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ANALYSIS OF SCIENCE PROCESS SKILLS AMONG ELEMENTARY SCHOOL STUDENTS

Astri Sutisnawati, Yuli Rahmawati, M. Syarif Sumantri

[123] Universitas Negeri Jakarta,
Email: astri.sutisnawati@mhs.unj.ac.id

ABSTRACT

Elementary school students frequently face difficulties in grasping abstract science concepts, often exhibiting limited foundational scientific skills. Additionally, they tend to experience a teacher-centered approach to science instruction, which may impede their engagement and understanding. This study aims to investigate the science process skills of fifth-grade students as they explore the topic of light and its various properties. Conducted across three different schools, the research involved a total of 90 fifth-grade students. A qualitative methodology was employed to gain insights into the development of their science process skills during the learning experience. Data collection included assessments of science process skills as well as detailed observation sheets to monitor student engagement and performance. The findings indicated that students' performance on the science process skills tests fell within a moderate range. They encountered the most challenges in planning and conducting investigations, vital components of scientific inquiry. In contrast, they demonstrated greater proficiency in observational activities, suggesting that they possess the ability to make careful observations—an essential foundational skill in science education. This study highlights areas for improvement and underscores the importance of fostering a more hands-on and exploratory approach to teaching science.
Keywords: science process skills, elementary school, student.

INTRODUCTION

Elementary school science education focuses on understanding both living organisms and inanimate objects in the universe, as well as their interactions. It also explores human life, both as individuals and as social beings interacting with their environment (BSKAP, 2022). One of the primary goals of Science Learning (IPAS) in elementary schools is to develop process skills that enable students to identify, formulate, and solve problems through hands-on activities (BSKAP, 2024). Science learning involves activities that not only provide knowledge but also foster critical thinking skills. These skills help students understand and generate facts, concepts, principles, laws, and theories. Additionally, students learn procedural knowledge, which includes methods for acquiring information through scientific activities based on Science Process Skills (Hamadi et al., 2018). Science process skills are fundamental components of scientific inquiry that empower students to engage deeply with the subject matter. These skills, which include observing, classifying, measuring, predicting, and experimenting, promote logical and rational thinking as students learn to analyze data, draw conclusions, and formulate hypotheses. By actively participating in hands-on experiments and

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observational studies, students enhance their understanding of scientific concepts while developing critical thinking and problem-solving abilities. This process not only increases their interest in science but also fosters a collaborative learning environment where they can share ideas and challenge each other's reasoning. Ultimately, mastering these process skills equips students with the tools they need to navigate the complexities of the scientific world and encourages a lifelong curiosity about the natural phenomena around them.Science process skills are essential tools that foster logical and rational thinking in the field of science. By developing these skills, students become more engaged and actively participate in their learning experiences. This not only deepens their understanding of scientific concepts but also encourages critical thinking and problem-solving abilities, making science education more interactive and enriching.. This approach encourages students to comprehend how learning should be conducted and supports sustainable educational practices (Burns et al., 1985; Karamustafaoğlu, 2011)

Science process skills are divided into two categories: basic skills and integrated skills. Basic process skills include the abilities to observe, infer, measure, communicate, classify, and predict. Integrated process skills, on the other hand, involve controlling variables, providing operational definitions, formulating hypotheses, interpreting data, and conducting experiments (Collette & Chiappetta, 1984). Science process skills are essential tools that scientists use to investigate the natural world and gather information. These skills are divided into two main categories: basic skills and integrated skills. Basic process skills consist of fundamental abilities that serve as the foundation for scientific inquiry. These include the ability to observe, which allows scientists to notice and describe phenomena accurately; to infer, which enables them to draw logical conclusions based on observations; to measure, which provides quantifiable data about various properties; to communicate, allowing for the sharing of findings and ideas; to classify, helping in organizing information into categories; and to predict, which involves making informed guesses about future outcomes based on current knowledge. Integrated process skills, on the other hand, involve more complex thinking and application of basic skills in conducting scientific investigations. These skills include controlling variables, which is crucial for ensuring that experiments produce valid results by isolating factors being tested; providing operational definitions that clarify concepts and ensure consistency in measurement; formulating hypotheses, which are testable statements that guide research; interpreting data, allowing scientists to analyze results and draw meaningful conclusions; and conducting experiments, which involves designing and executing procedures to test hypotheses systematically. Together, these skills enable scientists to explore, learn, and advance our understanding of the world around us.

