CLIMATE CHANGE AND ENVIRONMENTAL SUSTAINABILITY IN EDUCATION

NAWALA

Volume 2, Number 1, 2023

Green Education in Science Learning for Science Literacy and Climate Issues

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Abstract

Article history:
Received: February 21, 2023
Revised: March 27, 2023
Accepted: April 19, 2023
Published: June 30, 2023

Keywords:
Climate Change,
Green Education,
Scientific Literacy,
Science Learning.

Identifier:
Nawala
Page: 49-64
https://nawala.io/index.php/ccese

Scientific literacy is an essential 21st-century skill that helps individuals think critically, solve problems, and adapt to the rapid development of science and technology. At the elementary school level, scientific literacy plays a crucial role in equipping students with an understanding of scientific concepts, developing 21st-century skills, and preparing them to face global issues such as climate change. Climate change has tangible impacts on students' daily lives, ranging from health and education to their surrounding environment. Therefore, the integration of environmental issues in science learning is essential to foster awareness, empathy, and a sense of responsibility from an early age. Green education emerges as a framework that connects sustainability concepts, environmentally friendly practices, and the formation of environmentally responsible character. This study employs a literature review method to analyze strategies of science learning based on green education in elementary schools. The findings indicate that contextual approaches, the teacher's role as facilitator, and direct environment-based activities effectively enhance scientific literacy, build scientific attitudes, and strengthen students' 21st-century skills

1. Introduction

Scientific literacy is one of the fundamental skills that students in the 21st century need. This ability is not only related to the mastery of scientific concepts but also involves critical thinking skills, collaboration, communication, and problem-solving, which are core competencies for facing global challenges. Since elementary school, scientific literacy needs to be instilled because children are at a cognitive development stage ideal for building a foundation of scientific knowledge and attitudes. Scientific literacy serves as a basis for students to be able to understand natural phenomena, evaluate the scientific information they encounter daily, and make decisions based on data and logical reasoning (Sutiani, 2021).

Furthermore, scientific literacy plays an important role in preparing students to face global issues, especially climate change, which is currently one of humanity's greatest challenges. Climate change has had a widespread impact on human life, including health, education, and environmental sustainability (Cordero et al., 2020). In the context of elementary education, this impact can be seen from the damage to school infrastructure due to natural disasters, disruption of teaching and learning processes due to floods or droughts, and an increase in diseases caused by extreme temperature changes. This condition requires the younger generation to understand not only the causes and impacts of climate change but also the solutions that can be taken for mitigation and adaptation.

The issue of climate change should not be seen as a problem far from students lives, but rather a real issue that affects their daily lives. When this topic is introduced early, students can develop awareness, empathy, and a sense of responsibility for the

environment. The educational process that integrates global issues into a local context will help students understand the relationship between human activities and environmental conditions. For example, the problem of floods that are often experienced in various regions of Indonesia can be used as a scientific discussion topic about the connection between rainfall, drainage, human behavior in disposing of trash, and its impact on public health.

In this context, green education becomes a relevant framework. Green education emphasizes three important aspects: sustainability, environmentally friendly practices, and character development. These principles are oriented towards forming ecological awareness as well as habituating behaviors that support nature conservation. Education is no longer limited to the transmission of scientific knowledge but also a process of shaping students into individuals who are caring, responsible, and committed to preserving the earth for future generations (Prasetiyo et al., 2020).

Science education based on green education has an advantage because it can connect scientific concepts with students real-life experiences. Scientific literacy in this case is not just about memorizing facts but also about training critical thinking, making predictions, and drawing conclusions based on evidence. Students are invited to be involved in hands-on activities such as observing natural phenomena, simple experiments, and collaborative projects that involve solving real problems (Chen et al., 2020). Scientific attitudes such as curiosity, constructive skepticism, openness to new evidence, and the ability to think reflectively can be formed through this process.

