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The Relationship between Science Literacy and Problem-Solving Skills of Students of Phase Changes of Matter Cours-e

Muhammad Ikhsan Sukaria
Prodi Pendidikan Guru Sekolah Dasar, Universitas Negeri Makassar
Corresponding Author: Muhammad Ikhsan Sukaria
Muhammad.ikhsan@unm.ac.id

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A B S T R A C T

This study aims to analyze the correlation between science literacy and problem-solving skills of elementary school students in science subjects, specifically in the material of phase changes of matter. A quantitative correlational research design was employed, involving 55 students from SD Inpres 12/79 Macanang, Bone, South Sulawesi. The research utilized two main instruments: a science literacy test consisting of multiple-choice questions with reasoning (two-tier) to assess students' scientific understanding and reasoning, and a problem-solving test in the form of open-ended questions. The results showed a strong positive correlation (r = 0.65) between science literacy and problem-solving skills, indicating that students with higher science literacy tend to perform better in problem-solving tasks related to phase changes. These findings highlight the importance of enhancing science literacy to improve students' problem-solving abilities in science education. Therefore, it is essential to focus on fostering science literacy in elementary education to equip students with the necessary skills to address real-world problems effectively.

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INTRODUCTION

Scientific literacy and problem-solving ability are two interrelated competencies that play a crucial role in meaningful science education. At the elementary school level, Integrated Natural and Social Sciences (IPAS) education holds a strategic role in establishing the foundations of students' scientific literacy from an early age. IPAS not only teaches students about the concepts of the natural universe but also fosters logical, critical, and systematic thinking. According to (Putri, 2022), scientific literacy is the ability to use scientific knowledge to make responsible decisions and to solve problems in various life contexts. Scientific literacy is essential because it facilitates students in understanding natural phenomena through evidence-based approaches and scientific reasoning. It is a mandatory competency for students to meet 21st-century challenges and is crucial due to its direct relationship with understanding scientific concepts.

The low level of scientific literacy among elementary students remains one of the primary challenges in the Indonesian education system. This issue is evident in the results of international assessments such as the Programme for International Student Assessment (PISA), which consistently places Indonesia at the lower ranks in scientific literacy. The 2018 PISA report indicates that Indonesian students achieved an average science literacy score of only 396, significantly below the OECD average of 489 (OECD, 2019a). This low achievement suggests that many students are unable to use scientific knowledge to explain phenomena, evaluate evidence-based information, and make decisions in real-life contexts. These findings are supported by local studies, such as that of (Sari, 2017), which revealed that elementary students in several regions of Indonesia demonstrated weak understanding of basic scientific concepts, including recognizing cause-effect relationships in natural phenomena.

One contributing factor to this low level of scientific literacy is the prevailing instructional approach that emphasizes rote memorization over the development of higher-order thinking skills. Science instruction at the elementary level often focuses on low-order cognitive domains such as remembering and understanding, while providing limited opportunities for students to analyses, evaluate, and create—skills essential for scientific problem-solving. According to (Widodo, 2018), science education that remains teacher-centred renders students passive and unaccustomed to thinking critically when facing science-related issues. This directly impacts their ability to independently solve scientific problems, as they are not trained to apply learned concepts in real-life contexts.

Problem-solving ability, on the other hand, is an essential cognitive skill in science learning. It requires students to functionally apply their existing knowledge in new contexts. According to (Tuan & Chin, 2005), problem-solving involves complex higher-order thinking processes, including analysing problems, integrating information, and evaluating alternative solutions. In science education, problem-solving ability heavily relies on students' conceptual understanding and their capacity for scientific reasoning.

Problem-solving is one of the key competencies in science education, requiring students to systematically utilize various cognitive skills. In the context of science learning, problem-solving encompasses more than just finding answers to scientific questions. It involves identifying the problem, formulating hypotheses, collecting and analysing data, and drawing conclusions based on evidence. According to (Gunawan, 2020), the problem-solving process includes four main stages: (1) understanding the problem, (2) devising a plan, (3) carrying out the plan, and (4) reviewing the results. These stages are highly relevant in science education because they support the development of scientific thinking and investigative skills that are central to the science curriculum.

Scientific literacy and problem-solving skills are intrinsically linked in science learning. Scientific literacy encompasses the understanding of scientific concepts, the ability to apply scientific knowledge in real-life contexts, and the capacity to evaluate evidence-based information (Yore et al., 2007). In solving scientific problems, students must rely on their scientific literacy as a foundation to interpret problems, make predictions, and evaluate alternative solutions. Research by (Laugksch, 2000) shows that students with a high level of scientific literacy are more capable of solving complex problems as they can integrate knowledge, process skills, and scientific attitudes in decision-making. This is supported by (Zubaidah, 2016), who found a significant positive correlation between scientific literacy and problem-solving skills among elementary students in Turkey.

