspects or simple phenomena, identify data patterns, understand basic terms, and follow explicit procedures.
Level 1a	Students at this level can utilize primary procedural knowledge in everyday life to recognize and explain simple scientific phenomena.
Level 2	Students at this level can use every day content and procedural knowledge to scientifically explain, interpret data, and answer simple design questions.
Level 3	Students at this level can utilize complex content knowledge to identify and explain phenomena in unfamiliar or complex situations.
Level 4	Students at this level can utilize their advanced content knowledge to explain unfamiliar events and phenomena.
Level 5	Students at this level can utilize abstract scientific concepts to explain complex phenomena, events, and processes that involve causal relationships.
Level 6	Students at this level provide explanations of scientific concepts from physical, life, and earth sciences to offer explanatory hypotheses or make predictions about new scientific phenomena.

The study analyzed data on scientific literacy skills in context, knowledge, and science competence among Class VIII students at Junior High School 2 Sukorejo (JHS 2 Sukorejo). The average value achievement of test results per indicator was low, indicating that participants' scientific literacy abilities needed to be adequately developed. Based On information according to Figure 2, the aspect of science context falls within the low category. The personal context indicator has an average value of 60.0, which falls in the enough category. Similarly, the national, local context indicator has an average value of 45.0, also categorized as Deficient. Lastly, the global context indicator has an average value of 37,50, considered low.

These findings are attributed to students' difficulty connecting scientific context to their everyday lives. This aligns with the results of a study (Subaidah et al., 2019), which states that the low level of science literacy among students results from their limited ability to do more than memorize and recognize scientific knowledge. They often need help to apply scientific theories to real-life situations. In Indonesia, students tend to excel in rote memorization but need to gain proficiency in applying the knowledge they possess.

In the aspect of scientific literacy competency, the indicator of explaining scientific phenomena has an average value of 65 in the medium category, the indicator of interpreting data and proving it scientifically has an average value of 35 in the Low category, and the indicator of evaluating and designing scientific investigations has an average value of 45, namely in the deficient category. According to Januaresty et al. (2021), the factors that cause students' low mastery of the competency aspect are that students need to understand the terms in several scientific investigation activities and spend more time with knowledge that encourages memorization. In line with this, Nofiana and Julianto (2017), low levels of one dimension of scientific literacy will influence other dimensions of scientific literacy. Students need more conceptual understanding of scientific knowledge to impact low-science applications. Facts in the field show that although students are very good at memorizing, they could be more skilled in applying the knowledge they have.

Based on Figure 3, 45 students are at Level 2; in this level, students utilize everyday content and procedural knowledge to identify scientific explanations, interpret data, and address questions in simple experimental designs. They can also use basic scientific knowledge to draw valid conclusions from data sets and demonstrate basic epistemic knowledge by identifying scientifically investigateable questions. Students must still build their knowledge to explain the phenomena or problems stated in the questions (Rohmah & Hidayati, 2021; Mellyzar et al., 2022). However, students at this level still need help to answer questions on more complex phenomena. For example, this research was seen when they were asked to explain the phenomenon of blood circulation in the human body. Another example from further research can be seen when students are asked to explain basic scientific terms and concepts in everyday life (Selamet et al., 2021; Yanti et al., 2020).

Based on Figure 3, at level 3, 38 students have achieved; students at this level can utilize complex content knowledge to identify and explain phenomena in unfamiliar or complex situations. As a result, PISA's explanation of level 3 indicates that students can utilize content knowledge that is quite complex at this level to identify or construct relevant explanations about phenomena in less familiar or more complicated situations. According to the data below, which was gathered from students at this level, they can already use a variety of concepts to construct an explanation or argument pertinent to the issue (Subaidah et al., 2019). When the students are asked to explain a problem relating to environmental pollution brought on by coal mining activities, it can be seen in this study. Students are asked to explain fluid dynamics in the second research example (Sabrina et al., 2021).