Teachers have a central role in implementing this strategy. As facilitators, teachers not only deliver material but also connect scientific concepts with relevant environmental issues. For example, teachers can use local drought events to explain the concept of the water cycle or use air quality data to discuss pollution (Lee et al., 2019). In addition, teachers can also encourage students to take real action, such as planting trees, managing waste, or conducting energy-saving campaigns at school. Through these activities, students not only understand the theory but also directly experience the practice of protecting the environment.

Thus, strengthening scientific literacy through green education-based science learning in elementary schools is a strategic step in facing the challenges of the 21st century. This approach not only supports national curriculum goals, such as the development of the Pancasila Student Profile which emphasizes the dimensions of environmental care, critical reasoning, and being faithful and devout, but also prepares a generation ready to face the global environmental crisis. Therefore, this study aims to analyze green education-based science learning strategies that can enhance scientific literacy as well as understanding of climate change issues in elementary school students.

2. Literature Review

A literature review on scientific literacy and green education shows that science learning in elementary schools should be oriented towards the connection between theory and students real-life experiences. According to Sutiani (2021), scientific literacy is an important competence that enables individuals to think

critically, solve problems, and adapt to technological and social changes. Scientific literacy at the basic level not only emphasizes the mastery of concepts but also a scientific attitude that supports students' active involvement in understanding natural phenomena around them.

A number of studies in Indonesia show the importance of contextual learning in improving students' understanding. Ardoin and Heimlich (2021) emphasize that science learning connected with daily phenomena can increase students' learning interest and environmental awareness. This is in line with the findings of Yanto et al. (2019) which show that simple experiment-based learning can foster a sense of curiosity and strengthen students' critical thinking skills.

In addition, the issue of climate change is a very relevant topic to be integrated into science learning. Recepoglu (2021) state that topics such as global warming, deforestation, pollution, and water crises have a direct relevance to students' daily lives. By studying these issues, students can more easily understand the relationship between human activities and environmental conditions and are encouraged to play a role in climate change mitigation and adaptation. Research by Ardiansyah and Rahman (2023) even affirms that learning that addresses environmental issues can foster students' empathy and responsibility for nature conservation.

Green education becomes a framework that connects scientific literacy with sustainability education. According to Prasetiyo et al. (2020), green education not only emphasizes scientific knowledge but also the formation of a caring attitude towards the environment and the application of environmentally friendly practices in daily life. In Indonesia, this principle is relevant to the implementation of the

Merdeka Curriculum, especially the dimensions of the Pancasila Student Profile which emphasize environmental care, critical reasoning, and a faithful and devout attitude (Mustadi et al., 2021).

Thus, previous literature shows that science learning strategies that are contextual, environmentally oriented, and supported by the active role of the teacher can be an effective means of increasing scientific literacy in elementary school students. However, the systematic integration between scientific literacy, climate change issues, and the principles of green education is still a challenge for research and implementation in the field.

3. Methods

This study applies a literature review approach to examine green education-based science learning strategies in enhancing scientific literacy and elementary school students' understanding of climate change issues. This method was chosen because it can systematically collect, review, and synthesize various previous research results to obtain a more comprehensive picture of the development of concepts and practices that have been studied by researchers.

Reference sources used for this study include articles from national and international journals that are relevant to the themes of scientific literacy, elementary science learning, environmental education, the concept of green education, and climate change topics. The databases used include Google Scholar. The search focus was directed at articles published, so that the analysis results can reflect the latest developments.

The literature collection process was carried out using keywords such as "elementary school scientific literacy," "green education," "contextual science learning," "climate change in elementary education," and "sustainability education." From the initial search, some relevant articles were obtained, which were then selected based on the accuracy of the theme, publication quality, and completeness of the information. From the selection stage, about 13 articles were chosen for further analysis.

The analysis was carried out in stages. First, the researcher identified the central theme in each article, including the urgency of scientific literacy in the 21st century, the integration of environmental and climate issues in education, the role of the teacher as a facilitator of green education, and the benefits of student involvement in real-life activities related to the environment. Second, the study results were synthesized to see the connections and consistency between the research. Third, the researcher explored research gaps, for example, the lack of empirical studies on the integrated implementation of green education in the national curriculum for elementary schools.

