Education For Sustainable Development (ESD) climate-based in biology education

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Abstract: *Education for Sustainable Development (ESD) based on climate change in biology learning is an innovative approach to equip students with knowledge, skills, and critical awareness of complex environmental issues. This research discusses the implementation of ESD in the biology curriculum with a focus on climate change, as well as how its integration shapes sustainable attitudes and behaviors in students. Through a literature review, this research identifies effective teaching methods, such as problem-based learning and collaborative learning, which can help students understand the impact of climate change on life and ecosystems. The results obtained indicate that the application of ESD in biology education can enhance students' scientific understanding and critical thinking skills, which are essential for making responsible decisions in the future. The conclusion of this study is that climate change-based ESD is not only relevant for biology education but also important for shaping a more adaptive, responsible generation ready to face global sustainability challenges.*

Key Words*:* Biology education, Climate change, Education For Sustainable Development

Introduction

Climate change has become one of the biggest challenges facing society in the 21st century. Its wide-ranging and complex impacts affect not only the environment, but also social, economic and health aspects. Therefore, education plays a crucial role in equipping future generations with the necessary knowledge and skills to face this challenge. Wise development is sustainable development. Sustainable development is a development effort that aims to improve the quality of life of people around the world, both for present and future generations, without exceeding the carrying capacity of the earth in the utilization of natural resources(Purnamasari & Hanifah, 2021). Education for sustainable development (ESD) is also emerging as a relevant and innovative approach, especially in the field of science education such as biology.

Sustainable development is development to meet needs without reducing the ability or capacity of future generations to meet their own needs (UNESCO, 2017). The term sustainable is a concept of a better human life in the midst of natural limitations by maintaining a balance of life in three dimensions, namely social, economic, and environmental (Novidsa *et al.,* 2020). There are 17 goals with 169 measurable achievements, namely sustainable development goals (SDGs). One of the efforts in realizing the SDGs is through education. Education can be described as a great hope for designing a better sustainable future and is also an effort to overcome the environmental crisis. This approach through education is known as Education for Sustainable Development (ESD). ESD-

based education promotes a holistic understanding of environmental issues, including climate change, and encourages students to develop sustainable attitudes and behaviors.

In the learning process by integrating ESD into the curriculum, including in biology learning, students not only learn about the basic concepts of biology, but also how climate change affects ecosystems and their daily lives. This is important because a deep understanding of the impacts of climate change can shape students' critical awareness and ability to make responsible decisions. In addition, ESD can also be integrated into various fields of study such as science or IPA, social science, and even language (Rahmawati *et al.,* 2021).

This article aims to explore the application of climate change-based ESD in biology learning. Through a comprehensive literature study. The research will identify effective teaching methods, such as problem-based learning and collaborative learning approaches, that can enhance students' understanding of climate change. Research from this relevant literature review is expected to provide insights into how ESD integration can strengthen students' critical thinking skills and prepare them to face global sustainability challenges.

As such, this research is not only relevant for educators and curriculum developers, but also for policy makers who seek to create an education system that is responsive to environmental challenges. Through this approach, we hope to shape a more adaptive and responsible generation in the face of increasingly pressing environmental issues.

Method

This research was prepared using the literature review method, which was carried out in four stages. The first stage was the determination of the topic, followed by the search and selection of articles relevant to the topic. The third stage involved analyzing and synthesizing the literature, while the fourth stage focused on organizing the paper. The discussion in this study centered on research results that discussed the characteristics of Education for Sustainable Development (ESD) and its application in biology learning. A total of seven articles related to the implementation of ESD in biology learning, published in various journals over the past five years, became the main material in this review. The results of this literature review are expected to provide an overview of the implementation of ESD in biology learning.

