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Integration of Local Wisdom in Biology Learning as a Strategy for Overcoming the Waste Crisis

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Abstract

This research examines the impact of integrating local wisdom into biology education on waste management at Madrasah Aliyah Al-Jawahir, Bandung Regency. Using a qualitative case study approach, the study explores how values such as cooperation, Preserve, cooperation, and permission, when applied to waste management, influence students' understanding of biology and the environmental conditions of the school. Participants included the school principal, biology teachers, and students actively engaged in the program. Data collection methods encompassed in-depth interviews with school leaders and biology teachers, direct observation of waste management practices, documentation via notes and visual media, and questionnaires assessing students' understanding of biology related to waste management. Thematic analysis was employed to identify critical patterns and themes from the data. Findings indicate that integrating local wisdom into biology lessons at MA Al-Jawahir has significantly benefited both the environment and students. Implementing composting and recycling practices has reduced organic waste, improved cleanliness, and generated economic benefits through compost sales. Most students exhibited a good to excellent grasp of biology in the context of waste management, as reflected in the questionnaire results. The study concludes that incorporating local wisdom into biology education offers a practical, sustainable solution for addressing waste issues, aligning with regional regulations that promote environmental stewardship in educational institutions. The research recommends expanding this program within the curriculum and extracurricular activities and involving more stakeholders to foster a cleaner, healthier environment.

Keywords: biology learning, local wisdom, waste crisis

INTRODUCTION

The waste crisis has become a global problem that affects the environment, human health, and the sustainability of natural resources, including Indonesia. Indonesia has a large population (Choirunnisa et al., 2023). However, the country still faces challenges in various fields (Irawan, 2022), with waste management being one of the most significant (Lasaiba, 2024). Waste that is not managed correctly will not only cause environmental problems but can become health, economic, and social problems (Mulyati et al., 2023).

Various strategies have been proposed to overcome the waste crisis (Alamanda et al., 2020). Facilities, including modern technology and improvements to waste management infrastructure, have been used (Tuhumury et al., 2024). However, some strategies require high costs (Nainggolan et al., 2023). Not effective in the long term, this approach may lead to more significant challenges down the road (Puspitasari & Hidayat, 2022). Therefore, exploring alternative, more sustainable, affordable solutions is critical to utilizing local wisdom.

Local wisdom often reflects knowledge and experience tested for years (Anwar et al., 2023). Wise use of technology can preserve and develop this wisdom (Antonio et al., 2024). In Indonesia, local

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communities have local wisdom that can contribute to better waste management, such as traditional recycling techniques, using organic compost materials, and reusing materials considered waste. The contribution and role of local communities are significant in expressing their culture and traditions. Also, local communities play a role in effective waste management practices (Amelia & Susanti, 2024).

Local wisdom, based on wise use of the environment, inspires biology learning integrated with local wisdom. Local and Cultural Wisdom in Biology lessons is a learning approach that integrates local wisdom, knowledge, and practices (Adinugraha, 2020). This can be an effective strategy to overcome the waste crisis. Through this learning, students will not only understand biological concepts but also gain practical skills and values that they can apply in their daily lives to manage waste wisely. In addition, this approach can increase students' environmental awareness and strengthen their cultural identity. Exploring how local wisdom can be integrated into biology learning is essential, making it easier to achieve learning goals.

Previous studies have shown that integrating local wisdom in education can provide significant benefits, including biological learning. We can find research showing the potential of South Sumatra's local wisdom as a basis for contextual learning media for high school biology (Anzelina, 2023). Apart from that, research has been carried out regarding integrating environmental education through an eco-pedagogy approach in social studies learning in elementary schools (Adela & Permana, 2020). Social Studies Learning Based on Local Wisdom of the Baduy Tribe to Cultivate the Environmentally Caring Character of Elementary School Students (Yulianto et al., 2023); apart from that, the integration of local wisdom values in elementary/MI mathematics learning in the 2013 curriculum (Nuraini, 2022), has also become an exciting topic researched. Apart from the social and mathematical fields, local wisdom can also be integrated into science learning, including reflection on the value of local wisdom in elementary school science learning (Rahmatih et al., 2020). They are strengthening digital literacy based on local wisdom (Widiana, 2023) and strengthening Local Wisdom Values in Science Learning in the Independent Curriculum to Form Pancasila Student Profiles (Safitri et al., 2023). Development of science learning tools based on local wisdom to improve students' cognitive learning outcomes (Khaerani et al., 2020). Development of high-class local wisdom-based science learning modules in elementary schools (Widiya et al., 2021). Meta-analysis of the effect of integrating local wisdom in science and physics learning on learning outcomes (Fauzi et al., 2022). Training on Preparing Chemistry Modules Based on Local Wisdom for High School Teachers in Sungai Banyak, Jambi (Sanova et al., 2022). Even at every level of education, the integration of local wisdom in learning makes a positive contribution; this is shown by research entitled Innovation in Early Childhood Learning: Local Wisdom Approaches in Management Practices (Idhayani et al., 2023) up to the high school level. In previous research, local wisdom was integrated into learning to facilitate the achievement of learning objectives.

