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Analysis of Local Wisdom Integration in Biology Learning to Support Education for Sustainable Development (ESD)

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Abstract

This study analyzes the integration of local wisdom in biology learning as an effort to support Education for Sustainable Development (ESD). Local wisdom includes various knowledge and practices that contribute to environmental sustainability and play a role in enriching biology learning to make it more contextual and meaningful. The results showed that the application of local wisdom, such as traditional practices in natural resource management and the utilization of medicinal plants, can help students understand the concepts of ecosystems, biodiversity and conservation better. In addition, this approach is aligned with ESD goals, including improving the quality of education, sustainable consumption and production, and mitigating climate change. Nevertheless, the implementation of local wisdom in learning still faces obstacles, such as limited teaching materials and the readiness of educators. Therefore, supportive policies, training for teachers, and development of local wisdom-based learning media are needed to achieve ESD goals optimally.

Keywords: *Biology Learning, Education for Sustainable Development, Local Wisdom*

Abstrak

Penelitian ini menganalisis integrasi kearifan lokal dalam pembelajaran biologi sebagai upaya mendukung Pendidikan untuk Pembangunan Berkelanjutan (ESD). Kearifan lokal mencakup berbagai pengetahuan dan praktik yang berkontribusi terhadap keberlanjutan lingkungan dan berperan dalam memperkaya pembelajaran biologi agar lebih kontekstual dan bermakna. Hasil penelitian menunjukkan bahwa penerapan kearifan lokal, seperti praktik tradisional dalam pengelolaan sumber daya alam dan pemanfaatan tanaman obat, dapat membantu siswa memahami konsep ekosistem, keanekaragaman hayati, dan konservasi dengan lebih baik. Selain itu, pendekatan ini selaras dengan tujuan ESD, termasuk peningkatan kualitas pendidikan, konsumsi dan produksi berkelanjutan, dan mitigasi perubahan iklim. Meskipun demikian, implementasi kearifan lokal dalam pembelajaran masih menghadapi kendala, seperti keterbatasan bahan ajar dan kesiapan pendidik. Oleh karena itu, kebijakan yang mendukung, pelatihan bagi guru, dan pengembangan media pembelajaran berbasis kearifan lokal diperlukan untuk mencapai tujuan ESD secara optimal.

Keywords: *Pembelajaran Biologi, Pendidikan untuk Pembangunan Berkelanjutan, Kearifan Lokal*

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INTRODUCTION

Education for Sustainable Development (ESD) is an educational approach that aims to empower individuals to contribute to creating a sustainable future (UNESCO, 2020). This approach emphasizes the development of knowledge, skills, values, and attitudes needed to face global challenges, including climate change, environmental sustainability, and social justice. In the context of science education, especially biology, ESD can be realized through the integration of local wisdom in learning. Local wisdom reflects traditional practices and knowledge that have been proven to contribute to environmental sustainability, so it can be a source of contextual and meaningful learning for students (Afnan et al., 2024).

Local wisdom as knowledge passed down from generation to generation has great potential in enriching biology learning. In addition to including an understanding of the environment and the use of natural resources, local wisdom also contains cultural values that emphasize ecological balance and respect for nature (Suanda et al., 2024). For example, in indigenous communities in various regions in Indonesia, there are local wisdom-based environmental management practices that are in line with sustainability principles, such as the subak system in Bali for water management and sustainable agriculture (Widiarini et al., 2025). By linking scientific concepts in biology, such as ecosystems and biodiversity, with local wisdom practices, students can more easily understand the relationship between humans and the environment holistically (Niman, 2019; Tomi et al., 2024).

The integration of local wisdom in biology learning not only enriches the subject matter but also helps students develop a critical attitude towards environmental issues (Silahooy et al., 2024). Studies show that local wisdom-based learning models can improve students' understanding of scientific concepts by connecting theory with real practices in their communities (Putri & Darussyamsu, 2021). For example, in the Kerinci region, a local wisdom-based biology learning tool was developed to teach biodiversity with a contextual approach, which was shown to increase students' interest in learning science (Tomi et al., 2024).