Results and Discussion

Education Concept for Education for Sustainable Development (ESD)

Education for Sustainable Development (ESD) is an educational approach that aims to prepare individuals to contribute to the achievement of sustainable development goals. The achievement of educational goals is one of the most important social aspects of national development. The concept of Education for Sustainable Development (ESD) emerged as a response to various environmental crises and humanitarian issues faced today, as well as challenges that may occur in the future. According to Primasti, (2021)ESD focuses on developing the knowledge, skills, and attitudes needed to face environmental, social, and economic challenges. The Sustainable Development Goals (SDGs), with targets until 2030,

have become an integral element of ESD today (UNESCO, 2020). Therefore, by raising awareness of sustainability issues in ESD, it can form a generation that is more concerned about the environment and able to take actions that have a positive impact. Here are some of the main concepts in ESD:

1. Environmental Awareness: Increase understanding of environmental issues, including climate change, biodiversity loss, and pollution, and their impacts on communities and ecosystems.
2. Critical Thinking Skills: Develop students' ability to analyze, evaluate, and make informed decisions regarding sustainability issues.
3. Active Participation: Encourage students to get involved in community activities and sustainability-focused projects, so that they can contribute directly to positive change.
4. Interdisciplinary: Integrates various disciplines to provide a holistic understanding of the complex issues faced by society today. 5. Social
5. Justice: Takes into account the social and economic aspects of sustainability, including issues of social justice and human rights, and how they interrelate with the environment.
6. Action-based Education: Promotes learning through real-life experiences and practical actions that students can take to support sustainability.
7. Sustainable Development: Promotes the concept of development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs.
8. Collaboration and Partnership: Encourage collaboration between various stakeholders, including government, educational institutions, non-governmental organizations, and the private sector in an effort to achieve sustainability goals.
9. Efficient Use of Resources: Teaches the importance of sustainable and efficient management of natural resources to ensure availability for future generations.
10. Innovation and Creativity: Encourage students to think creatively and innovatively in finding solutions to existing sustainability challenges.

Integrating some of these concepts in education, ESD aims to shape individuals who not only have the knowledge but also the attitudes and skills needed to create a sustainable future.

The role of Biology Education in ESD

Biology education has a crucial role in integrating the principles of sustainability(Sari *at al.,* 2014). Biology education is an important foundation in the development of biology curriculum and teaching methods, covering philosophical, pedagogical, and scientific aspects. Philosophically, biology education aims to instill an understanding of life and the processes underlying biodiversity. This involves the exploration of basic biological principles such as evolution, ecology, genetics and physiology, all of which explain how living organisms interact and evolve within their environment (Hatchi at al, 2024). Thus, biology education not only conveys scientific knowledge but also develops critical thinking and a holistic understanding of life. An effective pedagogical approach is needed to convey these

concepts in an engaging and relevant manner for students, ensuring not only memorizing information but also understanding and applying it in real-life contexts. The scientific aspect of biology education provides the basis for continuous innovation and new discoveries in the field of biology and related sciences.

Through biology education in biology materials about ecosystems, biodiversity, and interactions between living things and the environment, students can understand the impact of human activities on nature(Lasaiba, 2023). Thus, biology education not only teaches scientific facts but also equips students with a deep understanding of the importance of maintaining ecological balance. Here are some of the roles of biology education in ESD according to Kurniawan *at al,* (2023);

1. Increased Environmental Awareness: Biology education helps students understand the interactions between living things and their environment, as well as the impact of human activities on ecosystems. With this knowledge, students can be more aware of the importance of maintaining environmental sustainability.
2. Scientific Skills Development: Through ESD-oriented biology learning, students are trained to develop basic scientific working skills, such as observation, experimentation, and data analysis. These skills are essential for solving complex environmental problems.
3. Integration of Sustainability Values: Biological education enables the integration of sustainability values in the curriculum, which helps students understand the principles of sustainability and their social responsibility towards the environment.
4. Project-based Learning: Biology education often involves project-based learning that allows students to be directly involved in activities related to sustainability, such as waste management and biodiversity conservation. This not only enhances their understanding but also encourages real action in their communities.
5. Preparation for Global Challenges: By providing knowledge on global issues such as climate change and biodiversity loss, biology education prepares students to become future leaders capable of facing these challenges.
6. Development of Pro-Environmental Attitudes: Biology education contributes to the development of positive attitudes towards the environment, encouraging students to take actions that support sustainability and protect natural resources.