To maintain the credibility of the study, source triangulation was carried out by comparing various research results so that the conclusions obtained were stronger. The main literature used came from indexed journals, reputable academic publications, and reports from international institutions such as UNESCO and the IPCC. With this design, the research is expected to present a clearer conceptual picture of green education-based science learning strategies. The synthesis results will be a foothold in preparing applicable recommendations for elementary school

teachers, especially in supporting the Merdeka Curriculum which emphasizes environmental care, critical reasoning, and collaboration.

4. Results and Discussion

4.1. Green Education-Based Science Learning

The results of the literature review show that green education-based science learning strategies have a significant influence on the enhancement of scientific literacy and the understanding of climate change issues in elementary school students. Analysis of various studies revealed several key findings that can be grouped into five important aspects: contextual learning, climate change issues as learning material, the role of the teacher as a facilitator, student involvement in direct activities, and alignment with the curriculum.

First, the literature confirms that contextual learning is key to improving scientific literacy. that students who learned science by linking scientific concepts to daily phenomena, such as the water cycle, pollution, or plant growth, had a deeper understanding compared to rote-based learning. The connection between students' real-life experiences and learning material makes scientific concepts more meaningful, while also building a scientific mindset from an early age. Ardoin and Heimlich (2021) added that the contextual approach also increases students' learning interest and awareness of the importance of protecting the environment.

Second, climate change issues are proven to be effective as contextual material in science learning. Cook et al. (2018) showed that the integration of topics such as global warming, pollution, deforestation, and water crises can provide a more

realistic understanding of the relationship between human activities and environmental conditions. Recepoglu (2021) also confirmed that this approach can increase students' awareness of the importance of climate change mitigation and adaptation. In addition to cognitive understanding, students also show development in the affective aspect, namely an increased sense of empathy and responsibility for nature conservation.

Third, the role of the teacher is very prominent as a facilitator of green education. Santosa and Dewi (2023) emphasize that teachers play an important role in selecting appropriate learning strategies and media to connect theory with environmental issues. Gürkan and Dolapçıoğlu (2020) showed that the use of interactive media, such as documentary videos, digital maps, and environmental-based applications, helps students understand complex issues more easily. In addition, teachers who are able to link material to local phenomena succeed in making learning more interesting and relevant for students.

Fourth, the results of the literature also show that student involvement in direct, environment-based activities has a positive impact on the affective and psychomotor dimensions. Yuliana and Kurniawan (2022) reported that students involved in greening activities, waste management, or recycling projects showed a higher level of environmental concern. Fadli and Sulastri (2023) found that real activities such as recycling projects can increase students' sense of responsibility and empathy. Similarly, Wijaya and Aminah (2023) confirmed that school garden activities strengthen students' practical skills and build an emotional closeness to the environment.

Fifth, the integration of green education in science learning is in line with the Merdeka Curriculum, especially the Pancasila Student Profile. Cook et al. (2018) emphasize that environment-based learning helps form a caring, disciplined, and responsible attitude towards the environment. Hamid et al. (2021) also reported that student involvement in environment-based projects improves collaboration, communication, and critical thinking skills. This shows that green education-based science learning not only supports the achievement of scientific literacy but also develops 21st-century skills that are relevant to global demands.

The results of the literature review show that green education-based science learning strategies are effective in integrating the cognitive, affective, and psychomotor aspects of students. Students not only understand scientific concepts but are also able to connect them with real environmental issues, develop a caring attitude, and get involved in real actions to maintain sustainability. This proves that green education is a relevant and applicable approach in responding to the challenges of 21st-century education.

