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An Analysis of Science Literacy Ability Elementary School Students

Dzuhrotul Ulumiyah[1]✉, Mohammad Syarif Sumantri[2], Yuli Rahmawati[3], Vina Iasha[4]

Universitas Negeri Jakarta, Indonesia[1,2,3]

Sekolah Dasar Negeri Pondok Bambu 06 Jakarta, Indonesia[4]

E-mail: dzuhrotulululumiyah_9918819008@mhs.unj.ac.id[1], syarifsumantri@unj.ac.id[2], yrahmawati@unj.ac.id[3], vinaiasha@gmail.com[4]

Abstrak

Artikel ini bertujuan untuk mengetahui pencapaian literasi sains siswa kelas IV SD. Penelitian ini menggunakan metode kualitatif dengan teknik pengumpulan data berupa wawancara dan pertanyaan terbuka. Penelitian ini melibatkan guru kelas empat dan siswa kelas empat. Berdasarkan kerangka teori yang ada, dikembangkan alat penilaian yang mengukur kemampuan untuk: a) mengenal konsep-konsep ilmiah (literasi nominal); b) mendefinisikan beberapa konsep kunci (literasi fungsional); c) menggunakan pemahamannya tentang konsep ilmiah untuk menjelaskan fenomena (literasi konseptual); dan d) menggunakan Ilmu Pengetahuannya untuk membaca artikel pendek (literasi multidimensi). Hasil penelitian menemukan bahwa penilaian literasi nominal menunjukkan pengetahuan IPA siswa masih terbatas. Penilaian literasi fungsional dapat dilihat minat siswa terhadap IPA yang masih minim. Hasil penilaian literasi konseptual pemahaman siswa terhadap fenomena ilmiah sehari-hari masih kurang, dengan literasi multidimensi dapat dinilai pemahaman siswa terhadap bacaan paragraf masih terbatas.

Kata Kunci: Literasi sains, sains, sekolah Dasar

Abstract

This article has aimed to investigate the scientific literacy achievement of fourth-grade elementary school students. The research used a qualitative method with data collection techniques in interviews and open questions. This study involved a fourth-grade teacher and fourth-graduate students. Based on the existing theoretical framework, an assessment tool was developed, which measurement's ability to: a) recognize scientific concepts (nominal literacy); b) define some key concepts (functional literacy); c) use their understanding of scientific concepts to explain phenomena (conceptual literacy); and d) use their knowledge Science to read a short article (multidimensional literacy). The study results found that the nominal literacy assessment showed the students' knowledge of Science was still limited. Functional literacy assessment can be seen students' interest in Science which is still minimal. Conceptual literacy assessment results in students' understanding of everyday scientific phenomena are still lacking, with multidimensional literacy can be assessed students' understanding of paragraph reading is still limited.

Keywords: *science literacy, science, elementary school*

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✉ Corresponding author :

Email : dzuhrotulululumiyah_9918819008@mhs.unj.ac.id

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INTRODUCTION

Scientific literacy is science education's primary and fundamental goal (Augustine, 2009; Azmy et al., 2022). This is in line with DeBoer and McFarlene that scientific literacy is a widely recognized educational concept and has become the education field's primary coalfield (DeBoer, 2011; McFarlane, 2011). Therefore scientific literacy is critical to be applied in elementary schools (Al Sultan et al., 2021; Hu et al., 2018). Scientific literacy ability is an ability that students must possess. Scientific literacy can be defined as a person's ability to master science, communicate science, and apply scientific knowledge to solve problems (Devi & Aznam, 2019; Valladares, 2021). They have a high attitude and sensitivity to themselves and their environment and can make decisions based on scientific considerations.

Through scientific literacy, students are expected to ask, find, or determine answers to questions that arise from curiosity. Then the interest must be directed to a scientific attitude and scientific thinking to solve the problems they face scientifically. However, several factors influence the low scientific literacy of students, including students' attitudes towards science, the science learning process at school, and students' interest and motivation in learning science Fields (Bellová et al., 2021). In addition, many students today believe that science is dry and boring (Döring, 2020; Sari et al., 2022). So this results in low scientific literacy.