In the midst of increasingly strong globalization, local wisdom-based learning plays an important role in preserving students' cultural identity (Pugu et al., 2024). By reintroducing cultural values in the context of education, students can understand the importance of maintaining their ancestral heritage while still adapting to the development of modern science (Suanda et al., 2024). In biology learning, for example, the use of ethnobotanical concepts can help students understand the relationship between local plants and their culture. Studies on Malay traditions, such as Tepung Tawar, show how cultural practices can be linked to learning about biodiversity and medicinal plant utilization (Septiani, 2025).

Although the integration of local wisdom has many benefits, its implementation still faces various challenges. One of the main challenges is the lack of understanding and readiness of teachers in adopting this approach into the biology curriculum (Utami et al., 2022). Most teachers are still oriented towards textbook-based learning approaches and have not explored the potential of local wisdom as a learning resource. In addition, the limitations of teaching materials that accommodate the integration of local wisdom are also an obstacle that needs to be overcome through the development of more comprehensive learning tools (Indrawan & Mahendra, 2021).

To overcome these challenges, collaboration between various stakeholders is needed, including teachers, academics, government, and local communities. Teachers need to be trained to understand how local wisdom can be effectively integrated into biology learning. In addition, the development of teaching materials based on local wisdom, whether in the form of modules, interactive learning media, or community-based projects, can be a solution to enrich students' learning experience (Iksan et al., 2023; Zebua et al., 2024). Studies also show that the ethnopedagogical approach can be an effective strategy in integrating local wisdom values into the formal education system (Septiani, 2025).

The integration of local wisdom in biology learning is a strategic step to support Education for Sustainable Development (ESD). By linking biological concepts with time-tested cultural practices, students can gain a deeper understanding of the environment and

sustainability. In addition, this approach also contributes to the preservation of local culture and the strengthening of students' identity amidst the challenges of globalization. To achieve a more optimal implementation, synergy between various parties is needed in developing innovative and local wisdom-based learning models.

METHODS

This study used an in-depth content analysis approach to examine the integration of local wisdom in biology learning and its relevance to Education for Sustainable Development (ESD). Data collection was done purposively through various academic sources such as collections of articles, reference books, and relevant policy documents. The main focus of this research is to identify how local wisdom is applied in biology learning, both in terms of the type of wisdom used, the learning model applied, and its relationship with biological materials.

The analysis was conducted using content analysis techniques to identify patterns in the literature and categorize the main findings based on certain aspects. Some of the elements examined include the types of local wisdom integrated - such as traditional ecological practices and socio-cultural values - as well as learning methods such as Project-Based Learning and ethnopedagogy. This research highlights the relevance of biological materials to local practices, such as biodiversity conservation and traditional biotechnology. The results of this analysis provide insights into how the integration of local wisdom can enhance students' understanding of biology in a contextual and environmentally-based manner.

RESULTS AND DISCUSSION

Results

Based on the literature analysis, it was found that local wisdom that is often integrated into biology learning includes traditional knowledge about natural resource management, such as sustainable agriculture, forest management, and biodiversity conservation (Alimah, 2019). For example, in Indonesia, local wisdom about the subak system in Bali is often used as an example in ecosystem learning and water conservation (Suanda et al., 2024). In addition, traditional knowledge of the use of medicinal plants is also often integrated into biology materials on biodiversity and biotechnology (Ramdani et al., 2024). The application of local wisdom in biology learning can provide a deeper understanding of ecosystem balance and community-based conservation practices (Anzelina, 2023).

Learning models that are often used in the integration of local wisdom are contextual learning and project-based learning (PJBL) models. The contextual learning model allows students to connect biology material with their daily lives, while project-based learning encourages students to conduct research or projects related to local wisdom. In addition, the discovery learning model is also often used to encourage students to discover biology concepts through the exploration of local wisdom (Lestari & Bahri, 2021). Learners have greater opportunities to be actively involved in exploring various natural phenomena related to local wisdom. This exploration process indirectly strengthens their skills in making in-depth observations and systematic scientific investigations.

