The Role of Science Learning in Building Climate Change Awareness in Students

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ABSTRACT

This study aims to analyze the role of Natural Science (IPA) learning in shaping students' awareness of climate change. Using a descriptive qualitative approach and case study method, this study involved students, science teachers, and learning documentation at an elementary school that has integrated climate change issues into its curriculum. Data were collected through interviews, classroom observations, and document analysis. The results showed that IPA learning has a positive contribution in increasing students' knowledge about climate change, as well as fostering environmentally conscious attitudes and behaviors. Contextual and participatory learning strategies, such as discussions and environmental projects, have proven effective in strengthening student awareness. However, it was also found that the lack of teacher training and limited learning media are obstacles to optimally strengthening climate awareness. Therefore, it is necessary to strengthen teacher capacity and systematically integrate climate change material into the IPA curriculum.

Keywords: Science Learning, Climate Change, Student Awareness, Environmental Education

INTRODUCTION

Climate change has become an increasingly pressing and complex global issue, with tangible impacts directly felt in various aspects of human life, including on the younger generation (Lawrance et al., 2022). Global temperature changes, sea level rise, extreme weather, and ecosystem damage not only threaten environmental sustainability but also impact the health, education, and economic future of future generations. The younger generation is in the most vulnerable and strategic position, as they will bear the long-term burden of this climate crisis, yet they also have great potential to become agents of change. This situation demands increased climate awareness and literacy from an early age, so that they have the knowledge, critical thinking, and adaptive and mitigative skills needed to face global environmental challenges.(Jha & Dev, 2024)Therefore, integrating climate change issues into the educational curriculum and actively involving the younger generation in environmental movements are crucial steps in shaping a future society that is more resilient, environmentally conscious, and responsible for the sustainability of the planet.

Children and adolescents are the most vulnerable groups to the impacts of climate change, both physically, psychologically and socially, but ironically they often lack adequate understanding of this issue.(Clemens et al., 2022)Their still-developing bodies and immune systems make children more susceptible to illnesses caused by environmental changes, such as respiratory infections, skin diseases, or digestive disorders triggered by extreme weather and declining water quality. Furthermore, psychological stress from natural disasters, relocation, or uncertainty about the future can impact their mental health and development.

On the other hand, adolescents who are in a transitional period of self-discovery can also experience eco-anxiety if they are not equipped with the correct understanding and adequate emotional support. Unfortunately, climate and environmental education has not been

comprehensively integrated into the school learning system, leaving many lacking basic knowledge, adaptation skills, or critical awareness of the threat of climate change. This situation emphasizes the need for systematic efforts to improve climate literacy among children and adolescents through contextual, participatory, and action-based education, so that they are not merely victims but are also able to become part of the solution in addressing the global climate crisis.(Trott, 2019).

Education plays a strategic role as a primary instrument in fostering environmental awareness and caring attitudes from an early age. Through a structured educational process, children and adolescents not only gain knowledge about environmental issues and climate change, but also develop critical thinking, empathy for nature, and a moral responsibility for the preservation of the earth.(Vladova, 2023)Sustainability-oriented education enables students to understand the relationship between human activities and their impact on the environment, and encourages them to adopt environmentally friendly behaviors in their daily lives. Beyond simply conveying information, effective environmental education must be contextual, applicable, and participatory, involving students in reforestation projects, waste management, energy conservation, or environmental awareness campaigns in the community.(Bentz et al., 2025). Thus, education is not only a means of delivering material, but also a vehicle for character formation and an agent of social change capable of fostering a generation that is ecologically conscious, proactive, and committed to sustainable development. In the context of the increasingly pressing global climate crisis, strengthening environmental education is an urgent need to create a greener and more sustainable future.(Agbedahin, 2019).