Climate Change Education

Climate change is a natural phenomenon that cannot be avoided because it has a major impact on the balance of the ecosystem. Some of the impacts include rising sea levels, erratic changes in seasonal patterns, food crises, extinction of various species of flora and fauna, the spread of tropical diseases such as dengue fever, diarrhea, malaria and elephantiasis, and extreme changes in the psychological conditions of humans and animals. These phenomena are the direct result of climate change. Although information about climate change has been widely disseminated, the information media is often considered the main source, although not all information conveyed is entirely accurate(Arwan *at al,.* 2022). Some of the information circulating actually increases anxiety and concern regarding

the phenomenon of climate change. One of the most common misinformation is the assumption that the greenhouse effect is caused by the reflection of glass from tall buildings and the equation of the term global warming with climate change (Amelia, 2019). Based on this, media literacy is very important to process information wisely and skillfully, especially information related to climate change.

Based on the results of the UNCHE international cooperation forum held in Stockholm, Sweden, in 1972 revealed that there is a link between poverty and low levels of education with development that cannot be managed effectively and efficiently (Ali, 2017). In this context, education has an important role in equipping people to understand that climate change is not only a matter of global warming and natural disasters, but also complexly affects human survival. Education has an important role that can be explained through three main dimensions related to climate change, namely as follows:

1. Education serves to increase the knowledge capacity and social attitudes of individuals and groups in mitigation efforts, so that the adverse effects of climate change can be prevented or minimized.
2. Education aims to develop knowledge, attitudes and skills to deal with climate change that is already occurring, where adaptation competencies are needed so that humans can adjust and act appropriately.
3. Education plays an ongoing role in encouraging, stimulating and strengthening understanding and awareness of the reality of change.

Designing climate change-based education starts with curriculum development. The curriculum is likened to the core that organizes all components to realize the desired educational goals. Climate change-based education needs to be designed and developed through critical analysis, relevant policy support, and the availability of learning resources and facilities. This also includes the readiness of teachers in managing emotional and psychological aspects related to climate change, so that it can be a source of strengthening values. Climate change-based education is closely related to sustainable development-based education. This is because one of the main focuses of sustainable development is climate change indicators, which directly affect human survival. Climate change-based teaching and learning processes are an important part of creating awareness and understanding of the issue.

Case Studies and Best Practices

Some educational institutions have successfully implemented climate-based ESD. For example, schools that implement real environmental projects have shown increased student awareness of sustainability issues. Analysis of these practices shows that students' active involvement in such projects not only increases their knowledge but also builds a sense of responsibility towards the environment. Here are case studies and best practices in biology education that integrate education for Education for Sustainable Development (ESD);

1. Projected Biodiversity Conservation in Schools

   Case study by Sari *at al,.* (2020): In some schools in Indonesia, biodiversity conservation projects are carried out by involving students in observing local flora and

fauna. Students learn about the importance of biodiversity and how to protect it through activities such as tree planting and creating school gardens.

2. Project Based Learning Program

   Case study by Yusof *at al,.* (2019): A program in a high school in Malaysia used a project- based learning approach to teach the concept of sustainability. Students conducted research on the impact of plastic pollution and designed solutions to reduce plastic waste in their environment.

3. Environmental Education Activities in the Community

   Case study by Medoza *at al,.* (2021): In the Philippines, an environmental education program involving students in waste management activities and recycling campaigns has successfully raised public awareness about the importance of sustainability.

4. Technology Integration in Learning

   Case study by Silvia *at al.,* (2022): The use of a mobile application for water quality monitoring in local rivers by students in Brazil helped them understand the impact of human activities on aquatic ecosystems and the importance of maintaining environmental quality.

5. Field Research Activities

   Case study by Johnson *at al.,* (2018): Schools in Australia implemented field research activities that allowed students to observe local ecosystems and conduct analysis on the impacts of climate change on specific species.

Based on the case study, it shows that biology education can be integrated with ESD principles to create meaningful learning experiences that have a positive impact on the environment and society.

Conclusion

Climate change-based Education for Sustainable Development ESD is not only relevant for biology education but also essential for shaping a generation that is more adaptive, respomible and ready to face the challenges of global sustainability.

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