In Figure 2, information is obtained that the knowledge aspect of the context knowledge indicator has an average value of 55.0 in the Enough category, the procedural knowledge indicator has an average value of 47.5 in the deficient category, and the epistemic knowledge indicator has an average value of 25.0 in the low category. This is because students have not mastered science concepts well, and learning in schools tends to transfer knowledge from teachers to students, which is carried out in an integrated manner. As a result, students understand scientific concepts only by memorizing.

Nofiana and Julianto (2017) stated that the low ability of students in the aspect of scientific knowledge was caused by students' low mastery of science concepts. The demand for teachers to complete teaching materials according to curriculum targets forces students to accept science concepts that may need to be fully understood. Many science concepts are misunderstood (misconceptions) or memorized, and in the end, these concepts are quickly forgotten. In line with this, according to Fakhriyah et al. (2017), students' activities only listen to the teacher's explanation; then, students learn science as a product, not as a process, attitude, and application. Further, on level 4, 19 students reached this level. PISA explains that students at this level can use complex content knowledge to construct explanations of less familiar events and phenomena. Based on the results obtained from this study in students at this level, when asked to provide an explanation or argument for the existing phenomenon

Rarely found in everyday life, they could use these concepts to construct explanations for phenomena or events that they had rarely encountered before. In this study, they were asked to explain the relationship between blood circulation and the disorders of human circulation. Nevertheless, students at this level still needed help with their explanation to conclude problems in everyday life that they still needed to understand that contained the effect of cause and effect. (Harlina et al., 2020). Based on this description, students' abilities in each indicator of scientific literacy are different. The average ability of students in each indicator of scientific literacy ability is included in the low category, with category L2, with a value range of 14.0–39.0. This shows that students are not yet able to apply their knowledge in everyday life. According to Mijaya et al. (2019), someone who is literate or literate in science can apply the knowledge they have in life. The low level of students' scientific literacy skills is because students are not used to working on questions such as scientific literacy. Students are used to being faced with questions that are closely related to content, and this is contrary to the characteristics of scientific literacy questions developed by PISA.

PISA scientific literacy questions are closely related to the application of scientific thinking in the context of everyday life and require high levels of reasoning to work on scientific literacy questions (Handayani et al., 2018). So, it is necessary to get used to working on scientific literacy-type evaluation questions that require high reasoning abilities. According to Fakhriyah et al. (2017), the high and low levels of scientific literacy are also caused by the understanding of science learning, which leads students to the formation of scientific literacy, which teachers need to understand better. Another factor that causes students' low scientific literacy skills is the intensity of practicum provision.

Students who often do practicums have superior scientific literacy competencies compared to students who never do practicums. This is because carrying out practicums will train students' science process skills. This skill supports students' achievement of scientific literacy competencies because students play an active role in learning, not just understanding theory. In line with this, Jufrida et al. (2019) said that students tend to memorize concepts but are less able to use their knowledge. Learning that tends only to memorize concepts, theories, and laws causes students to have difficulty applying the knowledge gained in everyday life.

Low scientific literacy among students can be attributed to several factors, including teachers' lack of knowledge about scientific literacy, students' disinterest in reading, and assessment tools that still need to improve students' scientific competency. It is well known that science education still uses a teacher-centered method of instruction, which makes learning less meaningful. As a branch of science, science should be taught in a way that develops students' ability to overcome challenges (Ridzal et al., 2023). According to the study's findings, JHS 2 Sukorejo students' scientific literacy needs to be improved in order for them to get better in the future. The results also clarify how several factors may have contributed to the student's scientific literacy. One of the factors that can lead to this, according to research by Saraswati (2021), Merta et al. (2020), and Andriani et al. (2021), is the need for textbooks to be improved in order to increase students' scientific literacy skills. Additionally, according to Surapto et al. (2022), students also believe that textbooks are less appealing. Dhitareka et al.'s research, which explained that Indonesian science textbooks have a lot of science learning material, supported this.

