



Analysis of the Effectiveness of the Inquiry Learning Model in Improving Elementary School Students' Scientific Literacy

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ABSTRACT. Scientific literacy is one of the fundamental competencies that elementary school students must develop to face the challenges of scientific and technological advancement in the 21st century. However, various studies indicate that the level of scientific literacy among elementary school students in Indonesia remains relatively low. One contributing factor is the use of learning models that have not fully encouraged active student engagement in the learning process. This article aims to analyze the effectiveness of the inquiry-based learning model in improving elementary school students' scientific literacy through a literature review approach. The method employed in this study is a literature review by examining relevant sources, including national and international journal articles, textbooks, and research reports related to inquiry-based learning and scientific literacy. The results of the analysis indicate that the inquiry-based learning model is effective in enhancing elementary school students' scientific literacy, as it encourages students to actively observe, ask questions, formulate hypotheses, conduct investigations, and draw conclusions based on scientific evidence. Furthermore, inquiry-based learning contributes to the development of students' critical thinking skills, conceptual understanding of science, and scientific attitudes. Therefore, the inquiry-based learning model can be considered a strategic alternative for science instruction in elementary schools to sustainably improve students' scientific literacy.

Keywords: inquiry-based learning, scientific literacy, elementary school

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INTRODUCTION

Scientific literacy has become a crucial educational goal in the 21st century, particularly at the elementary school level where foundational scientific understanding and attitudes are formed. Scientific literacy enables students to understand scientific concepts, apply scientific knowledge to daily life, and make informed decisions based on evidence. However, several international and national assessments indicate that elementary school students' scientific literacy remains at a low to moderate level, especially in developing countries, including Indonesia (OECD, 2019). This condition highlights the urgency of improving science learning practices to better support students' literacy development.

One of the contributing factors to low scientific literacy is the dominance of teacher-centered learning models that emphasize memorization rather than inquiry and critical thinking. Conventional teaching methods often limit students' opportunities to actively engage in scientific processes such as questioning, investigating, and reasoning. As a result, students tend to have difficulty connecting scientific concepts with real-world phenomena and lack deeper conceptual

understanding (Furtak et al., 2012). This situation indicates the need for instructional models that place students at the center of the learning process.

Inquiry-based learning is widely recognized as an instructional approach that aligns with the nature of science learning. This model emphasizes students' active involvement in identifying problems, formulating questions, conducting investigations, and drawing conclusions based on evidence. Previous studies suggest that inquiry-based learning promotes meaningful learning experiences by engaging students in authentic scientific practices (Hmelo-Silver, Duncan, & Chinn, 2007). Through these processes, students not only acquire scientific knowledge but also develop higher-order thinking skills and scientific reasoning.

Furthermore, inquiry-based learning has been shown to have a positive impact on students' scientific literacy. Research indicates that students who engage in inquiry-based activities demonstrate better understanding of scientific concepts, improved ability to interpret data, and stronger scientific attitudes compared to those taught using traditional methods (Minner, Levy, & Century, 2010). At the elementary level, inquiry-based learning helps students build curiosity and motivation toward science, which are essential components of lifelong scientific literacy (Zion & Mendelovici, 2012).

Despite the growing body of research on inquiry-based learning, studies that specifically analyze its effectiveness in improving scientific literacy through a systematic literature review remain limited. Many existing studies focus on experimental designs or classroom action research, while comprehensive analyses synthesizing previous findings are still scarce. Therefore, this study aims to fill this gap by analyzing relevant literature to examine the effectiveness of inquiry-based learning models in enhancing scientific literacy among elementary school students. Through this literature-based analysis, the study is expected to provide theoretical insights and practical implications for improving science instruction at the elementary level (Mayer, 2014).

METHOD

This study employed a literature review method to analyze the effectiveness of the inquiry-based learning model in improving elementary school students' scientific literacy. A literature review was chosen because it allows researchers to systematically examine, evaluate, and synthesize findings from previous studies in order to identify patterns, relationships, and research gaps related to a particular topic (Snyder, 2019). This method is considered appropriate for developing conceptual understanding and theoretical insights regarding inquiry-based learning and scientific literacy.