In contrast to other research in this study, integrating local wisdom in biology learning on environmental pollution material is not only expected to increase students' understanding of the material. However, it is also expected to be the best strategy for solving the waste crisis problem. Through the use of local wisdom, students can learn about various traditional practices that are

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effective and environmentally friendly in managing waste and preventing pollution (Ningrum et al., 2023). For example, composting techniques, processing organic waste, and reusing valuable materials can still be taught as part of environmental pollution prevention material. By understanding and applying this local wisdom, students gain theoretical knowledge and practical skills in dealing with the waste crisis problem effectively (Adzim et al., 2023). This is expected to help reduce the amount of waste produced and its negative environmental impact. In addition, integrating local wisdom in biology learning can foster an environmentally caring attitude in students, encourage them to be more responsible in managing waste, and become active agents of change in their communities (Marlina et al., 2023). Through this approach, it is hoped that students will achieve biology learning objectives and contribute significantly to resolving the waste crisis and preserving the environment. Integrating local wisdom in biology and learning about environmental pollution material will be a sustainable and effective solution to overcoming complex environmental problems while improving the overall quality of education.

This research aims to integrate local wisdom in learning to achieve several main goals. First, increase understanding and achievement of learning goals from a cognitive, affective, and psychomotor perspective. By linking learning material to the local context, it is hoped that students can more easily understand and master it (Saputri & Desstya, 2023). Second, it positively impacts solving environmental problems, especially waste-related ones. Through understanding and applying local wisdom values and practices, students will be taught the importance of maintaining a clean environment and effective waste management, including traditional methods that have proven successful in reducing, recycling, and utilizing waste (Setyaningsih et al., 2023). Third, they should instil an environmentally caring attitude in students so that they can become active agents of change in their communities (Pravitasari & Nugraheni, 2024). Thus, this research focuses on improving the quality of learning and making a real contribution to preserving the environment through sustainable education. Furthermore, by focusing on innovations that integrate local wisdom in biology learning, it is hoped that this research can provide new contributions that increase understanding of the material and offer new strategies to obtain practical and sustainable solutions to overcome the waste crisis through an approach that respects and utilizes local wisdom.

METHOD STUDY

This research uses a qualitative approach with a case study method to understand the impact of integrating local wisdom in biology learning on waste management at Madrasah Aliyah (M.A.) Al-Jawahir (Amanda & Fernandes, 2024; Sururuddin *et al*., 2023). This approach was chosen to gain an in-depth understanding of waste management practices and how applying local wisdom influences students' understanding of biology and the environmental conditions of madrasas (Mustakim *et al*., 2024). The research was conducted at MA Al-Jawahir, Bandung Regency, with research subjects consisting of madrasa heads, biology teachers, and students involved in local wisdom-based waste management programs. Madrasah principals and biology teachers were chosen as the primary sources of information to obtain information regarding program implementation and results. Data collection techniques include in-depth interviews, observation, and biological understanding tests (Saraswati *et al*., 2024). In-depth interviews were conducted with madrasa heads to obtain data regarding the benefits of applying local wisdom in waste management in madrasas, with questions including

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examples of waste management practices, program effectiveness, economic benefits, and program development plans. Direct observations were carried out in the madrasah environment to observe the waste management process carried out by students, helping researchers see firsthand how students collect, process, and utilize waste (Dewi, 2023). Documentation in the form of activity records from waste management activities is used to support data obtained from interviews and observations. In addition, questionnaires were given to students to measure their understanding of biological material, especially those related to waste management and local wisdom (Aprilianti & Suratsih, 2023).