The science process skills that students develop are not confined to the classroom setting; they play a crucial role in helping students address everyday challenges. These skills, which include observation, experimentation, and analytical reasoning, empower students to approach problems systematically and effectively. By honing these abilities, students improve their critical thinking, enabling them to make informed decisions in various life situations. Furthermore, the ability to think critically and solve problems is essential not only in academic contexts but also in social interactions, fostering collaboration and enhancing communication skills in group settings. Ultimately, these skills prepare students to navigate the complexities of both their personal and professional lives(Aydoğdu et al., 2014). According to the (Kebudayaan, 2022) the indicators of science process skills are as shown in table 1:

The indicators of science process skills	Description
Observe	When making observations, students pay close attention to phenomena and events, take notes, and compare the information collected to see the similarities and differences. Observations can be made directly or using other instruments such as questionnaires, interviews.
Questioning and predicting	Students are encouraged to ask questions about things they want to know when making observations. At this stage, students also connect their knowledge with the new knowledge to be learned so that they can predict what will happen with the law of cause and effect
Plan and conduct investigations	Students make plans and draw up operational steps based on correct references. Students can answer questions and prove predictions by conducting investigations. This stage also includes the identification and inventory of operational factors both internal and external in the field that support and hinder activities
Processing, analyzing data and information	Students select and organize the information obtained. He interprets the information obtained honestly and responsibly. Furthermore, analyze using the right tools and methods, assess the relevance of the information found by including reference references, and conclude the results of the investigation.
Evaluating and reflection	Students assess whether the activities carried out are in accordance with the planned goals or not. At the end of this cycle, students also review the learning process undergone and things that need to be maintained and/or improved in the future.
Communicate results	Students report results in a structured manner through oral or written, using charts, diagrams and illustrations, and are created into digital and non-digital media to support explanations. Students then communicate the results of their findings by publishing the results of the report in various media, both digital and or non-digital. Reporting can be done in collaboration with various parties.

The TIMSS (Trend in International Mathematics and Science Study) is an international assessment that evaluates the science achievement of fourth-grade elementary and eighth-grade students in various countries every four years. In 2023, the science assessment for fourth-grade elementary students focuses on three main areas: life science (45%), physical science (35%), and earth science (20%). It tests proficiency across three cognitive domains: knowing (40%), applying (40%), and reasoning (20%). Indonesia participated in TIMSS from 1999 to 2015 but did not take part in the 2019 and 2023 cycles (Centurino & Kelly, 2023). According to the latest data, the average science score of fourth-grade students in Indonesian elementary schools remains below the international average in several assessment cycles.

Based on observations in three elementary schools in Sukabumi City, it was found that the science learning approach is still centered around teachers, predominantly using the lecture method with occasional practicum activities. The topic of light and its properties is challenging for students to grasp when learning is limited to reading books and listening to teacher explanations. As a result, the learning experience lacks meaning, as students do not engage in hands-on activities, investigations, or other meaningful experiences that allow them to explore concepts directly. Students have fewer opportunities to discover and build their own understanding, and they receive limited experience in collaboration, presenting experimental results, and developing various skills. Furthermore, the assessment methods employed by teachers primarily consist of written tests that focus on cognitive aspects, neglecting the psychomotor and affective domains. Effective science learning should emphasize hands-on experiences, exploration,

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and inquiry, enabling students to learn actively and creatively through their own observations and discoveries. This approach encourages students to develop essential science process skills such as observing, questioning, predicting, inferring, and communicating, all tailored to their cognitive development stages.

METHOD

This study employs a qualitative research approach, focusing specifically on fifth-grade students across three elementary schools in Sukabumi City. The total participant population consists of 90 students, selected to provide insights into their science processing skills. To gather data, the research utilized two main instruments: SCS test sheets and detailed observation forms. The SCS test sheets were designed to assess the students' scientific understanding and abilities in processing information. In parallel, the observation forms were specifically tailored to align with predetermined indicators of science processing skills, such as formulating hypotheses, conducting experiments, and analyzing data. The observation forms were structured using a four-point Likert scale to capture various levels of student performance and engagement . Each point on the scale corresponds to specific descriptors, allowing for nuanced evaluation of the students' skills. Additionally, a rubric was developed to facilitate consistent and objective assessment across different observers, ensuring reliable data collection and analysis. This comprehensive methodological framework aims to provide in-depth insights into the students' scientific capabilities and learning processes.All data were analyzed following the Miles and Huberman model and then compared with a classification table.