Natural science (IPA) learning has great potential in building scientific awareness and fostering a caring attitude towards environmental issues, including climate change. As a subject that focuses on understanding natural phenomena and scientific processes, IPA provides a strong foundation for students to recognize the symptoms of climate change, understand its causes, and examine its impact on ecosystems and human life.(Maspul, 2024)Through a learning approach based on observation, experimentation, and problem-solving, students are not only trained to think critically and analytically but also guided to develop a responsible attitude towards the environment. Science topics such as the water cycle, carbon cycle, greenhouse effect, and environmental pollution can serve as relevant entry points for integrating climate change issues into the curriculum in a contextual and applicable manner.(Fettahlıoğlu & Aydoğdu, 2020). Furthermore, science learning designed interactively through projects, field studies, or simulations can spark students' emotional engagement with the surrounding environment and motivate them to take real action. Thus, science serves not only as a vehicle for knowledge transfer but also as a strategic medium for developing a young generation with ecological insight, awareness of the importance of preserving the earth, and readiness to face the challenges of climate change scientifically and ethically.

Although many educational curricula, both at the national and international levels, have included the topic of climate change in various subjects, especially science, geography, and citizenship education, their implementation in the field still faces various obstacles that prevent learning objectives from being achieved optimally.(Krampe et al., 2024)In many cases, the topic of climate change is simply treated as an additional subtheme presented theoretically, without reinforcement through contextual activities, hands-on practice, or connections to the realities of students' daily lives. As a result, students' understanding of climate change issues tends to be shallow and rote, without developing critical awareness and a real attitude of environmental concern.(Impraim et al., 2023).

Furthermore, a lack of teacher training, limited relevant and up-to-date teaching materials, and a limited number of project-based or environmental action-based learning approaches also hinder the effectiveness of this topic. Addressing these challenges requires innovation in teaching methods that are more participatory, collaborative, and based on real-world issues facing the surrounding environment. Integrating climate change learning into the

curriculum should focus not only on cognitive achievement but also on developing sustainable attitudes and skills, so that students not only understand climate change as a global phenomenon but are also encouraged to become agents of change in preserving the environment.(Rocha et al., 2020).

A contextual, applicable learning approach is needed, capable of integrating environmental values comprehensively into the teaching and learning process of Natural Sciences (IPA), to meet the challenges of 21st-century learning that demands not only mastery of knowledge, but also the formation of environmentally conscious character. A contextual approach allows students to relate science material to the realities of their daily lives, so that scientific concepts are no longer abstract, but relevant and meaningful. Meanwhile, an applicable approach emphasizes the importance of active student involvement in real-life activities such as experiments, field studies, observations of the surrounding environment, and solution-based projects to local environmental problems. Through these activities, students not only learn to understand the scientific process, but are also trained to develop critical, collaborative, and creative thinking skills in addressing environmental issues.(Cheng et al., 2019).

In addition, the integration of environmental values such as responsibility, care, sustainability, and ecological ethics in every science learning process will help shape ecological awareness from an early age.(Miao & Nduneseokwu, 2024)Teachers play a key role in realizing this approach by designing learning that focuses not only on content but also on developing attitudes and concrete actions that reflect a concern for the earth. Thus, science learning can be a strategic tool for producing a generation that is not only scientifically intelligent but also has a green character and is ready to become agents of positive change in facing global environmental challenges.

There are not many studies that have in-depth explored the real role of Natural Science (IPA) learning in raising awareness of climate change in students, especially at the elementary and secondary education levels.(Monroe et al., 2019)Most research tends to focus on the cognitive aspects of understanding scientific concepts, without contextually linking them to global environmental issues such as climate change. In fact, it is at the elementary and secondary levels of education that the foundation of environmental awareness and concern should be systematically built. This lack of research indicates a significant gap that needs to be filled by new research that not only assesses students' academic achievement but also examines how science learning processes can internalize ecological values and shape climate change awareness sustainably. Holistic studies that prioritize an experiential pedagogical approach, local contextualization, and the integration of environmental values are still essential to ensure that science learning truly contributes to shaping a young generation that is aware of, cares about, and takes action on the climate crisis.(Monus, 2022).