Given the importance of both competencies, there is a need for instructional approaches and assessment strategies that can objectively evaluate the relationship between scientific literacy and problem-solving ability. Unfortunately, many learning approaches in elementary schools still prioritize verbal mastery of content without providing sufficient space for exploration and the application of concepts in real problem-solving contexts. Therefore, a literacy-based instructional approach that emphasizes students' active engagement in investigating and solving scientific problems needs to be developed from an early age. Assessment of the relationship between scientific literacy and problem-solving ability must also employ appropriate instruments, such as context-based questions, performance assessments, or diagnostic tools capable of evaluating students' conceptual depth. A study by (Nugraha & Setiawan, 2020) using a problem-based learning approach showed that instruction involving problem-solving scenarios can enhance scientific literacy while strengthening students' scientific thinking strategies.

One science topic that reflects gaps in conceptual understanding is the topic of changes in the states of matter. Although this topic is concrete and frequently encountered in daily life, many students still experience misconceptions. Research by (Suryawati & Osman, 2018) revealed that students often confuse physical and chemical changes and incorrectly attribute phenomena such as evaporation and melting to scientifically inaccurate causes.

For example, some students believe that evaporated water “disappears” without being able to explain it in particle terms.

LITERATURE REVIEW

Scientific literacy is a fundamental competency that not only encompasses the understanding of scientific concepts but also the ability to apply scientific knowledge in everyday life critically and reflectively. According to the Organisation for Economic Co-operation and Development (OECD, 2019), scientific literacy is defined as the ability to engage reflectively with issues related to science and the capacity to use scientific knowledge to identify questions, obtain evidence, and make decisions based on logic. Scientific literacy is especially crucial for elementary school students as it provides an early foundation for developing comprehensive scientific understanding and helps prevent misconceptions that may persist into higher levels of education (Suryawati & Osman, 2018)

On the other hand, problem-solving skills in science learning encompass the abilities to identify problems, formulate solution strategies, implement those solutions, and evaluate the outcomes. The problem-solving process consists of four systematic stages that require higher-order thinking skills, such as analytical, synthetic, and evaluative thinking (Yuliati, 2017). These skills are aligned with the demands of the Merdeka Curriculum, which emphasizes contextual and competency-based learning. In the context of science, problem-solving skills are not only tools for achieving cognitive learning outcomes but also serve as learning objectives themselves, as they bring students closer to the scientific methods used by scientists to address real-world problems (Dani & Koenig, 2011).

The relationship between scientific literacy and problem-solving ability has been explored by numerous researchers. Temel & Sen (2015) found that students with high levels of scientific literacy exhibited better problem-solving capabilities than those with lower levels. This is because scientifically literate students possess strong conceptual understanding and are able to interpret information critically, enabling them to develop rational and evidence-based solutions. Scientific literacy provides a framework of knowledge and critical thinking skills that empower students to formulate solutions for complex scientific problems, including topics like changes in the state of matter, which are often prone to misconceptions

The topic of changes in the state of matter is one of the key areas in elementary science that requires deep conceptual understanding, as it involves concepts such as energy transformation, particle structure, and the physical properties of substances. However, various studies have shown that students often hold misconceptions related to changes in the state of matter, such as the belief that substances disappear during evaporation or that water becomes "dead" after boiling (Bybee, 2013). These misconceptions often arise from instructional approaches that emphasize rote memorization over scientific reasoning. Therefore, enhancing students’ scientific literacy can be an effective strategy to reduce these misconceptions and simultaneously improve their

problem-solving abilities in accurately understanding and analysing scientific phenomena (Widodo, 2018).

METHODOLOGY

This study employs a quantitative approach with a correlational research design. This approach is chosen because it aligns with the main objective of the research, which is to determine the relationship between scientific literacy and students' problem-solving abilities on the topic of changes in the state of matter. Correlational research enables the researcher to identify the extent of the relationship between two variables without manipulating students' conditions. In this study, scientific literacy serves as the independent variable, while problem-solving ability is the dependent variable.

The research was conducted at SD Inpres 12/79 Macanang, Bone Regency, South Sulawesi, on May 1, 2025. This school was selected because it has implemented the Merdeka Curriculum and includes the topic of changes in the state of matter that aligns with the focus of this research. The research subjects consisted of fifth-grade students, with a total sample of 55 students selected through purposive sampling. The selection of the sample was based on the criterion that the students had studied the topic of changes in the state of matter in science lessons.