Several studies have researched the importance of scientific literacy. Analysis related to scientific literacy in science learning (biology) was conducted in junior high school, where reasoning and understanding in making decisions play an important role in learning natural concepts (Ardiyanti et al., 2019; El Islami et al., 2019). Analysis of science literacy skills in junior high school in Physics course has been conducted. The results of this study indicate that scientific literacy in junior high school is adequate, although some aspects are still lacking (Budiarti & Tanta, 2021; Yuliati et al., 2018). Sartika et al. analyzed the level of scientific literacy in junior high schools and found that students' scientific literacy skills were still low (Sartika & Ahda, 2021; Zulela et al., 2022). Meanwhile, research related to students' scientific literacy skills using an ethnopedagogical approach has also been carried out (Hasan et al., 2021; Rahmawati et al., 2021).

Based on the journal literature that has been carried out, there is still scarce information related to analyzing scientific literacy skills in elementary schools. In addition, the use of a comprehensive theoretical scale from Bybee, which consists of scientific literacy, nominal scientific literacy, functional scientific literacy, conceptual scientific literacy, and multidimensional scientific literacy, is still not available (Bybee, 1997; Ningrum et al., 2022). Therefore, this research was conducted to determine the level of scientific literacy ability of elementary school students in terms of the taxonomy of scientific literacy.

RESEARCH METHOD

This research was conducted with a qualitative descriptive approach because it contains characteristics such as allowing to express perceptions, the role of researchers from researchers, aligning the original setting, flexibility in research design, realizing inductive analysis with qualitative data. (Maxwell, 2013; Merriam, 2009; Patton, 2002).

Data collection was carried out by giving open questions in a google form to each student, followed by interview activities to dig deeper into students' understanding of science. Five students from 14 elementary school students in grade IV were taken as samples. The data collection process has the following stages:

1. Interviews with fourth-grade elementary school teachers provided various ideas for triggers for further discussion.
2. The teacher's view provides an overview of what a practical and successful definition looks like, in contrast to the ideal illustration of scientific literacy, Testing the extent to which agreement on the content of the description resulted from the previous stage (Shwartz et al., 2006).

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RESULT AND DISCUSSION

Result

Since scientific literacy is a multi-dimensional and complex term, assessing its aspects and components isn't easy. Therefore, a series of assessment tools were developed based on the theoretical framework. For each level of scientific literacy, certain aspects are selected and assessed using various tools.

Open Questions 1: Identify and define the concept of Science

This question aims to assess the nominal and functional levels of scientific literacy. Open questions consist of a list of concepts such as Living things and life processes, objects and their properties, energy and changes, and the earth and the universe. The students were interviewed to rate the level of introduction to each material which varied from "Do not know the material" to "understand the material." Each student also had to rate their desire to hear more about each material which varied from "Not interested at all" to "Very interested".

Table 1
Categories of Science Concepts

Categories	Items
Living things and life processes	Humans, animals, plants, and interactions with the environment and health
Objects and their properties	Liquid, solid, and gas
Energy and its changes	Force, sound, heat, magnetism, electricity, light, and simple machines
Earth and the universe	Earth, earth, solar system, and other heavenly bodies

Content validation: The concepts included in the open-ended questions are necessary to reflect the main ideas in the definition of 'scientific literacy. Therefore, the scientist validates the alignment of the concept with the main idea. Concepts are also grouped into more general content-related categories, as described in Table 1. In the second part of the open-ended questions, students are expected to explain more familiar concepts in everyday life in their own words.

Open Questions 2: Identify and define the concept of Science

This questionnaire assesses students' ability to refer to scientific explanations about certain phenomena. The development of this interview instrument consists of the following steps:

1. Familiar scientific phenomena were chosen for this interview, such as floating eggs, evaporating water, and mixing water and oil.
2. Interview with five students. The students were asked to explain the phenomenon.
3. Student responses during oral interviews became the basis for preparing open question two, designed to assess students' ability to explain scientific phenomena. Transcript analysis provides true and false explanations of each phenomenon. These answers are used as items in open questions. This procedure improves the content validity of available questions.

