Analysis of Elementary School Students' Science Literacy in Learning Natural and Social Sciences (IPAS)

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Abstract

This study aims to analyse the scientific literacy skills of elementary school students in learning Natural and Social Sciences (IPAS) with a focus on four indicators, which are understanding basic scientific concepts (content knowledge), critical thinking and inquiry skills (scientific inquiry), the ability to apply scientific concepts in a social context (contextual application), and scientific attitudes. The research method used is descriptive qualitative with data collection techniques through observation, interviews, and documentation. Observations were conducted to observe learning activities, while interviews were conducted with teachers and principals to find out their responses regarding students' scientific literacy. The results of the study indicate that students' understanding of basic scientific concepts is quite good, especially when learning uses a practical approach and is based on the context of everyday life. Students' critical thinking and inquiry skills still need to be improved, especially in terms of asking questions and formulating hypotheses. Students' ability to apply scientific concepts to a social context shows positive results, especially through project activities that are relevant to the surrounding environment. Students' scientific attitudes, such as curiosity, are starting to develop, but attitudes of accuracy and precision still require further development. The conclusion of this study is that elementary school students' scientific literacy can be improved through inquiry-based learning methods, projects, and experiments involving real-life contexts and active guidance from teachers. This study recommends strengthening learning programs that encourage critical thinking, scientific attitudes, and the application of science in everyday life.

Keywords : Scientific Literacy, Elementary School, Science Learning

1. Introduction

The problem of science literacy among elementary school students is a crucial issue in the world of education, especially related to students' ability to understand, analyze, and apply science concepts in daily life. Science literacy not only includes the understanding of scientific knowledge, but also includes the ability to think critically and solve problems scientifically, which is very important for the younger generation in facing the challenges of the modern world (DeBoer, 2000; Idyl et al., 2024). The results of the Program for International Student Assessment (PISA) show that students' science literacy in Indonesia is ranked relatively low compared to other countries, indicating a lag in terms of mastery of science at an early age (Idil et al., 2024). This problem is thought to be rooted in the lack of implementation of a student-centered and exploratory learning process, which can effectively improve students' conceptual understanding as well as critical thinking skills (Bybee, 2010).

According to Rustaman (2016); Widoretno (2022), the learning process in elementary schools still tends to be conventional and does not stimulate student involvement in contextual experiments or problem-solving. In addition, there is a gap in the provision of learning facilities and media that support scientific activities in the classroom, which has implications for students' low ability to conduct the science investigation process independently (Harlen, 2015; Ayurachmawati & Widodo, 2016). Another factor that exacerbates this condition is the low perception of teachers on the importance of developing science literacy from an early age, as well as the limitations of training to integrate inquiry-based science learning processes (Nurhanifah & Utami, 2023).

Science literacy itself is defined as the ability of individuals to understand scientific concepts, apply that knowledge in real-life contexts, and develop critical thinking in solving science-related problems (Roberts, 2000; Laugksch, 2000). Science literacy is not only limited to understanding scientific theory, but also includes the ability to critically evaluate information, understand the impact of science on the environment and society, and actively engage in scientific issues

relevant to daily life (Idil et al., 2022). According to the National Research Council (2012), science literacy indicators include understanding basic science concepts (content knowledge), critical thinking and inquiry skills (scientific inquiry), ability to apply science concepts in a social context (contextual application), and scientific attitudes (scientific attitudes). At the elementary school level, science literacy is measured through indicators such as observation skills, understanding of scientific processes, and students' ability to argue and draw conclusions based on the data obtained (Shwartz et al., 2006; Rustaman, 2016).

The importance of science literacy for elementary school students lies in its role in equipping students with the basic skills necessary to understand the world around them, solve problems, and make responsible decisions (Nbina & Obomanu, 2010). Science literacy not only develops scientific knowledge, but also improves critical and analytical thinking skills which are the foundation for learning at the next level (Bybee, 2010). In today's era full of information and technological change, science literacy skills allow students to critically filter information and actively participate in science issues that affect lives, such as environmental, health, and technological issues (Laugksch, 2000; Wahyuni & Putra, 2021). Science literacy also plays an important role in shaping students as responsible citizens, as it helps to understand the impact of human actions on nature and society (Yuenyong & Narjaikaew, 2009).