The instruments used in this study consisted of two types of tests. First, a scientific literacy test designed based on the OECD scientific literacy indicators, including content knowledge, contextual understanding, and scientific competencies. This instrument used two-tier multiple-choice questions to measure students' understanding of scientific concepts as well as their reasoning behind each choice. Second, a problem-solving skills test in the form of open-ended questions designed to assess students' abilities to analyze and solve problems related to changes in the state of matter. The questions were developed with contexts relevant to everyday life. The criteria for categorizing levels of students' scientific literacy and problem-solving skills were determined based on the following benchmarks.

Tabel 1. Interpretation Criteria

Achievement Level (%)	Category
81-100	Very Good
61-80	Good
41-60	Fair
21-40	Poor
0-20	Very Poor

(Sugiyono, 2018)

Prior to use, both instruments were tested for validity and reliability. The validation process was conducted by expert lecturers in the field of science education to ensure the alignment of the indicators with the aspects being measured. A pilot test of the instruments was carried out in a school with similar characteristics, and the results indicated that the instruments were both valid and reliable. The reliability test using Cronbach's Alpha yielded values

above 0.70 for both instruments, indicating that the instruments were suitable for use in this study.

Data collection was conducted in a single session on May 1, 2025, with the duration adjusted according to the time available at the school. After the data were collected, analysis was carried out using inferential statistical techniques, specifically the Pearson Product-Moment Correlation test, to examine the relationship between scientific literacy and students' problem-solving abilities.

Tabel 2. Interpretation Criteria

Interval Value r	Interpretation
0.00-0.199	Very Bad
0.20-0.399	Bad
0.40-0.599	Enough
0.60-0.799	Strong
0.80-1.000	Very strong

(Sugiyono, 2018)

RESEARCH RESULT

The results of the analysis using the Pearson correlation test indicate a significant positive relationship between scientific literacy and students' problem-solving skills. The obtained correlation coefficient was 0.65 indicating a strong relationship between the two variables. This means that the higher the level of students' scientific literacy, the better their ability to solve problems related to changes in the states of matter.

Students' scientific literacy abilities vary across each scientific literacy indicator. The highest average score was found in the concept understanding indicator, with a percentage of 80%, which falls into the Good category. An overview of students' scientific literacy abilities can be seen in Figure 1.