Learning methods that are often used in the integration of local wisdom are observation, interviews with community leaders, and simple experiments. The observation method is used to observe traditional practices related to biology, such as land management or the use of medicinal plants. Interviews with community leaders help students understand the cultural values underlying these practices, while simple experiments allow students to test biology concepts in the local context. The application of this method not only encourages students' active participation in the learning process but also enriches their understanding of the application of biology concepts in everyday life (Rose et al., 2024). Through direct involvement with the surrounding community, students have the opportunity to hone their communication skills and build social skills that are crucial in understanding various community perspectives on environmental issues (Handayati et al., 2023).

Biology materials that are often raised in the integration of local wisdom include ecosystems, biodiversity, and biotechnology. For example, materials about ecosystems are often associated with local wisdom about forest management or traditional irrigation systems. Biodiversity material is often linked

to traditional knowledge about medicinal plants or local animals, while biotechnology material can be linked to traditional practices such as fermentation or making herbal medicines. This approach allows students to experience more contextualized learning, as they can relate biology concepts to real situations they encounter in their daily lives (Surata, 2019). Through this method, students can also develop a deeper understanding of the need to maintain the balance of the ecosystem and maintain the survival of species that are only found in certain areas (Nurjanah et al., 2024).

The integration of local wisdom in biology learning also encourages students to develop critical and creative thinking skills. For example, students are invited to analyze how local wisdom can be applied in a modern context to support sustainable development. This is in line with ESD objectives that emphasize the importance of developing critical thinking skills and innovative solutions to face global challenges. With this approach, students not only understand the theory but also learn how to solve environmental problems by utilizing local resources in a sustainable manner. This approach also allows students to explore alternative local wisdom-based technologies that can be adapted in a modern context (Budiarti & Airlanda, 2019).

In addition, integrating local wisdom into biology learning can strengthen students' cultural identity. By learning local wisdom, students not only understand biological concepts but also appreciate their cultural heritage. This can encourage students to care more about their environment and culture, thus supporting ESD goals (Januardi et al., 2022).

However, implementing local wisdom integration in biology learning still faces various challenges, such as the lack of local culture-based teaching resources, teachers' limited understanding of how to connect biology materials with local wisdom, and the lack of support from the curriculum, which is still oriented towards conventional approaches. Therefore, strategies and collaboration between various parties are needed to ensure that this integration can run effectively and positively impact students.

Discussion

The integration of local wisdom in biology learning aligns with constructivism learning theory, which emphasizes that knowledge is built through experience and interaction with the environment (Vygotsky & Cole, 1978). In this context, local wisdom can be a rich source of experience for students to understand biology concepts. For example, traditional knowledge of forest management can be used as a context for learning the concepts of ecosystems and interactions between organisms. By utilizing local knowledge, students can gain a more in-depth and contextual understanding of ecosystem balance and the influence of human activities on the environment.

In addition, the integration of local wisdom also supports the theory of cultural-based learning, which emphasizes the importance of connecting learning with students' cultural context. By integrating local wisdom, learning biology becomes more relevant and meaningful. Students not only understand scientific concepts but also learn how to apply them in real life, which can increase their motivation and involvement in learning.

Integrating local wisdom in biology learning has an important role in supporting the achievement of Education for Sustainable Development (ESD) goals. Local wisdom, which includes traditional knowledge and practices passed down through generations, contains sustainability values relevant to biological concepts (Alimah, 2019). By integrating local wisdom in learning, students can understand the concepts of ecosystems, nutrient cycles, and conservation more contextually and meaningfully. This supports the 4th ESD goal (Quality Education), which emphasizes inclusive, equitable, and culturally relevant education.

Furthermore, local wisdom-based teaching also supports ESD goal 12 (Sustainable Consumption and Production). Many traditional practices promote the principles of resource efficiency and waste reduction, such as the use of organic fertilizers from crop residues in traditional agriculture. By understanding and applying these practices, students not only learn biology concepts such as the recycling of matter and the interaction of organisms but also gain awareness of the importance of a sustainable lifestyle. This can encourage students to apply such principles in

their daily lives, thus contributing to the creation of more responsible consumption patterns.