As a result of the development process described above, five phenomena were selected for the final open questions. Almost all items have a contextual flavor, i.e., relevance to students' everyday experiences. The inclusion of 5 different phenomena in the assessment tool seems essential because it can increase the generalizability of the resulting data.

Students who answer open questions are asked to refer to several sentences related to each phenomenon and determine whether the sentence is true or not. They can also choose the "I don't know" possibility.

The following are examples of items in open question 2: "Water and oil will not mix or mix if they are put in one container". Here are some statements related to this phenomenon. Students need to decide whether the information is true or false. Students can also select the "I don't know" option.

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Table 2
Item open questions 2

No.	Questions	True Statement	False Statement	I don't know
1.	Water and oil will not mix or mix if put in one container			
2.	Eggs will float if they are in water that contains a lot of salt			
3.	Ice cream can be formed by utilizing salt in the manufacturing process			
4.	Fizzy drinks will produce foam if sprinkled with salt			
5.	Coins will float if you put them in water with a fork			

Open Questions 3: Reading from short paragraphs

This questionnaire assesses the students' ability to analyze a paragraph about the subject matter. This aspect is considered as part of conceptual and multidimensional scientific literacy. For evaluating the embodiment of higher-order cognitive skills (analysis, synthesis, and interpretation of information) in the context of science, the researcher developed three short paragraphs:

Living things cannot live alone. Living things depend on other living things, for example, humans. To survive, humans need to eat. The food we eat comes from plants and animals. Meanwhile, animals and plants cannot live and reproduce appropriately without the help of humans. So, it is proven that there is a reciprocal relationship between living things.

Symbiosis does not only occur between living things but also occurs between living things and their environment, for example, a cow excretes manure that can fertilize the soil, or a tree produces oxygen that can cool the surrounding air.

Relationships that occur between living things are not always beneficial. Some relationships are detrimental. Based on this, three types of plants are known: parasitic plants, epiphytic plants, and saprophytic plants.

The paragraphs are followed by open-ended questions, which can be divided into three categories:

1. Understanding the information included in the paragraph (reading comprehension);
2. Relates to prior scientific knowledge
3. Decision making or reasoning

Open-ended questions (Multidimensional Literacy)

1. Based on the reading above, Mention 3 types of plants that are harmful!
2. Based on the reading above, every living thing is interdependent with other living things, which we usually call symbiosis. What symbiosis do you know?
3. What happens when many parasitic plants are attached to a plant? Explain!

Table 3
The used instrument to assess different levels of scientific literacy

Literacy Level	Scientific Literacy Domains	Scientific domain literacy Specific aspects (ability)	Instrument
Nominal Literacy	Content	Introduction to science concepts	open questions interview
Functional Literacy	Content	Ability to define/explain scientific concepts	open questions interview
Conceptual Literacy	Content and Context	Ability to lead to scientific explanations of everyday life phenomena	open questions interview
Multidimensional Literacy	Context + Skill	Ability to refer to written paragraphs	open questions interview

Analyzing student responses to written paragraphs

Researchers categorize student answers according to the following 1-3 scale:

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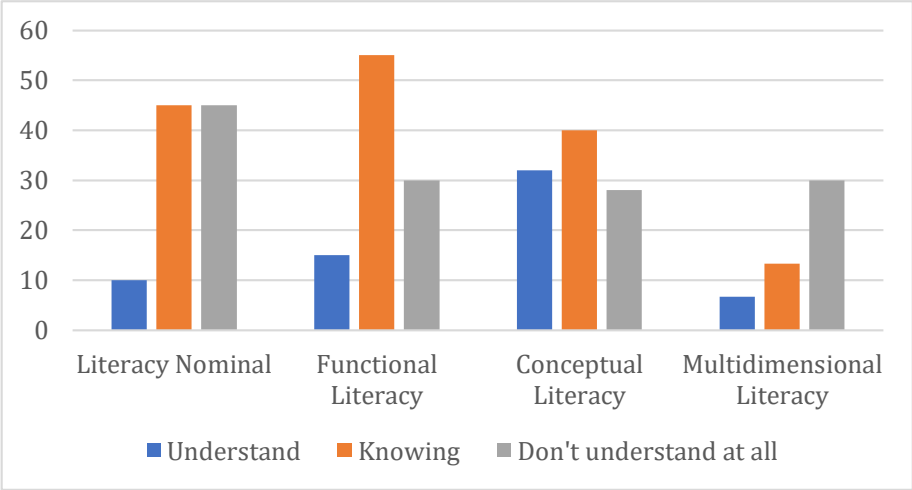
1. Wrong answers and explanations mean no understanding or unrelated reasons.
2. Partially true: contains evidence of understanding and limited reasoning abilities.
3. Correct answer: demonstrates reasoning and understanding abilities.

Discussion

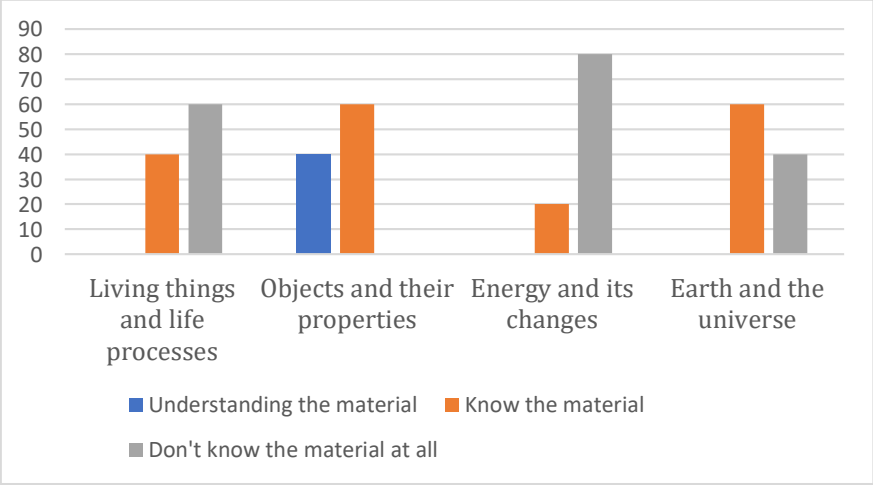
Student achievement at each level of scientific literacy is interpreted in learning with the idea of content and skills to be discovered in the lesson. The assessment tool was used to measure students' ability to understand science at the level of scientific literacy.



Graph 1. The results of students' scientific literacy abilities

Based on graph 1, it is found that the nominal literacy assessment shows that students' knowledge of science is still limited, where students can only mention big points in science have not yet been able to explain and understand basic science. Functional literacy assessment can be seen from students' interest in science, which is minimal. Most students are only interested in science, and some admit that they are not interested in science. Conceptual literacy assessment results in students' understanding of everyday scientific phenomena, which is still lacking. Students only answer without knowing whether it is right or wrong. This is because the lack of direction from the teacher to introduce everyday scientific phenomena results in low scientific literacy. Meanwhile, multidimensional literacy can be assessed from students' understanding of paragraph reading, which is limited, and there is no understanding of connecting new information with previous ones.