However, there is still room for improvement in the content's quality. According to Kelana and Pratama (2019), teaching materials that relate to the traits of indicators of scientific literacy-based teaching materials are required to develop students' scientific literacy. According to Pursitasari et al. (2020), the characteristics of literacy-based teaching materials—which contain four indicators of scientific literacy-based teaching materials according to Chiapetta et al. (1991)—effectively enhance students' scientific literacy skills. These indicators are science as the body of knowledge, science as a way of investigating, science as a way of thinking, and the interaction of science, technology, and society.

To develop their scientific literacy skills, teachers must use questions based on scientific literacy in their lesson plans and training of students. Due to a lack of training with questions resembling these PISA questions, Indonesian students currently have low average scientific literacy skills, as evidenced by PISA results (Hasasiyah et al., 2019). Getting students accustomed to responding to questions based on scientific literacy is one method for enhancing students' scientific literacy abilities. Their ability to comprehend and interpret questions with these indicators of scientific literacy is improved with increasing familiarity with these types of questions (Arrohman et al., 2022). As a result, before they can use them with their students, science teachers must learn how to develop questions based on indicators of scientific literacy (Azizah et al., 2022).

However, in education, learning models are essential. Students' abilities in scientific literacy can also be impacted by the use of learning models that the teacher presents during the learning process (Agustina et al., 2020; Lestari et al., 2021). According to PISA, scientific literacy skills require knowledge from three different contexts: personal, local, and global (Fakhriyah et al., 2017; Utami et al., 2022). In order to enhance students' scientific literacy skills, it is necessary to have learning that can connect scientific problems, such as identifying, analyzing, and drawing conclusions on phenomena that occur in everyday life (Winarni, 2019; Alvina et al., 2022; Budiarti & Tanta, 2022). The level of science literacy can be improved through learning methods that stimulate students' curiosity about the subject matter and encourage them to address problems presented by the teacher. These are believed to foster the development of science process skills, which are an integral part of the competence aspect of science literacy.

Students who are engaged in the learning process more actively, with greater interest, and with greater focus due to the problem-based learning model have higher levels of scientific literacy. This is in line with the benefits of problem-based learning models (Munawar et al., 2023), which also include improving students' creativity and critical thinking, motivating them to learn, assisting them in applying their knowledge in new contexts, encouraging them to be creative and innovative in proving their problem-solving theories; and fostering a desire to collaborate and the ability to form strong bonds in group work. The problem-based application uses real-world issues, gathers data and draws conclusions, applies logic and its applicability in a given situation, and then applies these steps to solve issues and improve knowledge (Arrafi et al., 2023).

The PBL model will provide opportunities for students to learn better and, of course, learn more actively because this model is student-centered. This learning style expedites students' scientific literacy via exploratory and analytical tasks (Nirmayani et al., 2023). In summary, science literacy can play a pivotal role in shaping students' future career choices, and it can be enhanced through a combination of personalized approaches, tailored materials, effective teaching methods, and activities that stimulate curiosity and problem-solving skills.

CONCLUSION

Fundamental Finding: Improvements in students' scientific literacy abilities are needed, according to study data gathered at JHS 2 Sukorejo. With a maximum score of 70, just 19 out of the 102 pupils in the study could demonstrate scientific literacy at level 4. To meet the requirements for levels beyond this, however, most pupils still need further help and improvement in their scientific literacy. **Implication:** Several factors can contribute to the low levels of students' literacy skills. For instance, the textbooks used may not adequately cater to students' needs in terms of content based on scientific literacy indicators. Additionally, students may have needed to be trained to answer questions with scientific literacy indicators like those used in assessments such as PISA. This lack of exposure to such questions can make students unfamiliar with similar queries, necessitating assistance. Furthermore, the choice of teaching models can also influence students' scientific literacy skills. There should be a focus on enhancing students' scientific literacy skills in the future, which presents a challenge for researchers to engage in these efforts actively. **Limitation:** This study is limited to describing the scientific literacy skills of junior high school students based on tests that use questions aligned with scientific literacy indicators according to PISA at each level of achievement reached by the students**. Future Research:** For future research, the findings of this study can be valuable for other researchers in determining the interventions required to facilitate students in developing their scientific literacy skills and training them to achieve better results, including through problem-based learning approaches.

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