Table 2: Classification of Science Process Skills Test Criteria

Percentage Score	Criteria Classification
100-80	Height
79-60	Medium
≤59	Low

Table l 3: Classification of Science Process Skill Observation Criteria

Percentage Score	Criteria Classification
> 75% s/d 100%	Excellent
> 50% s/d 75%	Good
> 25% s/d 50%	Bad
0% s/d 25%	Very Bad

RESULTS AND DISCUSSION

The Science Process Skills Test is designed to evaluate students' understanding and application of key scientific concepts through a series of 10 essay questions. These questions are aligned with the Science Process Skill Indicators established by the Ministry of Education and Culture, ensuring that they reflect the essential skills needed for scientific inquiry. To gauge the reliability of the test, we employed Cronbach's Alpha, which yielded a score of 0.704. This statistic suggests a moderate level of internal consistency among the test items, indicating that the questions are reasonably reliable in measuring students' science process skills. During the validity assessment, it was determined that one of the questions did not meet the necessary standards and was

therefore classified as invalid. In response, this question was revised to better align with the testing criteria. The updated questions were subsequently administered to the research subjects, allowing us to gather fresh data. Upon analyzing the results of the test, we found that the average score for the students' science process skills was 63.4. This score provides valuable insight into the overall proficiency of students in applying scientific methods and principles, highlighting areas where further instruction may be beneficial. Table 3 provides a detailed breakdown of the science process skills for each indicator.:

Table 4 . Science Process Skills Test Results

No	Indicator	Percentage	Criteria
1	Observe	83,5%	Height
2	Questioning and predicting	70,2%	Medium
3	Plan and conduct investigations	58,8%	Low
4	Processing, analyzing data and information	65,5%	Medium
5	Evaluating and reflection	71%	Medium
6	Communicate results	82%	Medium
	Average	71,83%	Medium

As presented in Table 4, the data reveals significant insights into students' science process skills across various indicators. Notably, the Planning and Conducting Investigations category shows the lowest performance, with only 58.8% of students demonstrating proficiency in this area. This suggests a need for targeted intervention to enhance their investigation skills, which are critical for practical scientific inquiry. In contrast, the Observing category stands out with a high proficiency rate of 83.5%. This indicates that a majority of students are skilled at making observations, a foundational skill in science that involves noticing and describing phenomena accurately. Overall, when we assess the students' science process skills based on the test data, they are categorized as falling within the moderate criteria range, with an average score of 71.83%. This average suggests that while students possess a reasonable understanding of science process skills, there remains room for improvement, particularly in planning and conducting investigations. Enhancing these skills could lead to more successful outcomes in scientific exploration and critical thinking.

The observation sheet utilized is a structured type, comprising four scales: Very Good, Good, Not Good, and Very Bad, with a total of 10 items. Each criterion for attitude is assessed using rubrics. Table 5 presents the results of the analysis of this observation sheet.

Table 5 . Science Process Skills Observation Results:

No	Indicator	Percentage	Criteria
1	Observe	83,4%	Excellent
2	Questioning and predicting	74,2%	Good
3	Plan and conduct investigations	60,8%	Good
4	Processing, analyzing data and information	71,5%	Good
5	Evaluating and reflection	70,2%	Excellent
6	Communicate results	82,5%	Excellent
	Average	73,7%	Good

As presented in Table 5, the assessment of students' science process skills revealed some noteworthy findings. Specifically, the indicator related to Planning and Conducting Investigations exhibited the lowest proficiency among students, with only 60.8% demonstrating adequate skills in this area. This suggests that many students may struggle with effectively planning and implementing scientific investigations. In contrast, another indicator also recorded a percentage of 60.8%, which indicates a potential issue with the

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consistency of the data reported. This discrepancy raises questions about the accuracy and reliability of the assessments in this particular context. Despite these challenges, the overall data derived from observations indicate a more favorable outcome for students' science process skills. On average, students achieved a commendable score of 73.7%. This suggests that while some specific areas need improvement, the majority of students are demonstrating a satisfactory level of proficiency in their science process skills overall.

Planning and conducting scientific investigations is currently one of the areas that shows the lowest levels of engagement among students. This is concerning because active participation in scientific investigations plays a crucial role in education. When students take part in these investigations, they move beyond being passive recipients of information; they become explorers and discoverers, engaging directly with concepts and patterns found in natural phenomena. Through hands-on investigations, students learn to formulate hypotheses, design experiments, collect and analyze data, and draw conclusions based on their findings. This process not only enhances their understanding of scientific concepts but also helps them develop critical thinking, problem-solving skills, and a systematic approach to inquiry. Furthermore, involvement in scientific investigations cultivates essential scientific attitudes, such as curiosity, skepticism, and an appreciation for evidence-based reasoning. As students delve into investigations, they gain a deeper comprehension of the material they study. This approach enables them to connect theoretical knowledge with real-world applications, making learning more relevant and engaging. Consequently, their ability to critically assess information and interact thoughtfully with their environment improves significantly. Ultimately, fostering a culture of scientific investigation is vital for enhancing scientific literacy among students. In today's rapidly advancing society, where science and technology play an integral role in shaping our lives, possessing strong scientific literacy is essential. It empowers individuals to make informed decisions, understand complex issues, and engage meaningfully in discussions about scientific advancements and their implications for the future (Sulfiyah & Cahyaningsih, 2021)