Nominal Literacy



Graph 2. The result of the open question about understanding basic science material

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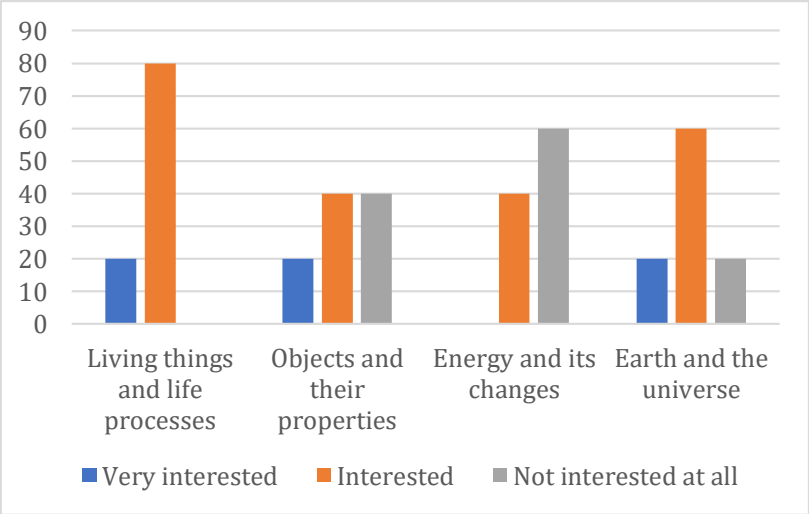
Open questions and interviews conducted from 5 students who were sampled showed that most only knew basic science material, in the category of living things and life processes, objects and their properties, energy, and changes, as well as the earth and the universe. Graph 2 shows that students have not understood basic science material. This is evident from the results of the Open questions that have been carried out. In the categories of living things and life processes, 40% of students answered that they knew the material, and 60% of students responded that they did not know the material at all. For the objects and their properties category, 60% of students answered that they knew the material, and 40% responded that they understood it. In the energy and its changes category, 20% of students answered that they knew the material, and 80% of students did not know the material at all. While the category of earth and the universe, 60% of students answered that they knew the material, and 40% responded that they did not see it.

It can be concluded that the ability of students to know has not yet been understood. This results in low scientific literacy. With scientific literacy, students are expected to understand the environment, health, economy, and other problems modern society faces that rely heavily on technology and scientific knowledge (Fanny et al., 2021; Fontenelle-Tereshchuk, 2021).

Functional Literacy



Graph 3. The result of the open question about interest in learning basic science

Graph 3 showed that students have limited knowledge of basic science categories and minimal interest in learning basic science. This is indicated by 20% of students are very interested in studying living things and life processes, and 80% of students are only interested in these materials. For objects and their properties, 20% of students are very interested, 40% are only interested, and 40% are not interested in studying the material. In the energy and its changes category, 40% of students are only interested, and 60% are not interested in learning the material. Meanwhile, 20% of students were very interested in the earth and universe categories, 60% were only interested, and 20% were not interested.

This shows that students' interest in science is minimal, resulting in low scientific literacy in elementary schools. This follows what You et al. conveyed about the low scientific literacy of students, including students' attitudes towards science, the science learning process at school, and students' interest and motivation in the learning science (Rachamatika et al., 2021; Sudrajat et al., 2021; You et al., 2021).

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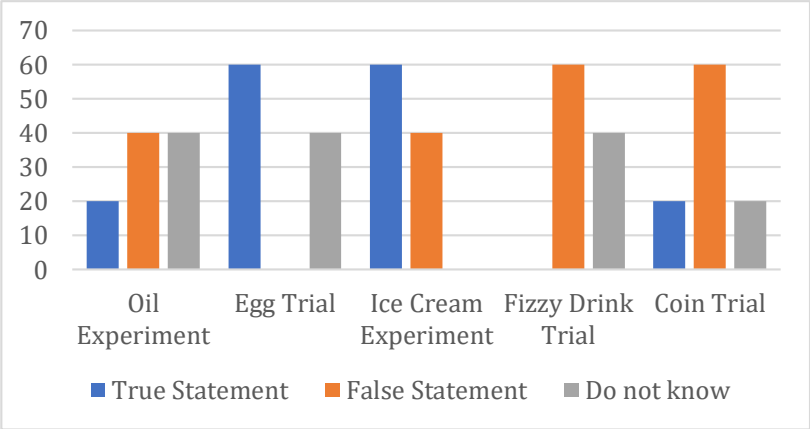
Conceptual Literacy