In addition to providing a deeper understanding of biological concepts, the integration of local wisdom in biology learning also contributes to ESD goal 13 (Climate Change Management). Local knowledge on adaptation to climate change, such as traditional agroforestry techniques that conserve soil moisture and reduce carbon emissions. Through this learning, students not only understand the concept of climate adaptation and mitigation but also realize the importance of maintaining environmental balance as a concrete step to deal with the impacts of climate change.

However, to integrate local wisdom effectively, teachers need to have a deep understanding of it and how to connect it with biology materials. Teachers also need to develop appropriate learning methods and strategies, such as project-based learning or contextual learning, that allow students to explore local wisdom actively. A teacher's ability to master local wisdom can be improved through a specially designed training program, with the main focus on implementing culturally grounded pedagogical strategies (Harisanti, 2019).

The role of teachers in the integration of local wisdom is very important because teachers act as facilitators who help students connect local wisdom with biology concepts. Teachers also need to create an inclusive learning environment where students feel comfortable sharing their knowledge and experience about local wisdom. In addition, teachers need to collaborate with community leaders and cultural experts to enrich learning materials with local wisdom. To make the learning materials richer with local wisdom values, teachers need to collaborate with community leaders and cultural figures. Through this collaboration, learning can be developed more contextually, allowing students to see how biology concepts are applied in real life in the environment around them. This form of community involvement in the learning process also has the potential to enhance the learning experience, making it more meaningful for students. Students do not only rely on textbooks as the main source but also gain direct insight from experiences that are aligned with local wisdom (I Wayan Suanda et al., 2024).

Related parties, such as the government and educational institutions, also have an important role in supporting the integration of local wisdom. The government can develop policies and curricula that support local wisdom-based learning, while educational institutions can provide resources and training for teachers to integrate local wisdom into biology learning. Efforts to strengthen policies that integrate local wisdom in the education system can serve as an important strategy to preserve cultural heritage amid the development of the modern era (Handayani et al., 2022).

Furthermore, the use of digital-based learning media can also be a solution in introducing local wisdom to students more widely (Zebua, 2025). The development of e-learning based on local wisdom has been proven to improve student understanding and provide a more interesting learning experience (Nurjanah et al., 2024). Advances in digital technology open up opportunities for students to explore a variety of information about local wisdom from various regions. With extensive access to these resources, they can make comparisons and analyze cultural differences in relation to biological concepts (Sahil et al., 2023).

Meanwhile, the utilization of interactive learning applications supported by virtual reality technology can provide a more immersive learning experience. Through this approach, students have the opportunity to explore local wisdom practices in more depth in the field of biology so that their understanding of the relationship between culture and life science is enhanced (Burhan et al., 2024).

Thus, the integration of local wisdom in biology learning not only supports ESD goals, but also enriches students' learning experiences and strengthens their cultural identity. To achieve this, collaboration between various parties, including teachers, researchers, cultural experts, and the government, is needed to develop effective learning models and methods that are relevant to the local context.

CONCLUSIONS AND SUGGESTIONS

A biology learning approach that integrates local wisdom is proven to support the achievement of Education for Sustainable Development (ESD) by helping students understand biology concepts in a more

contextualized manner. Local wisdom not only enriches learning materials but also instills sustainability values related to students' daily lives. This strategy plays a role in improving the quality of education, preserving local culture, and fostering environmental awareness. However, its implementation still faces obstacles, such as limited teaching resources and educators' readiness. To overcome these challenges, cooperation between the government, educational institutions and the community is needed to develop the curriculum and provide teacher training. With optimal support, the integration of local wisdom in biology learning can be an effective solution in sustainably realizing ESD goals. Utilizing local wisdom in biology learning will greatly help students to facilitate their learning. Therefore, it is better to use the concept of local wisdom in learning at school.

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