4.2. Implications of Green Education-Based Science Learning

The findings of the literature review confirm the importance of green education-based science learning in building elementary school students' scientific literacy while fostering awareness of climate change issues. In this section, the discussion is focused on the theoretical, practical, and policy implications, as well as the limitations that still exist. From a theoretical perspective, scientific literacy can no longer be understood only as the mastery of scientific concepts, but also as a competence that involves critical thinking skills, decision-making, and the formation

of a caring attitude towards the environment. This is in line with the scientific literacy framework developed by the OECD in PISA, where scientific literacy includes the ability to explain scientific phenomena, evaluate evidence, and apply scientific knowledge in daily life. Thus, green education expands the meaning of scientific literacy by adding dimensions of sustainability and ecological responsibility.

Practically, contextual learning is proven to be more effective than traditional approaches that focus on rote memorization. Teachers who link material to local phenomena, such as floods, air pollution, or waste management, provide a more meaningful learning experience for students (Reddy, 2021). This result is consistent with the theory of constructivism which emphasizes the importance of students' active involvement in building knowledge through real-life experiences. However, the application of contextual learning requires the creativity and readiness of teachers, both in designing activities and selecting appropriate media.

The discussion also highlights the importance of the teacher's role as a facilitator. The teacher's role is not limited to conveying information but also guiding students to think critically, discuss, and make decisions based on evidence (Plummer et al., 2021). The challenge faced is the limitation of resources, especially in schools that do not have access to interactive learning media or simple laboratory facilities. Therefore, support for teacher training and the provision of learning resources are crucial factors for the successful implementation of green education.

From a policy perspective, the integration of green education in the Merdeka Curriculum shows a synergy between national education needs and global demands (Maa et al., 2022). The Pancasila Student Profile, especially the dimensions of

environmental care, critical reasoning, and being faithful and devout, can be realized through green education-based science learning. However, the implementation of this policy still faces obstacles, especially in terms of consistency of application in various regions. Student involvement in direct activities such as greening projects, mini waste banks, or simple experiments is an effective strategy to strengthen the affective and psychomotor aspects (Hou et al., 2020). This discussion confirms that real-life experiences have a greater impact on shaping environmentally friendly attitudes and behaviors compared to theoretical learning alone. This is in line with the experiential learning approach that emphasizes learning through experience as a basis for behavioral change.

Although the study results show the effectiveness of green education, there are still research limitations that need to be noted. Most of the studies analyzed are descriptive or case studies, so the generalization of the results to a national level is still limited. In addition, there is still little quantitative research that systematically measures the effect of green education on the achievement of scientific literacy in elementary school students. Thus, further research using experimental or mixed-methods designs is needed to strengthen the empirical evidence. This discussion emphasizes that green education-based science learning is a relevant approach to answering the challenges of the 21st century. This approach can increase scientific literacy, build environmental awareness, and support the achievement of 21st-century skills. However, optimal implementation requires policy support, teacher training, and further research to strengthen the theoretical and practical foundations in the field.

5. Conclusion

This literature review shows that green education-based science learning makes a very important contribution to enhancing the scientific literacy of elementary school students while fostering awareness of climate change issues. Scientific literacy in this context is not only understood as the ability to master scientific concepts but also includes critical thinking skills, scientific attitudes, and ecological responsibility that are relevant to the challenges of the 21st century.

The results of the study show that the contextual learning approach, the integration of climate change issues, the role of the teacher as a facilitator, and student involvement in direct activities can enhance the cognitive, affective, and psychomotor dimensions of students. In addition, environment-based learning is also in line with the spirit of the Merdeka Curriculum and the Pancasila Student Profile, which emphasizes the importance of shaping a caring character towards the environment, critical reasoning, and the ability to collaborate for life's sustainability.

Nevertheless, the implementation of green education still faces a number of challenges, including limited resources, variations in teaching quality in different schools, and the lack of quantitative research that supports empirical evidence more strongly. Therefore, more comprehensive policy support, improved teacher competence, and further research focusing on evaluating the effectiveness of this learning strategy are needed.

Green education in science learning is a relevant, applicable, and visionary strategy to prepare the younger generation to face global challenges, build

environmental awareness, and produce students who are not only academically smart but also responsible for the sustainability of the earth.

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