Children's science literacy is influenced by a variety of factors, including teaching methods, learning environment, the role of teachers, and parental support. Interactive and inquiry-based learning methods have proven to be effective in improving scientific understanding, as they encourage students to actively participate in exploration and problem-solving (Thuneberg et al., 2022; Angelia et al., 2022). In addition, the role of teachers as facilitators is very important in building science literacy, especially through the use of relevant and contextual learning strategies, as well as the ability of teachers to convey science concepts in an interesting and easy-to-understand way for students (Rustaman, 2016). In addition, a supportive learning environment, such as laboratory facilities

and access to adequate learning resources, also plays an important role in helping students develop science skills (Suparya et al., 2022). Another factor that also influences is parental support, which can help children expand their understanding through science-relevant activities at home (Glynn et al., 2009). The ability of teachers to combine contextual knowledge with science literacy is very important to apply it in Natural and Social Sciences (IPAS) learning (Putri et al., 2023).

Science and social studies subjects combined into science subjects in the Independent Curriculum are expected to encourage students to manage both the natural and social environment (Rahma et al., 2024). IPAS in elementary schools aims to introduce basic concepts about the natural and social environment, as well as how they interact with each other. At the elementary school level, these subjects usually cover basic topics such as the environment, cultural diversity, ecosystems, energy, and simple natural processes. The purpose of IPAS is to prepare students with the basics of scientific knowledge that can be used to understand the surrounding phenomena, both related to natural sciences and social aspects (Dewi & Prasetyowati, 2023). IPAS in elementary schools is often designed in an integrated manner so that students not only understand scientific facts, but also be able to interpret the relationships between concepts, which encourages critical and analytical thinking skills. Through IPAS, students learn to relate natural knowledge to surrounding social phenomena, such as the relationship between the environment and people's habits, or the influence of human activities on environmental conditions. Thus, IPAS not only provides a factual understanding of science, but also develops students' ability to apply that knowledge in a social context, which is an important component of science literacy. In addition, the integration between scientific and social aspects in IPAS encourages students to consider various perspectives in problem solving, both scientifically and socially, which ultimately improves their critical awareness and logical thinking skills (Bybee, 2010).

Several previous studies have shown that the level of science literacy of elementary school students still needs significant improvement in various countries, including Indonesia. Research conducted by Aprilia et al. (2021) found that students' science literacy is still relatively low, especially in the aspects of critical thinking skills and mastery of basic science concepts. Another study by Latif et al (2022) identified that traditional teaching methods that tend to be passive and less interactive are one of the causes of low science literacy. The research from Ramadhan (2023) emphasizes the importance of project-based and experiment-based learning in increasing student engagement in science. In general, these studies show that although science literacy is an important focus in education, improvements are still needed in learning methods and curriculum development that is more oriented towards scientific thinking skills to improve students' understanding of science from an early age.

Based on the above background, this study aims to describe the science literacy of elementary school students in science learning. In addition, this research is expected to contribute to the improvement of curriculum and teaching practices relevant to the needs of modern science literacy, which is an important competency in facing global challenges such as climate change and technology (Millar & Osborne, 2000). Given the importance of science literacy in preparing the young generation who are able to think critically and play an active role in a knowledge-based society, the results of this study can also provide useful recommendations for science education policies at the elementary level (Nbina & Obomanu, 2010).

2. Method

This study uses a qualitative approach. Qualitative research focuses on the exploration of phenomena in natural contexts without the manipulation of variables, with the primary goal of understanding reality holistically and contextually (Creswell & Creswell, 2017). Through this approach, researchers can explain how individuals understand and respond to their experiences in a

particular context (Babchuk, 2017). In this study, the researcher wants to understand the science literacy of elementary school students in science learning, so that the researcher can explain how students can understand and respond to their abilities (science literacy).

The data sources of this study consist of primary and secondary data sources. The primary data source is students (science literacy ability), while secondary data sources from books and scientific articles are relevant. The location of the research was conducted at SD Muhammadiyah Surabaya.

The data collection techniques in this study used observation, interviews, and documentation. Observation is a method of collecting data by directly observing phenomena in the field (Creswell & Creswell, 2017). In this study, observations were made to observe the science literacy of elementary school students in science learning. Interviews are data collection techniques that are carried out through direct interaction between researchers and respondents to dig into information in depth (Kvale, 2009). In this study, the researcher conducted interviews with teachers and principals to find out their responses to the science literacy of elementary school students in science learning. Documentation is a method of data collection that involves the analysis of written documents, images, or recordings that are relevant to the research (Bowen, 2009). In this study, the documentation collected by the researcher was in the form of files of science literature work, transcripts of interviews from teachers and principals, etc.