This questionnaire assesses students' understanding of biological material related to waste management and local wisdom. The understanding indicators used include students' knowledge of basic ecological concepts and the role of organisms in the waste decomposition process, as well as their awareness of the environmental impact of waste on ecosystems. Additionally, the questionnaire measures students' understanding of the waste segregation process, both organic and inorganic, and waste disposal methods such as recycling and composting. Students' comprehension of local wisdom is also assessed, including how local practices and traditions contribute to waste management and their awareness of the community's historical and cultural approaches to waste reduction. These indicators also evaluate students' ability to apply biological concepts to solve real-world waste management problems and how local wisdom can be integrated with modern waste management techniques. Finally, the questionnaire assesses students' attitudes towards waste management, including their perception of the importance of waste management in preserving the local environment and their attitudes towards adopting local wisdom in daily waste management practices.

The comprehension test results are categorized into four levels of understanding: poor, sufficient, sound, and very good (Kurniawan & Oktariza, 2021). Data from interviews, observations, and questionnaires were analyzed qualitatively using the thematic analysis method (Nabila et al., 2021). The analysis steps include data transcription, coding, categorization, and interpretation. Data transcription was carried out by transcribing the results of interviews and observations into text form. Coding is carried out by identifying and coding the main themes that emerge from the data; then, these themes are grouped into categorizations to find patterns and relationships between these themes. Data interpretation is based on the research context to answer research questions and draw conclusions (Marina & Sudirman, 2024). To ensure the validity and reliability of the data, researchers used triangulation techniques by combining various data sources (interviews, observations, and student comprehension test results) (Ardyan et al., 2023). Apart from that, member checking is carried out by asking the information source to review the interview transcript to ensure the accuracy of the data obtained (Rohani et al., 2024). With this research method, a comprehensive picture of the impact of integrating local wisdom in biology learning on waste management at MA Al-Jawahir and students' understanding of biology can be obtained.

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RESULTS AND DISCUSSION

Student Understanding

The results of the research show that the level of students' understanding of environmental management material at MA Aljawahir is quite good. Below is a graph of student understanding in Figure 1.

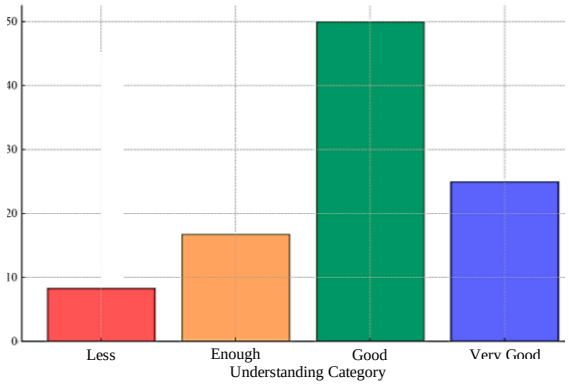

Figure 1. Graph of Student Understanding of Environmental Management Material

The graph above shows significant results in increasing awareness and involvement of 48 students in waste management. The data shows that 8.3% of students are in the "poor" category, 16.7% of students are in the "fair" category, 50% of students are in the "good" category, and 25% of students are in the "outstanding" category. This reflects that most students show good to excellent understanding and involvement in waste management activities through a learning approach based on local wisdom. The discussion of integrating local wisdom in biology learning as a strategy to overcome the waste crisis has significantly increased student understanding and engagement. With 75% of students in the sound and excellent categories, it is clear that this method is effective in increasing environmental awareness. Students who fall into the "good" and "excellent" categories understand the importance of waste management and are actively involved in practical activities such as separating waste, making compost, and recycling used items. This shows that a learning approach integrating local wisdom can motivate students to apply their knowledge in real action, reduce the waste crisis, and promote sustainable practices (Febriyanto et al., 2022).

This approach also shows that although some students are still in the "poor" and "sufficient" categories, their number is relatively small. This indicates the potential to increase their involvement through more inclusive teaching methods and intensive guidance. By providing more practical activities and projects based on local wisdom, schools can help all students achieve a higher level of involvement in waste management (Yonanda et al., 2022). Moreover, this approach solves the waste problem and strengthens students' ties to their local culture, which in turn can strengthen environmental awareness in the wider community. This research shows that integrating local wisdom in biology learning can effectively overcome the waste crisis in schools. With most students showing good to excellent engagement, this approach provides concrete evidence that waste management can be improved through education that connects students with relevant and beneficial traditional practices (Arring & Winarti, 2024). In conclusion, this research makes an essential contribution to

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sustainable curriculum development. It encourages other educational institutions to adopt a similar approach to maintain a better living environment.