The data sources in this study consisted of peer-reviewed journal articles, books, and research reports relevant to inquiry-based learning and scientific literacy at the elementary school level. The literature was collected from reputable academic databases such as Google Scholar, ERIC, and Scopus. The inclusion criteria for the selected literature were: (1) publications focusing on inquiry-based learning or scientific literacy, (2) studies conducted in elementary or primary education contexts, and (3) articles published within the last ten years to ensure the relevance and timeliness of the findings (Kitchenham & Charters, 2007).

The data collection process was carried out through a systematic search using keywords such as *inquiry-based learning*, *scientific literacy*, and *elementary school science education*. After the initial search, the identified articles were screened based on their titles, abstracts, and full texts to ensure alignment with the research objectives. Irrelevant or duplicate studies were excluded to maintain the quality and focus of the analysis (Xiao & Watson, 2019).

Data analysis in this study involved content analysis to identify key themes, concepts, and findings related to the implementation and effectiveness of inquiry-based learning in enhancing scientific literacy. The selected literature was analyzed by comparing research objectives, methodologies, and results to identify consistent findings and theoretical implications. This analytical process enabled

the synthesis of existing knowledge and the formulation of conclusions regarding the contribution of inquiry-based learning to students' scientific literacy development (Miles, Huberman, & Saldaña, 2014).

RESULT AND DISCUSSION

Result

Based on the analysis of the selected literature, several key findings were identified regarding the effectiveness of inquiry-based learning in improving elementary school students' scientific literacy. The results are organized into thematic sub-sections to provide a systematic and structured presentation.

1. Inquiry-Based Learning Enhances Students' Understanding of Scientific Concepts

The reviewed studies consistently indicate that inquiry-based learning contributes positively to students' conceptual understanding of science. By engaging students in observing phenomena, formulating questions, and conducting investigations, inquiry-based learning allows students to construct scientific concepts meaningfully rather than memorizing isolated facts. Research findings show that students taught through inquiry-based approaches demonstrate deeper conceptual comprehension compared to those taught using traditional lecture-based methods (Minner, Levy, & Century, 2010).

Several studies emphasize that inquiry-based learning helps elementary school students relate abstract scientific concepts to real-world contexts. Through hands-on activities and guided investigations, students are able to connect prior knowledge with new scientific ideas, resulting in improved conceptual clarity and retention (Furtak et al., 2012). This indicates that inquiry-based learning plays a crucial role in strengthening the conceptual dimension of scientific literacy.

2. Improvement of Scientific Process Skills Through Inquiry-Based Learning

Another prominent finding from the literature is the significant improvement of students' scientific process skills as a result of inquiry-based learning. These skills include observing, questioning, hypothesizing, experimenting, analyzing data, and drawing conclusions. Inquiry-based learning provides structured opportunities for students to engage directly in these scientific practices, which are essential components of scientific literacy (Hmelo-Silver et al., 2007).

Studies focusing on elementary education reveal that students exposed to inquiry-based learning demonstrate better ability to design simple investigations, interpret experimental results, and justify conclusions using evidence. Such skills are rarely developed through conventional teaching approaches that emphasize teacher explanations rather than student exploration (Zion & Mendelovici, 2012). This finding highlights the effectiveness of inquiry-based learning in fostering procedural and methodological aspects of scientific literacy.

3. Development of Critical Thinking and Reasoning Abilities

The literature also indicates that inquiry-based learning supports the development of students' critical thinking and scientific reasoning abilities. Inquiry-oriented classrooms encourage students to question assumptions, evaluate evidence, and engage in reflective thinking during the learning process. These cognitive activities are closely associated with higher levels of scientific literacy (Sadeh & Zion, 2012).

Several studies report that elementary school students participating in inquiry-based learning activities show increased ability to explain scientific phenomena logically and support their arguments with empirical evidence. This suggests that inquiry-based learning not only enhances content knowledge but also strengthens students' reasoning skills, which are fundamental for scientific literacy in both academic and everyday contexts (Furtak et al., 2012).

4. Positive Influence on Students' Scientific Attitudes and Motivation

In addition to cognitive outcomes, the reviewed literature reveals that inquiry-based learning has a positive impact on students' scientific attitudes and motivation toward learning science. Inquiry-based activities foster curiosity, openness to new ideas, and persistence in problem-solving, which are key affective components of scientific literacy (OECD, 2019).

Research findings indicate that elementary school students involved in inquiry-based learning tend to exhibit higher interest and engagement in science lessons. The active and student-centered nature of inquiry learning creates a supportive learning environment that encourages students to explore scientific questions enthusiastically and develop a positive disposition toward science (Zion & Mendelovici, 2012). These affective outcomes further strengthen the overall effectiveness of inquiry-based learning in enhancing scientific literacy.