The data analysis technique in this qualitative research refers to Miles & Huberman (1994), namely data reduction, data presentation, and conclusion drawn/verification. This model is often used because it offers a practical and structured approach to managing complex data.

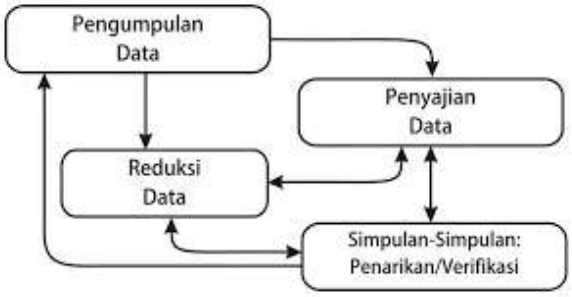

Figure 1. Flow of Qualitative Research Data Analysis Miles & Huberman (1994)

Data reduction is the process of selecting, focusing, and simplifying raw data obtained from the field. In this stage, data that is irrelevant or does not support the focus of the research is eliminated, while significant data is summarized or categorized. Miles & Huberman (1994) emphasize that data reduction is not only a process of elimination, but also the transformation of raw data into a more organized form. This allows researchers to understand the important patterns present in the data. This process is often carried out in conjunction with data collection, so that analysis and data collection run simultaneously (Miles et al., 2014).

The next stage is data presentation, which aims to display data in a format that makes it easy to interpret, such as a matrix, table, graph, or diagram. Data presentation helps researchers see the relationships between certain variables, patterns, or trends that emerge from the data. Miles & Huberman (1994) underline that good data presentation should be informative, simple, and focus on aspects relevant to the research objectives. With a clear presentation, researchers can more easily draw conclusions and make interpretations.

The final stage is the drawing of conclusions, which is done by identifying themes, patterns, relationships, or propositions that emerge from the data. The initial conclusions drawn should be verified by checking the consistency of the data, triangulating, or comparing the findings with relevant theories. Miles & Huberman (1994) affirm that verification is an essential step to ensure the validity and reliability of conclusions. This process allows researchers to sharpen their

interpretation and ensure that the results of the study are supported by strong evidence.

3. Result and Discussion

Observation Results

Based on the results of observations, the understanding of basic science concepts (content knowledge) of elementary school students in social studies learning shows the active involvement of students in understanding the process of plants producing food. Strengthening students' science literacy requires a contextual, interactive, and student-centered approach to learning to promote a deeper understanding of basic science concepts.

Based on the results of observations, critical thinking skills and inquiry of elementary school students in social studies learning show that students dare to ask questions, investigate a problem why plants that are not exposed to sunlight wither, discuss and find the answer themselves. However, students' ability to identify problems, formulate hypotheses, and draw conclusions still needs to be strengthened through a systematic and continuous inquiry-based learning approach. The development of science literacy through scientific inquiry skills requires the active role of teachers, the use of supportive media, and the habit of critical thinking in the learning process.

Based on the results of observations, the ability of students to apply science concepts to social contexts such as not picking plants carelessly has been seen in daily habits, because all parts of plants have an important role in the process of making food (photosynthesis) in addition to that students also show behavior of not playing under trees at night because at night trees emit carbon dioxide. Students also tend to understand concepts more easily if they are given stimulus in the form of real problems that are close to life. To develop contextual science literacy, inquiry-based learning strategies, projects, and problem-solving that involve students' direct interaction with social phenomena are needed.

Based on the results of observations, elementary school students' scientific attitudes in science learning develop well when given the opportunity to explore, discuss, and make observations through inquiry-based activities and hands-on practice. Attitudes such as curiosity, objectivity, openness, and perseverance tend to be more prominent in learning environments that favor active interaction and real problem-solving. Contextual and collaborative learning approaches need to be integrated consistently to foster scientific attitudes in elementary school students.

Teacher Interview Results

Based on the results of interviews with teachers regarding students' understanding of basic concepts of science in learning IPAS, it is shown that students' understanding of basic concepts of science in learning of science is greatly influenced by the teaching approach applied, the media used, and the level of active involvement of students in learning. Although most students show a good understanding of more concrete basic concepts, the biggest challenge lies in understanding abstract concepts that require a more in-depth approach and the use of more varied methods. Continuous evaluation and adjustment of learning strategies are expected so that students' understanding of basic science concepts can continue to develop optimally.

