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RESEARCH ARTICLE

Environmental conservation in biology learning: An effort to increase students' awareness of environmental issues

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ABSTRACT

Environmental degradation in Indonesia, including deforestation, plastic pollution, and biodiversity loss, poses serious threats to ecosystems and human well-being. Integrating environmental conservation into biology learning is crucial to fostering students' awareness and responsible behavior toward environmental issues. This study employs a qualitative approach through literature review and curriculum analysis to examine the integration of conservation themes in biology education. Findings suggest that project-based and contextual learning effectively enhance students' understanding and engagement with real environmental challenges. The use of digital tools further supports interactive learning experiences, promoting critical thinking and problem-solving skills. However, challenges such as limited resources and insufficient teacher training hinder effective implementation. Strengthening teacher capacity, improving curriculum design, and fostering collaboration among schools, government, and environmental organizations are essential to enhancing environmental education. This study underscores the potential of biology learning as a transformative tool in shaping a generation that is not only academically proficient but also environmentally conscious and proactive in sustainability efforts.

KEYWORDS

Biology Learning; environmental conservation; environmental issues; student awareness

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1. Introduction

The environment is the main foundation for the sustainability of life on earth (Helliwell, 2020). However, in recent decades, human activities have caused massive environmental damage, threatening the balance of global ecosystems. Indonesia, as

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one of the most biodiverse countries in the world, faces serious environmental challenges. Deforestation, plastic pollution, forest fires, and biodiversity loss are some of the environmental issues that dominate national and international environmental reports (Okorondu et al., 2022).

According to Global Forest Watch, Indonesia lost more than 10 million hectares of primary forest between 2002 and 2020, making it one of the countries with the highest deforestation rates in the world (Gaveau et al., 2021). In addition, Indonesia is also known as the second largest contributor of plastic waste in the world, with around 3.2 million tons of plastic waste dumped into the ocean every year (Arifin et al., 2023; Neo et al., 2021). Forest and peatland fires, especially in Sumatra and Kalimantan, have caused haze that is detrimental to public health and the country's economy. The loss of natural habitat also threatens the existence of endemic species such as orangutans, Sumatran tigers and Javan rhinos, which are now on the brink of extinction (Cochard, 2017; Strang & Rusli, 2021).

This environmental crisis not only affects ecosystems, but also human life. Climate change triggered by environmental degradation has led to natural disasters such as floods, droughts and rising sea levels (Sukumaran, 2022). In addition, air pollution from forest fires and motor vehicle emissions has increased cases of respiratory illnesses in major cities (Kaur & Pandey, 2021). If not addressed immediately, this environmental damage will worsen and impact future generations.

In this context, education plays a crucial role in shaping people's awareness and behavior towards the environment. Environmental education, especially through biology learning, can be an effective means to increase students' understanding of the importance of environmental conservation (Dillon & Herman, 2023; Yadav et al., 2022). Biology as a science that studies life and the interaction of organisms with their environment has great potential to integrate environmental issues into the learning curriculum. Through the right approach, students will not only understand biological concepts theoretically, but can also apply the knowledge in real contexts, such as environmental conservation and management efforts (Tariq, 2024).

However, the main challenge faced is how to integrate complex and multidimensional environmental issues into biology learning which is often limited to textbook materials. The education curriculum in Indonesia still tends to focus on academic achievement, while aspects of character education and environmental awareness are often neglected. In fact, effective environmental education requires a holistic approach that involves not only the transfer of knowledge, but also the formation of attitudes and practical skills (Uralovich et al., 2023). Therefore,

innovation is needed in biology learning methods that can link the subject matter with current environmental issues, so that students can understand the relevance of biological science in everyday life.

Based on the above background, some research questions that can be raised include how environmental issues in Indonesia, such as deforestation, plastic pollution, and biodiversity loss, can be integrated into biology learning, what is the impact of biology learning based on environmental conservation on students' awareness and behavior towards environmental issues, and what strategies are effective to increase the role of teachers in teaching environmental conservation through biology learning.

This article aims to analyze the role of biology learning in increasing students' awareness of environmental issues in Indonesia, present effective strategies for integrating environmental conservation issues into the biology curriculum, and provide recommendations for teachers, schools, and education policy makers in developing biology learning based on environmental conservation. By examining current environmental issues and linking them to biology learning, this article is expected to make a real contribution to efforts to increase the environmental awareness of Indonesia's younger generation. Through the right educational approach, students will not only become academically intelligent individuals, but also citizens who care and are responsible for the environment.

2. Literature review

2.1. Concept of environmental conservaction

Environmental conservation is a systematic effort to protect, maintain, and utilize natural resources wisely so that they can be enjoyed by present and future (Yahman & Setyagama, 2023). According to the International Union for Conservation of Nature (IUCN), environmental conservation includes three main principles: protection, preservation, and sustainable use (Mallarach, et al., 2019). Protection refers to efforts to safeguard ecosystems from damage, while preservation aims to maintain biodiversity and ecological functions (Hoffmann, 2022). Sustainable use emphasizes the use of natural resources that do not exceed the carrying capacity of the environment, so that the ecosystem can recover naturally.