Most previous research has focused more on curriculum content and students' cognitive knowledge of climate change, while the affective and behavioral dimensions, which reflect real awareness and concern for the issue, have received less attention. This gap indicates that evaluations of the effectiveness of science learning have not fully reflected its contribution to shaping students' attitudes and actions regarding climate change.(Ojala, 2023).

In fact, the role of science learning is not only limited to conveying scientific information, but also has great potential in shaping environmental values through a contextual and participatory learning approach. Furthermore, there are still few studies that contextually explore the dynamics of the science teaching and learning process in the classroom and how interactions between teachers, students, and subject matter directly contribute to the internalization of climate awareness. Therefore, more in-depth and holistic studies are needed to fill this gap, focusing on learning dimensions that can integrate cognitive, affective, and behavioral aspects in order to foster a comprehensive awareness of climate change in students.

This research presents scientific novelty by offering a holistic perspective in examining the interaction between science learning strategies, local context, and students' climate change awareness. Unlike previous studies that tend to focus solely on knowledge transfer, this research emphasizes the importance of students' emotional and behavioral engagement in addressing environmental issues through contextualized learning that is relevant to their daily lives. By combining cognitive, affective, and conative aspects, this research encourages the birth of a transformative science learning model: learning that not only fosters intellectual intelligence but also fosters critical awareness and encourages concrete actions in protecting the environment. This novelty makes a significant contribution to the development of more meaningful, sustainable, and relevant science pedagogy in responding to the challenges of climate change at the primary and secondary education levels.

The purpose of this study is to analyze and describe in depth how Natural Science (IPA) learning contributes to building students' awareness of climate change issues, not only from the cognitive aspect, but also in terms of attitudes and concrete actions that reflect concern for the environment. This study seeks to explore the role of IPA learning as a vehicle for ecological education that is able to shape students' scientific understanding, instill sustainability values, and encourage their active participation in mitigation and adaptation efforts to the impacts of climate change. Thus, this study aims to produce a complete picture of the effectiveness of IPA learning in fostering comprehensive climate change awareness among students.

METHOD

This study uses a descriptive qualitative approach with a case study type that aims to explore the role of science learning in building climate change awareness in students.(Saputri et al., 2025)The subjects were fifth-sixth grade elementary school students or seventh-ninth grade junior high school students at schools that have integrated climate change into their science curriculum, with additional participants such as science teachers and principals serving as triangulation sources. Data were collected through semi-structured interviews, classroom observations, and documentation in the form of syllabi, lesson plans, and relevant student assignments. The instruments used included interview guides, observation sheets, and document analysis formats. Data analysis techniques were conducted thematically, with steps of data reduction, data presentation, and conclusion drawing based on the Miles and Huberman model. Data validity was tested through source triangulation and member checking with participants. This study also considered ethical aspects, such as obtaining approval from the school and participants, maintaining confidentiality, and communicating the research objectives openly and clearly.(Pietilä et al., 2020).

RESULTS AND DISCUSSION

Improving Students' Knowledge about Climate Change

The increase in students' knowledge about climate change is evident in their ability to understand basic concepts such as global warming, the greenhouse effect, and changes in extreme weather patterns.(Handayani & Triyanto, 2022). Most students are able to explain the main causes of climate change, such as greenhouse gas emissions from motor vehicles and industry, and their impact on the environment and human life. This is inseparable from the integration of climate change material into science topics, particularly in learning about weather systems, the carbon cycle, and atmospheric phenomena. Scientific explanations accompanied by concrete examples from everyday life help broaden students' horizons and increase their awareness of the connection between human activities and the current state of the earth. Thus, science learning plays a crucial role in strengthening students' cognitive understanding of climate change issues in a relevant and meaningful way.(Shields, 2019).