Observation

Based on the observations made on 48 students at MA Aljawahir, the integration of local wisdom in biology learning has increased student involvement in waste management. Most students are active in various activities, such as separating organic and inorganic waste, making compost from organic waste, and using used items for crafts. Data shows that 83.3% of students can separate waste well, while 62.5% of students are involved in making compost from used cooking vegetables. Also, 75% of students used items for crafts, and 16.67% made wickerwork from coffee shells. Collecting used mineral water bottles for recycling was carried out by 41.67% of students, while 62.5% of students actively collected waste in recycling bins provided by the school. As many as 58.33% of students also took part in socialization regarding waste management. Integrating local wisdom in biology learning at MA Aljawahir has increased student involvement in waste management. Most students actively separate waste, compost, and use used items for crafts. This shows that a learning approach involving local wisdom improves students' theoretical understanding and motivates them to engage in sustainable waste management practices.

The approach implemented at MA Aljawahir includes introducing waste management practices adapted to local wisdom, such as using coffee shells to make matting and composting from vegetables used for cooking. These activities help students understand the cycle of organic materials and the importance of recycling and give them practical skills valuable in everyday life. Although most students show good involvement, some must fully participate in all activities. This signals a need for improvements in teaching methods and a more inclusive approach. Further interventions, such as increased coaching and mentoring, may be needed to ensure all students understand and apply waste management concepts well. Introducing more practical activities and projects based on local knowledge can help increase student participation and overall understanding. Integrating local wisdom through practical activities and community-based projects has proven effective in overcoming the waste crisis in the school environment and increasing students' awareness and skills in sustainable waste management (Wahyuni et al., 2023).

Interview

Based on the results of interviews with the head of MA Al-Jawahir, we obtained data regarding the integration of local wisdom in biology learning as a strategy to overcome the waste crisis. This interview was conducted to learn the benefits of applying local wisdom in waste management in the madrasah environment. Applying this local wisdom involves methods of composting and recycling waste, especially organic waste and used food packaging waste such as coffee, noodles, and snacks. This practice is carried out by madrasah students with the support of biology learning that links local wisdom values so that waste management becomes an integral part of the education curriculum. The head of the madrasah explained that the students actively collected organic materials from the canteen and the environment around the madrasah to make compost, which was then used for landscaping at the madrasah or sold to the local community. According to the head of the madrasah, this composting practice is very effective in overcoming the waste problem; the amount of organic waste disposed of has been drastically reduced, and the volume of waste entering landfills has also been reduced. One of the most striking changes felt was the increased cleanliness and comfort of the madrasah environment. The unpleasant odour previously often smelled around the rubbish area has disappeared, making the madrasah environment cleaner and more comfortable. The proceeds from the sale of this compost help finance other environmental activities at the madrasah and provide additional income for the madrasah and the students involved. Madrasah plans to continue developing this practice and

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integrating it into the more comprehensive curriculum and extracurricular activities, with the desire to involve more students and the community in sustainable waste management efforts. The head of the madrasah invites all parties to continue to support and actively participate in maintaining a clean and healthy living environment, hoping that waste management practices that utilize local wisdom can become an excellent example for madrasas and other educational institutions. The interview results show that applying local wisdom in waste management at MA Al-Jawahir brings significant benefits in terms of environment, cleanliness, comfort, and economy, proving that integrating local wisdom values in education can provide effective and sustainable solutions to environmental problems.

The interviews with the head of MA Al-Jawahir revealed that integrating local wisdom in biology learning has had a significant positive impact in overcoming the waste crisis in the madrasa environment. This step is by Bandung Regency regional regulations, which support environmental preservation through the active participation of educational institutions.

Several important things that can be explored from the results of this interview include those related to the Integration of Local Wisdom in Biology Learning. At MA Al-Jawahir, biology learning focuses on theory and practical applications that link local wisdom values to waste management. Students are taught to compost and recycle organic and non-organic waste, such as used food wrappers. The local wisdom values of Bandung Regency, such as cooperation and the principle of "ngamumule" (caring), are applied in this activity. Students work together to collect organic materials and process them into compost, which is reused for landscaping the madrasah or sold to the local community.