Based on the results of interviews with teachers regarding students' critical thinking and inquiry skills in understanding IPAS material, it shows that although students' critical thinking and inquiry skills in IPAS learning have shown progress, there are still some areas that need more attention. Especially in terms of increased depth of analysis and the ability of students to continue the inquiry process to a more substantial conclusion. For this reason, teachers assess the importance of a more innovative learning approach, such as assigning more challenging assignments, strengthening scientific experiments, and developing a culture of questioning and critical thinking in every learning activity. These steps are expected to ensure that students' critical thinking and inquiry skills can continue to develop and have a positive impact on their science literacy.

Based on the results of interviews conducted with teachers regarding students' understanding of relating science concepts to daily life, it shows that most students can relate science concepts to daily life, especially on topics that have direct relevance to their experiences. Nonetheless, there are challenges in connecting more abstract science concepts with real life, especially when students do not have hands-on experience or concrete examples that can be used to relate learning to their lives. For this reason, teachers emphasized the importance of applying more contextual learning methods and developing more experience-based activities, so that students can more easily understand and apply science concepts in their daily lives.

Based on the results of interviews conducted with teachers regarding students' curiosity, precision, and precision in learning science, it shows that students in general show high curiosity, but the challenge lies in developing precision and precision in the implementation of experiments and scientific observations. Appropriate guidance and contextual approaches can be taught to students to be more thorough and careful in the science learning process, as well as be more active in exploring the science knowledge learned.

Principal Interview Results

Based on the results of interviews related to teachers' competence in teaching basic science materials to students, it was found that the school has great attention to the development of teacher competence in the field of science and science. The principal revealed that most of the teachers in this school have educational backgrounds that are relevant to the field being taught. To ensure better mastery of science materials, schools occasionally hold trainings and workshops to improve teachers' understanding of basic science concepts and effective teaching methods. Training includes not only academic knowledge, but also pedagogical skills, such as how to teach complex topics in a simple and engaging way for students, as well as the use of learning media that supports the understanding of science concepts.

Based on the results of interviews related to the role of teachers in guiding students to develop critical thinking skills during social studies learning, the principal facilitated a workshop every semester vacation which was expected to be able to upgrade teachers' skills in teaching. The principal revealed that in every learning process, teachers are expected to use a more participatory and inquiry-based approach. This approach allows students to not only passively receive information, but also to be actively involved in the process of searching and analyzing information. For example, in the IPAS learning on the theme of the process of plants making food, students can observe plants directly so as to encourage students to think deeper, explore various possible answers, and connect the material learned with daily life. In this case, teachers are expected not only to provide correct answers, but also to guide students to find solutions through joint discussion and investigation.

Based on the results of interviews related to how teachers support students to connect the science knowledge they learn with the context of social life, it was found that schools have a holistic approach in integrating science knowledge with students' daily lives. The principal said that teachers invite students not only to learn science in the context of theory, but also to understand how science plays a role in solving social problems that occur in society. Teachers are asked to provide concrete examples from daily life related to the science topic being studied, such as the use of environmentally friendly technology, the importance of maintaining a clean environment, or the application of science in the field of public health. For example, in material on the respiratory system, teachers will relate it to the importance of a healthy lifestyle and clean air that can affect public health.

Based on the results of interviews related to the application of activities or learning methods used by teachers to instill scientific attitudes in students, it was found that schools have implemented various effective strategies in building scientific attitudes through social studies learning. One of the methods that is routinely applied is science experiments, which are designed to provide students

with hands-on experience in conducting scientific activities. The principal gave real examples, such as an experiment in basic physics learning, in which students were asked to do experiments on the concepts of force, mass, and acceleration. In this experiment, students are not only given instructions, but also encouraged to ask questions, design experimental procedures, collect data, and draw conclusions based on the results obtained. Through this experimental process, students are trained to think systematically and critically, as well as develop a deep curiosity about natural phenomena that occur around them.

Science Literacy of Elementary School Students in Science Learning

Based on the results of observations, most students have a basic understanding of the science concepts taught in science learning. The teacher said that this understanding is stronger when the material is delivered through contextual learning methods and involves hands-on practice, such as simple experiments or demonstrations. For example, in the material on the process of plants making food (photosynthesis), students can identify the basic processes and explain the stages of the concept. This is in line with the research of Bybee et al (2009) which states that an inquiry-based learning approach can improve students' understanding of science concepts. However, teachers also note that there are significant differences in the level of understanding of concepts between students, depending on learning ability and environmental support. This is reinforced by the findings of Tytler (2007) who showed that limitations of comprehension can occur if science material is delivered theoretically without being associated with students' real experiences. Therefore, teachers need to encourage project-based learning and environmental exploration so that students can more easily understand the relationship between theory and reality.