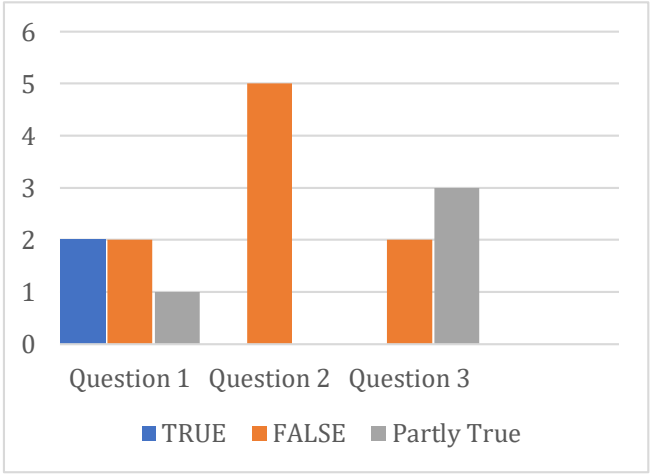


Graph 4. The result of an open question about students' ability in scientific explanation

The researcher focused on students' ability in scientific explanations for the phenomena of students' everyday lives. As shown in Graph 4, students tend never to do science experiments or experiments in class from the interview results obtained. On average, students do not understand scientific phenomena in their daily lives. This is evident from the interviews and open questions from some of the following phenomena: water and oil will not mix or mix if put in one container, 20% of students answered correctly, 40% answered incorrectly, and 40% did not know. The statement that the egg will float in water that contains a lot of salt, 60% answered correctly, and 40% did not know. The statement that ice cream can be formed by utilizing salt in manufacturing was that 60% of students answered correctly, and 40% answered incorrectly. Meanwhile, 60% answered incorrectly, and 40% did not know that carbonated drinks will produce foam if sprinkled with salt. As for the statement that coins will float if they are put into the water using a fork, 20% of students answered correctly, 60% of students answered wrongly, and 20% did not know.

The role of the teacher in the learning process, especially science, is significant. According to the content proposed by Sastradika et al., a teacher must develop students' scientific literacy abilities with various approaches and learning media that can stimulate and motivate students to learn (Sastradika et al., 2021; Setiawan et al., 2021; Utomo et al., 2021).

Multidimensional Literacy



Graph 5. The result of the open question about

Multidimensional scientific literacy means students understand and appreciate science and technology and their relationship to everyday life. More specifically, students begin to connect within and between

disciplines and science, technology, and the more significant problems that challenge our society (Bybee, 1997; Irawan & Iasha, 2021; Wahyudiana et al., 2021). Assessing all aspects of multidimensional scientific literacy may be complex and beyond current research. This level assessment is limited to a specific part: reading and understanding short articles, which examine the relationship between science and personal or social aspects. Ability to read, understand, relate new information to previous knowledge.

Graph 5 shows the results of interviews and open questions that have been conducted. Student A and Student B demonstrated reasoning ability and understanding of the information included in the paragraph, no irrelevant experience or reasoning related to prior scientific knowledge, and limited decision-making ability. Student C and student D expressed no understanding or unrelated reasons. Student E limited reasoning ability in understanding the information included in paragraphs and decision making or reasoning, no irrelevant experience or sense related to prior scientific knowledge. This shows that students' understanding of the reading is limited, and there is no understanding of connecting new information with previous ones.

CONCLUSION

The analysis of the scientific literacy ability of elementary school students has been successfully carried out. The research data found that the nominal literacy assessment showed that students' knowledge of science was still limited. Functional literacy assessment can be seen from students' interest in science which is still minimal. Conceptual literacy assessment results in students' understanding of everyday scientific phenomena lacking, while multidimensional literacy can be assessed from students' knowledge of paragraph reading is still limited. This study has limitations, which only assess students' current scientific literacy ability. There is no solution to improve scientific literacy. With the analysis of the scientific literacy assessment, it is hoped that future research can be a benchmark for developing ways to enhance students' scientific literacy in elementary schools.

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