Students' science process skills are typically classified as being at a "moderate" level. These skills are vital for deepening their comprehension of key scientific concepts and principles. By engaging in activities that foster these skills—such as making observations, forming hypotheses, conducting experiments, analyzing data, and drawing conclusions—students are better equipped to navigate the complexities of the scientific method. Furthermore, strong science process skills lay the groundwork for developing scientific literacy, which is crucial in today's data-driven world. This literacy empowers students to think critically about scientific issues, evaluate evidence, and engage thoughtfully with the natural environment. As students refine these skills, they not only enhance their academic performance in science but also cultivate a lifelong appreciation for scientific inquiry and its applications in real-world scenarios. Through honing these skills, students are expected to be better equipped to ask questions, formulate insightful and testable hypotheses, plan and conduct investigations, and analyze and interpret data. Effectively communicating their findings ultimately cultivates a lifelong interest in science learning (Anisa et al., 2023).

To effectively improve students' science process skills, it is essential to understand and apply the appropriate models, approaches, methods, and media in science education. One effective model is the Engineering Design Process (EDP), which has been shown to enhance these skills . This approach utilizes a cyclical design sequence that focuses on identifying and solving real-world problems. It is adaptable, allowing for the creation of

multiple versions that can be customized to suit various circumstances and contexts. This flexibility ensures that the solutions can effectively address a diverse range of challenges. (Sutisnawati et al., 2025). he Engineering Design Process (EDP) immerses students in practical, hands-on experiences that deepen their understanding of essential scientific concepts. Through engaging activities, they gain valuable insights into the field of engineering while developing vital skills needed for success in the 21st century, such as critical thinking, problem-solving, and teamwork. This comprehensive approach not only fosters creativity but also prepares students for real-world challenges they may face in their future careers (Schnittka et al., 2002). The EDP is designed to evolve through various educational stages. At the elementary level, the focus is on fostering creativity and generating ideas. As students advance to the upper secondary level, the emphasis shifts to analysis, testing, and evaluation, which helps develop their critical thinking skills. Finally, at the educator level, the focus is on redesigning and improving the learning experience to ensure that teaching methods continue to evolve and enhance student learning (Lin et al., 2018).

Science process skills are essential for students, as they involve actively engaging in and taking responsibility for learning a variety of scientific research methods. By participating in hands-on experiments, conducting investigations, and analyzing data, students develop a deeper understanding of scientific concepts. This active participation not only fosters curiosity but also encourages critical thinking and problem-solving abilities. Furthermore, the application of scientific knowledge gained through these experiences can significantly enhance students' long-term learning strategies, equipping them with valuable skills that extend beyond the classroom and into real-world situations. Emphasizing these skills prepares students to approach scientific challenges with confidence and independence (Alkan, 2016). Gaining these skills is crucial for students as they delve into and comprehend fundamental scientific concepts. These skills not only enhance their understanding of the subject matter but also empower them to engage in practical applications of science. Furthermore, science process skills such as observation, experimentation, and critical thinking play a vital role in enabling students to tackle specific tasks and resolve a wide array of problems effectively. By honing these skills, students are better equipped to approach scientific inquiries and contribute to the broader field of science (Harahap et al., 2022).

Acquiring a strong set of skills is essential for students as they advance their understanding of important scientific concepts. These skills not only help students grasp theoretical knowledge but also enable them to apply this knowledge in practical situations. Additionally, mastering science process skills such as observation, experimentation, data analysis, and critical thinking is crucial for completing specific tasks effectively. These skills empower students to approach a wide range of problems, allowing them to analyze situations, develop hypotheses, conduct experiments, and draw informed conclusions. Overall, a solid foundation in both scientific concepts and process skills prepares students for success in their academic pursuits and future careers in science-related fields (Shah et al., 2015). Science process skills are vital for evaluating how well students grasp various scientific concepts. These skills encompass a range of abilities, including observation, experimentation, analysis, and critical thinking. By developing these skills, students can better engage with scientific material, formulate hypotheses, conduct experiments, collect and analyze data, and draw informed conclusions. This not only deepens their understanding of scientific principles but also

prepares them for future studies and real-world applications in science (Abungu et al., 2014).

CONCLUSION

The findings of the study highlight an important opportunity for improvement in students' science process skills, which achieved an average score of 71.83%, classified as moderate. Notably, planning and conducting investigations scored the lowest at 58.8%, signaling a critical area for enhancement. In contrast, observation skills excelled with a score of 83.5%. With focused support, we can elevate these vital skills to empower students' scientific understanding and confidence. Science process skills are essential for effectively assessing students' comprehension of various scientific concepts. These skills enable students to systematically observe phenomena, formulate inquiries, conduct experiments, interpret data, and derive conclusions. By cultivating these skills, educators can facilitate a deeper understanding of scientific principles among students, ultimately enhancing their critical thinking and problem-solving capabilities. This holistic approach is vital for preparing students to apply their knowledge in practical and real-world contexts

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