Environmental conservation is closely related to the concept of ecosystem sustainability. Ecosystem sustainability refers to the ability of an ecological system to maintain its balance and function in the long term (Henderson & Loreau, 2023).

Environmental conservation is the key to achieving this sustainability, because without protection and maintenance efforts, ecosystems will be degraded, resulting in biodiversity loss, climate change, and ecological imbalance (Oguh, 2021). For example, tropical forests as the lungs of the world not only absorb carbon dioxide, but also serve as habitats for millions of species. If forests continue to be cut down without conservation efforts, their ecological functions will be lost, and the impact will be felt globally.

2.2. Environmental issues in Indonesia

Indonesia, as a country with abundant natural resources, faces complex environmental challenges. According to data from the Ministry of Environment and Forestry (KLHK), the deforestation rate in Indonesia reached 462 thousand hectares per year in the 2018-2019 period (Lubis, 2023). The main causes of deforestation are the expansion of oil palm plantations, mining, and illegal logging. The conversion of forest land into plantations and mining not only reduces forest cover, but also threatens the habitat of wildlife, such as orangutans and Sumatran tigers. As a result, Indonesia has one of the highest levels of greenhouse gas emissions in the world, especially from the forestry and peatland sectors.

Plastic pollution in the ocean is also a serious problem in Indonesia. The Citarum River, known as one of the dirtiest rivers in the world, symbolizes the poor management of plastic waste. Every year, around 200,000 tons of plastic waste from the Citarum River flows into the Java Sea, threatening marine ecosystems and public health (Gates, 2023). Forest and peatland fires, especially in Riau and Kalimantan, are another environmental issue that often occurs every year (Ohashi, 2021). These fires are largely caused by the practice of slash-and-burn land clearing for oil palm plantations and agriculture.

Biodiversity loss is also a serious problem in Indonesia. Endemic species such as orangutans, Sumatran tigers and Javan rhinos are threatened with extinction due to habitat destruction and poaching. According to the IUCN, the Sumatran orangutan population has declined by more than 80% in the last 75 years, while Sumatran tigers only have around 400 individuals left in the wild (Supriatna, 2022). The loss of biodiversity not only reduces Indonesia's natural wealth, but also disrupts the balance of the ecosystem, which ultimately impacts human life.

2.3. Environmental education in biology

Environmental education plays an important role in shaping people's awareness and behavior towards the environment. Constructivist learning theory emphasizes that knowledge is built through experience and interaction with the environment (Saleem et al., 2021). In the context of environmental education, students are invited to be actively involved in understanding environmental issues through observation, experimentation, and real projects. This approach not only improves students' understanding of biology concepts, but also develops critical and solution skills in dealing with environmental problems (Chusni et al., 2021).

Biology as a science that studies life and the interaction of organisms with their environment has great potential to integrate environmental issues into learning. Biology materials such as ecosystems, biodiversity, and climate change can be linked to current environmental issues, such as deforestation, plastic pollution, and biodiversity loss. For example, in studying forest ecosystems, students can be invited to analyze the impact of deforestation on biodiversity and climate change (Wigand et al., 2022). Thus, learning biology is not only theoretical, but also contextual and relevant to everyday life.

Some schools in Indonesia have implemented innovative environmental education programs. One example is the Adiwiyata program initiated by the Ministry of Environment and Forestry. This program encourages schools to create an environmentally friendly learning environment through activities such as tree planting, waste management and energy saving (Heleri & Ismanto, 2021; Zaliyanti & Azani, 2024). In addition, some schools also integrate environmental education into the biology curriculum through practical projects such as biopore making, organic plant cultivation and water quality monitoring. These programs not only increase students' environmental awareness, but also teach them to be responsible for the environment.

Many biology teachers are still focused on academic achievement and pay less attention to character and environmental education aspects. Therefore, training and workshops are needed for teachers to improve their understanding and skills in integrating environmental conservation into biology learning. In addition, collaboration between schools, government, and environmental NGOs is also needed to create a learning environment that supports conservation efforts.

By integrating environmental issues into biology learning, it is expected that students will not only become academically intelligent individuals, but also caring and responsible citizens of the environment. Effective environmental education can

be a long-term solution to overcome the environmental crisis in Indonesia, while forming a young generation that is ready to face environmental challenges in the future.

3. Methods

This research used a qualitative method with a literature study approach and curriculum analysis to examine the integration of environmental conservation themes in biology education (Guetterman et al., 2015). Data were collected through surveys or interviews with biology teachers and students, as well as scientific literature searches related to environmental conservation and biology education. In addition, biology education curriculum documents in Indonesia and secondary data on environmental issues in Indonesia were the main data sources. This approach allows researchers to understand how conservation themes are integrated in the curriculum and how teachers and students perceive the material.

Data were analyzed through content analysis to identify conservation themes included in the biology curriculum. Qualitative data obtained from surveys or interviews were interpreted to understand teachers' and students' perspectives on the importance of environmental conservation in biology learning. By combining the results of curriculum analysis and responses from respondents, this study is expected to provide recommendations to improve the effectiveness of delivering environmental conservation materials in biology education in Indonesia.