Indicators of students' critical thinking and inquiry skills still vary, as expressed by teachers and principals. Some students are able to ask questions that demonstrate a level of critical thinking, especially when the science learning is packaged in the form of a simple problem exploration or practicum. For example, in the observation of photosynthesis processes, students ask about the

role of sunlight and how its deficiency affects plants. However, the results of observations on the material of plant processes to make food (photosynthesis) show that the percentage of students' critical thinking skills of 80% is not even in all students because most of them still tend to receive information passively. These results are consistent with Harlen's (2010) research which states that students' critical thinking skills can be developed through inquiry-based science learning that demands exploration, observation, and reflection on a phenomenon. Teachers also added that the habit of asking questions, making hypotheses, and drawing conclusions still needs to be improved through inquiry-based learning methods and small group discussions. This is in accordance with the view of Neutzling (2019), who states that inquiry-based learning encourages students to learn through the process of questioning, finding out, and discovering learning concepts in depth for themselves. In addition, Sergiovanni (2015) stated that group work provides a collaborative environment that allows students to exchange ideas and learn different points of view, thereby deepening their understanding of the concepts learned.

The ability of students to apply science concepts in a social context shows positive results, students are able to apply the habit of not taking good care of plants even though they are not optimal. The principal stated that the school has made efforts to facilitate environmental project-based activities, such as the waste sorting program every 2 months and composting. Through these activities, students learn to connect science concepts, such as recycling and environmental sustainability, with everyday life. Demir (2020) explains that project learning provides students with an authentic learning experience, where students are directly involved in solving real problems relevant to daily life. Furthermore, Perry (2020) suggests that project learning can encourage students to think critically, integrate knowledge across disciplines, and develop collaborative skills. In addition, the teacher added that an example of the application of science in a social context can be seen from students' understanding of environmental pollution. Students can identify sources of pollution, such as plastic waste and air

pollution, as well as propose simple solutions, such as tree planting or reducing plastic use. This finding is in line with the study of Rocard et al. (2007) which emphasized the importance of science literacy in forming contextual thinking skills so that students are able to solve real problems in society.

Indicators of scientific attitudes that include curiosity, thoroughness, honesty, and open-mindedness show diverse developments. Observations show that students have a high level of curiosity when given the opportunity to conduct experiments or direct observations. Kolb et al. (2014) explain that experiential learning allows students to learn actively through direct involvement with the learning material. Through experimentation and observation, students not only acquire information, but also develop a deep understanding through direct interaction with observed phenomena. In the context of science education, Obe (2018) emphasizes that experimental activities stimulate students' curiosity because it provides them with opportunities to explore scientific questions and phenomena. Such hands-on experience increases motivation to learn and helps students build knowledge based on empirical observations. In addition, teachers noted that students often ask about the processes or phenomena they observe, such as "Why do many plants wither in the dry season?" or "How do plants excrete oxygen?". However, scientific attitudes such as precision and precision still need to be strengthened, especially in recording the results of observations or the implementation of experimental procedures. According to research from the OECD (2017) within the framework of PISA, scientific attitudes play an important role in building a critical and innovative mindset in students. Teachers try to develop this attitude through activities based on scientific practice and reflection on the results of experiments. For example, students are invited to assess the results of their photosynthesis experiments and discuss mistakes that occurred to form an open attitude to criticism and suggestions.

4. Conclusion

Based on the results of research and discussion, the science literacy of elementary school students in IPAS learning shows good potential, but there are challenges that need to be overcome in several aspects. Students generally have a fairly strong understanding of basic science concepts, especially when learning is done through contextual and practice-based approaches. Students' critical thinking and inquiry skills show varying development, with some students being able to ask questions and formulate hypotheses, but consistency in the development of these skills needs to be improved.

The students' ability to apply science concepts to social contexts shows positive results, especially through project-based programs that connect theory to everyday life. Scientific attitudes, such as curiosity, are already apparent to most students, but an attitude of rigor and openness to reflection on learning outcomes requires further attention. Supporting inquiry-based, experimental, and reflection-based learning, elementary school students' science literacy can be further developed and support the formation of scientific character at the elementary school level.

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