Discussion

The findings of this literature review indicate that inquiry-based learning is an effective instructional model for enhancing elementary school students' scientific literacy. The effectiveness of this model can be understood through its alignment with the core dimensions of scientific literacy, including conceptual understanding, scientific process skills, critical thinking, and scientific attitudes. Inquiry-based learning provides learning experiences that reflect the authentic practices of science, enabling students to actively construct knowledge through investigation and reflection rather than passive reception of information (Minner, Levy, & Century, 2010).

The improvement in students' conceptual understanding found in the reviewed studies supports constructivist learning theory, which emphasizes that knowledge is actively built through interaction with the environment. Inquiry-based learning encourages students to explore scientific phenomena and develop explanations based on evidence, allowing abstract concepts to become more meaningful and contextualized. This finding is consistent with previous research suggesting that inquiry-oriented instruction leads to deeper conceptual learning compared to traditional teacher-centered approaches (Furtak et al., 2012).

Moreover, the enhancement of scientific process skills observed in inquiry-based learning reflects the model's emphasis on engaging students in core scientific practices. By involving students in activities such as observing, experimenting, and interpreting data, inquiry-based learning supports the development of procedural knowledge essential for scientific literacy. This aligns with the view that scientific literacy is not limited to understanding scientific facts but also includes the ability to think and act scientifically in real-life situations (Hmelo-Silver et al., 2007). Consequently, inquiry-based learning helps bridge the gap between scientific knowledge and scientific practice at the elementary level.

The development of critical thinking and reasoning abilities further demonstrates the contribution of inquiry-based learning to scientific literacy. Inquiry-oriented instruction encourages students to ask questions, evaluate evidence, and justify conclusions, fostering reflective and analytical thinking. These skills are fundamental for enabling students to make informed decisions and solve problems in scientifically grounded ways. Previous studies emphasize that such cognitive engagement is a key predictor of students' long-term scientific literacy and academic success (Sadeh & Zion, 2012).

In addition to cognitive outcomes, inquiry-based learning also positively influences students' scientific attitudes and motivation. The active and student-centered nature of inquiry learning fosters curiosity, confidence, and a positive disposition toward science. This affective dimension is critical, as students who develop positive attitudes toward science are more likely to engage in scientific learning beyond the classroom. This finding is in line with international perspectives that

highlight motivation and interest as integral components of scientific literacy development (OECD, 2019).

Overall, the discussion of these findings suggests that inquiry-based learning offers a comprehensive approach to improving scientific literacy in elementary education. By integrating conceptual understanding, scientific skills, critical thinking, and positive scientific attitudes, inquiry-based learning addresses the multifaceted nature of scientific literacy. Therefore, this model can serve as a pedagogically sound alternative for science instruction in elementary schools, particularly in contexts where improving students' scientific literacy remains a critical educational challenge (Zion & Mendelovici, 2012).

CONCLUSION

Based on the findings of this literature review, it can be concluded that inquiry-based learning is an effective instructional model for improving elementary school students' scientific literacy. The reviewed studies consistently demonstrate that inquiry-based learning enhances students' understanding of scientific concepts by engaging them in meaningful learning experiences that emphasize exploration, investigation, and evidence-based reasoning. This approach enables students to construct knowledge actively and connect scientific concepts with real-life contexts.

In addition, inquiry-based learning significantly contributes to the development of students' scientific process skills, critical thinking, and reasoning abilities. By involving students in authentic scientific practices such as observing, questioning, experimenting, and drawing conclusions, inquiry-based learning supports the procedural and cognitive dimensions of scientific literacy. These skills are essential for preparing students to think scientifically and solve problems in both academic and everyday situations.

Furthermore, inquiry-based learning fosters positive scientific attitudes and motivation toward learning science. The student-centered nature of this model encourages curiosity, engagement, and persistence, which are crucial for sustaining students' interest in science over time. Taken together, these findings indicate that inquiry-based learning addresses the multidimensional aspects of scientific literacy in a comprehensive manner.

Therefore, inquiry-based learning can be considered a pedagogically sound and effective alternative for science instruction at the elementary school level. Its implementation is expected to contribute to the improvement of scientific literacy among students and support the achievement of broader educational goals in science education.

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