The Role of Teachers is Very Important in Contextualizing Material

The teacher's role is crucial in contextualizing science material to make it more relevant and meaningful to students. Teachers who are able to connect scientific concepts to local phenomena such as flooding caused by changes in land use, drought due to unpredictable seasons, or forest fires caused by extreme weather can foster empathy and concern in students for their surroundings. This approach transforms the material into something more than just theory, but also touches on the realities they experience directly.(Asad et al., 2021). Furthermore, the implementation of project-based learning strategies and group discussions has been shown to increase active student participation, develop critical thinking skills, and encourage them to collaboratively seek solutions to environmental problems. Through the active and reflective role of teachers, science learning can be an effective means of instilling transformative climate change awareness from an early age.(Wijayati et al., 2019).

Awareness of Environmentally Friendly Attitudes and Behaviors Begins to Form

Students' awareness of the importance of environmentally friendly behavior is beginning to take shape, marked by the emergence of positive attitudes and concrete actions in their daily lives. Many students are showing interest and commitment to taking simple yet meaningful steps, such as conserving electricity at home, disposing of trash properly, and reducing reliance on single-use plastics.(Priliantini et al., 2020). Not only that, several students have also been actively involved in various school activities oriented towards environmental conservation, such as waste recycling programs, planting trees in the school environment and around their homes, and participating in environmental campaigns organized by the school and community. This behavior shows that science learning that raises the issue of climate change has been able to foster ecological awareness that is not only cognitive, but also affective and behavioral, creating a younger generation that is more concerned and responsible for the future of the earth.(Utami, 2020).

Implementation Barriers in the Field

The implementation of science learning that integrates climate change issues in the field still faces several significant obstacles. One of the main obstacles is the unequal understanding among teachers of the concept and urgency of climate change, as well as how to effectively relate it to the science learning process.(Cross & Congreve, 2021)Many teachers still rely on conventional methods such as lectures, without developing more applicable contextual or action-based approaches. Furthermore, limited supporting facilities and infrastructure, such as laboratories, interactive learning media, or access to relevant learning resources, also hinder optimal teaching. The absence of specific training or workshops on environmental pedagogy and climate education also leads to a lack of innovation in delivering material. As a result, efforts to instill climate change awareness in students are often suboptimal, both in terms of conceptual understanding and the formation of ecological attitudes and behaviors.(Reid, 2019).

The Need for Integration of Materials and Teacher Training

The results of this study indicate that developing climate awareness in students will be more optimal if climate change material is integrated explicitly, repeatedly, and contextually into science lessons. This integration is not sufficient simply through inserting the topic into the syllabus; it needs to be realized through concrete and ongoing learning activities.(Hays & Reinders, 2020)To achieve this, teachers play a central role and need support in the form of training focused on developing media, methods, and learning approaches relevant to climate change issues. This training is expected to not only improve teachers' pedagogical competence in delivering environmental material in an engaging and applicable manner, but also equip them with the skills to design learning experiences that foster critical, caring, and responsible attitudes toward the environment. Thus, science learning can play a more strategic role in instilling a deep environmental awareness oriented toward concrete actions among students.

CONCLUSION

The results of the study indicate that science learning has a significant contribution in building students' knowledge about climate change, particularly through the introduction of scientific concepts such as the greenhouse effect, global warming, and their impacts on the environment. Teachers' contextualization of material that links climate change topics to local conditions has been shown to improve students' understanding while fostering empathy and concern for the surrounding environment. Active and participatory learning strategies, such as discussions, simple experiments, and environment-based projects, are effective in fostering environmentally friendly attitudes and behaviors. Students' awareness of the importance of preserving the environment is beginning to be seen through simple initiatives such as conserving energy and disposing of waste properly. However, teachers' limited understanding and minimal training are obstacles in optimizing science learning related to climate change issues. Therefore, it is necessary to strengthen teacher capacity and systematically integrate climate change material into the science curriculum, so that environmental awareness is formed sustainably and not incidentally.

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