4. Results and discussion

Integrating environmental issues in biology learning is a strategic step to form a generation that cares about nature conservation. In the context of biology education, materials such as ecosystems, biodiversity, and climate change are not only taught as theoretical concepts, but also linked to actual environmental issues that occur around students. According to Ardoin & Heimlich (2021), the use of local examples in learning not only increases the relevance of the material, but also encourages students' emotional and cognitive engagement. This is in line with the research of Herman et al. (2021) who found that contextualizing material through local environmental issues is effective in increasing students' understanding of the complexity of environmental problems.

In addition, integrating environmental issues in biology learning can also be done through an interdisciplinary approach. For example, the concept of biodiversity is not only discussed from a biological point of view, but also related to economic,

social and cultural aspects. For example, the loss of biodiversity in Indonesia's tropical forests not only affects the ecosystem, but also local communities who depend on the forest for their livelihoods.

4.1. Project-based and contextual learning strategies

One of the effective learning strategies to integrate environmental issues in biology is project-based learning (PBL). In PBL, students not only learn theory, but are also directly involved in real projects related to environmental conservation. For example, students can do tree planting projects, environmental cleanup, or river water quality monitoring. According to Mergendoller & Thomas (2005), PBL is effective in improving students' critical thinking skills, collaboration, and social responsibility. Research by Ardiansyah et al. (2024) also showed that PBL in the context of environmental education can increase students' awareness of the importance of preserving nature.

In addition to PBL, contextual learning is also an effective strategy to connect biology material with everyday environmental issues (Ardoin & Heimlich, 2021). For example, when studying the concept of pollution, students can be invited to analyze the impact of plastic waste on marine ecosystems. This approach not only makes learning more interesting, but also helps students understand the relevance of biological science in real life. According to Budiman et al. (2021), contextual learning is effective in increasing students' learning motivation and their ability to apply knowledge in real situations.

4.2. Technology utilization in environmental learning

In the digital era, technology utilization becomes an important component in environmental learning. The use of videos, simulations or interactive applications can help students visualize the impact of environmental damage more clearly. For example, simulations on the impact of global warming on polar ecosystems can help students understand the concept of climate change more deeply. According to Haleem et al. (2022), the use of digital media in environmental learning not only increases students' interest, but also strengthens their understanding of complex concepts.

In addition, technology also allows students to engage in collaborative projects with students from other regions or countries. For example, through online platforms, students can share data on air or water quality in their area and compare it with data from other areas. This not only broadens students' horizons, but also

teaches them about the importance of global cooperation in addressing environmental issues. Research by Dede (2010) shows that the use of technology in environmental education can improve students' collaboration and communication skills (Owens & Hite, 2022).

4.3. Impact on students' awareness and behavior

The integration of environmental issues in biology learning has been proven to have a positive impact on student awareness and behavior. According to Suárez-Perales et al., (2021), effective environmental education can change students' attitudes and behaviors in a sustainable manner. For example, after knowing the impact of plastic waste on marine ecosystems, students tend to be more aware of reducing the use of plastic in their daily lives. This is in line with the results of research by Zhang (2024) showing that environmental education can influence students' pro-environmental behavior, such as reducing energy consumption, recycling waste, and using environmentally friendly transportation.

In addition, environmental learning can also improve students' critical thinking and problem-solving skills. For example, when students are invited to analyze the causes and solutions to air pollution problems, they learn to identify problems, collect data, and propose realistic solutions. According to Bibi et al (2025), these skills are not only important for environmental awareness, butSX8 also for students' success in various aspects of life.

4.4. Challenges and recommendations

Although the integration of environmental issues in biology learning has many benefits, there are some challenges that need to be overcome. First, the lack of resources and facilities in some schools may hinder the implementation of learning strategies such as PBL or the use of technology. Secondly, the lack of teacher training on environmental education is also an obstacle. According to Parry & Metzger (2023) research, many teachers feel unprepared to integrate environmental issues in learning due to lack of knowledge and skills.

To overcome this challenge, collaborative efforts between the government, schools and communities are needed. For example, the government can provide training to teachers on environmental education and provide the necessary facilities. In addition, collaboration with non-governmental organizations (NGOs) or universities can also assist schools in developing effective environmental education programs. According to Reid (2021), this collaborative approach can improve the

quality of environmental education and ensure that students have meaningful learning experiences.

5. Conclusion

The integration of environmental issues in biology learning is an important step to form a generation that cares about the preservation of nature. Through strategies such as project-based learning, contextual learning, and technology utilization, students not only understand biology concepts, but also develop pro-environmental awareness and behavior. Although there are challenges in its implementation, collaborative efforts between various parties can help overcome these obstacles and ensure that environmental education becomes an integral part of the biology curriculum in Indonesia. Thus, biology education not only serves as a means of knowledge transfer, but also as a tool to shape a generation that is responsible for the future of the earth.

Conflict of interest

The authors declare that they have no conflict of interest.

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