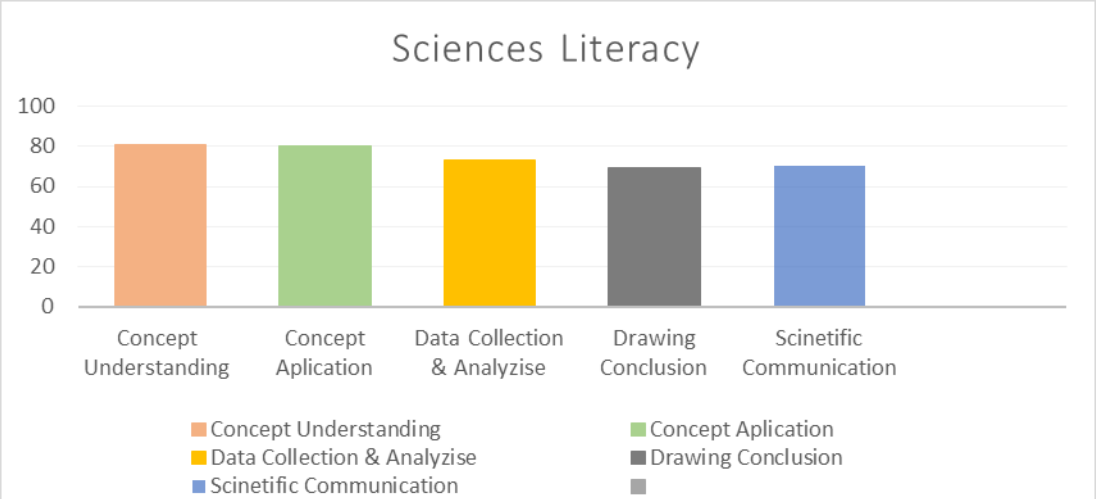

Figure 1. Achievement diagram for each aspect of student's scientific literacy

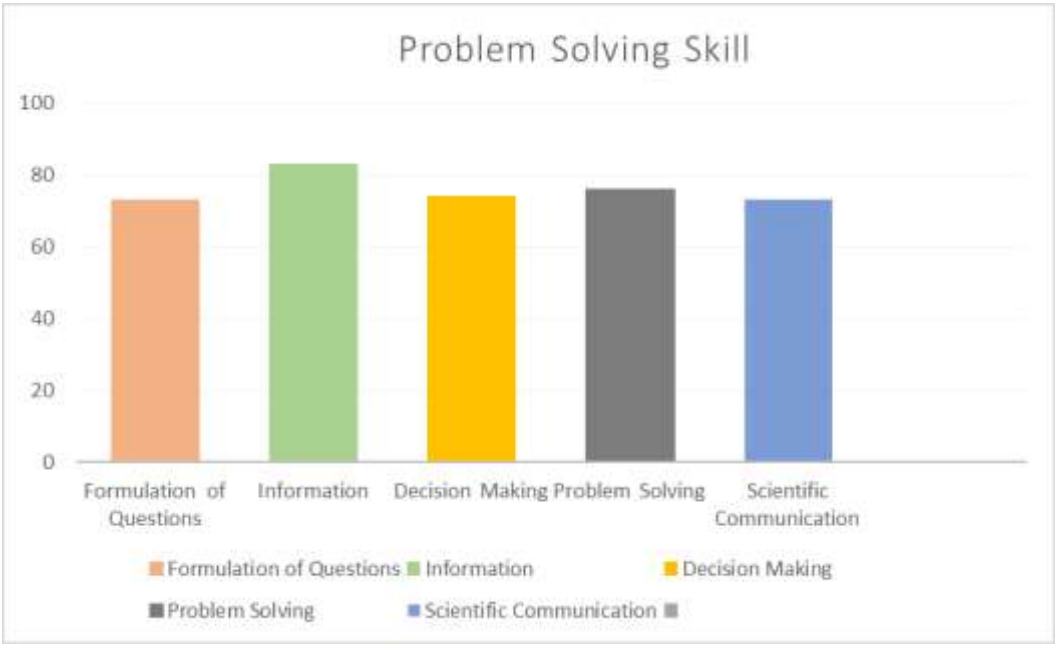

Figure 1. Achievement diagram for each aspect of students' problem solving skill

DISCUSSION

Scientific literacy encompasses students' ability to understand scientific concepts, process scientific information, and use that knowledge to solve problems. In the context of changes in the states of matter, strong scientific literacy enables students to more easily identify types of physical and chemical changes and apply those concepts to solve given problems. The correlation found in this study aligns with previous findings indicating that scientific literacy is not only related to conceptual understanding but also to critical thinking skills and problem-solving abilities (OECD, 2019b). Students with strong scientific literacy tend to be more skilled at analysing and interpreting the information needed to solve problems. Furthermore, these results are consistent with other studies showing that scientific literacy has a significant impact on other cognitive skills, including logical and critical thinking when facing problems (Putri, 2022). This indicates that scientific literacy goes beyond mastering scientific knowledge—it also includes the skills required to address real-life problems. Therefore, the findings of this study support the notion that scientific literacy contributes positively to students' problem-solving abilities. These results are in line with research by Dani & Koenig (2011) which found a reciprocal relationship between scientific literacy and problem-solving skills ($r = 0.78$, $p < 0.001$).

However, despite the significant relationship, the correlation coefficient obtained in this study does not indicate a very strong relationship. This may be due to other factors influencing students' problem-solving abilities, such as prior experience, teaching methods, or individual student motivation. Hence, while scientific literacy contributes to problem-solving skills, other factors must also be considered in efforts to enhance students' abilities to solve problems.

Overall, this study provides evidence that scientific literacy plays an important role in improving students' problem-solving abilities, particularly in

the topic of changes in the states of matter. Therefore, the development of scientific literacy should be an integral part of the elementary school curriculum, with an emphasis on teaching approaches that encourage students not only to understand scientific concepts but also to apply them in problem-solving contexts.

CONCLUSIONS AND RECOMMENDATIONS

Based on the research findings indicating a positive relationship between scientific literacy and students' problem-solving abilities in the topic of changes in the states of matter, it is recommended that teachers place greater emphasis on strengthening scientific literacy in science learning processes. Enhancing scientific literacy not only helps students gain a deeper understanding of scientific concepts but also significantly contributes to developing critical thinking and problem-solving skills.

Teachers can integrate learning activities that stimulate skills in reading, understanding, and evaluating scientific information from various sources, including texts, graphics, and experimental data. Inquiry-based and problem-solving learning approaches are also recommended to be consistently implemented across science topics, including the topic of changes in the states of matter.

This study focused only on the topic of changes in the states of matter, which represents a small part of the overall science curriculum. Therefore, the results of this research may not necessarily represent the relationship between scientific literacy and problem-solving abilities in other science topics that possess different characteristics.

ADVANCED RESEARCH

This study focused only on the topic of changes in the states of matter, which represents a small part of the overall science curriculum. Therefore, the results of this research may not necessarily represent the relationship between scientific literacy and problem-solving abilities in other science topics that possess different characteristics.

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