Furthermore, integrating local wisdom positively impacts the effectiveness of waste management. The composting and recycling practices carried out by MA Al-Jawahir students have proven effective in reducing the amount of waste produced. The head of the madrasah reported that since this program was implemented, there has been a significant reduction in the amount of organic waste thrown away, and the volume of waste going to landfills has also decreased drastically. This aligns with the Bandung Regency Regional Regulations, which emphasize reducing waste volume by sorting and processing at the source. The use of compost also supports local agriculture, a practice that the people of Bandung Regency have long carried out.

Theng and recycling waste can reduce the accumulating waste volume, thereby increasing clea, loneliness, and comfort in the MA Aljawahir environment. One of the direct benefits of applying local wisdom in waste management is improving the cleanliness and comfort of the madrasah environment. The unpleasant odour previously often smelled around the rubbish area has disappeared, making the school environment cleaner and more comfortable. The tradition of environmental cleanliness and beauty, known in Sundanese culture as "sampurasun" (a greeting that emphasizes cleanliness and politeness), is reflected in these results. Bandung Regency's vision is to create a clean and healthy environment through effective waste management programs.

Apart from the benefits felt in the MA Aljawahir environment, other benefits can also be felt, including economic benefits. The sale of compost produced from waste management provides additional income for the madrasas and students involved. These funds are used to finance other environmental activities at the madrasah, creating a cycle of sustainability that supports environmental conservation while providing economic benefits. This approach supports Bandung Regency policies that encourage a circular economy and sustainable resource management. The

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"sabilulungan" principle, which means cooperation and mutual assistance, is a strong foundation for this sustainable economic activity.

Furthermore, MA Al-Jawahir plans to continue developing and integrating this practice into the more comprehensive curriculum and extracurricular activities. They also want to involve more students and the community in sustainable waste management efforts. Community participation in waste management is one of the critical points in the Bandung Regency Regional Regulations, which encourage collaboration between the government, community, and educational institutions. Local wisdom such as "garum overtime" (maintaining the village) and "babarengan" (together) is very relevant in this context.

This perceived positive impact cannot be separated from the role of integrating local wisdom in biology learning and is also reflected in the results of students' understanding of biology. From the data, 8.3% of students obtained poor results, 16.70% sufficient, 50% good, and 25% excellent. This shows that most students (75%) have a good to excellent understanding of biological material linked to local wisdom-based waste management practices. This integration helps students to understand biological concepts better contextually and practically, strengthening their understanding through direct application in everyday life.

Ultimately, we can draw a common thread that integrating local wisdom in biology learning at MA Al-Jawahir brings significant environmental, cleanliness, comfort, and economic benefits. This approach is in line with Bandung Regency regional regulations, which emphasize the importance of environmental education and the active participation of educational institutions in waste management. With support and active participation from all parties, this practice can continue to develop and have a broader positive impact, proving that integrating local wisdom values in education is an effective and sustainable solution to environmental problems. The traditions and local wisdom values typical of Bandung Regency, such as cooperation, ngamumule, sabilulungan, and sampurasun, support this program's success.

Discussion

This research combines all data from various sources using triangulation techniques, namely interviews with madrasa heads, direct observation of student activities, and the results of tests on understanding environmental pollution prevention material. The main focus of the research is to integrate local wisdom from Bandung Regency in biology learning at MA Aliyah Al-Jawahir to overcome the waste crisis in the madrasa environment. Understanding local wisdom in this research includes knowledge and application of traditional values developed in local communities relevant to environmental conservation. The local wisdom in question includes principles such as gotong royong (community cooperation), ngamumule (maintenance), sabilulungan (togetherness), and sampurasun (respectful greetings and cleanliness). These principles teach about living in harmony with nature and provide practical guidance in managing waste sustainably. This research measured students' understanding of local wisdom through observation and questionnaires. The results show that students have a good to excellent understanding, reflected in their waste management practices at the madrasah. For example, students who understand the principle of cooperation are more likely to be involved in collective waste management activities, such as separating organic and non-organic waste and making compost from organic waste.

Integrating local content in biology learning at MA Al-Jawahir is carried out by incorporating local wisdom values into the curriculum and extracurricular activities. Some concrete steps in this

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integration include theoretical teaching, practical activities, collaborative projects, and continuous evaluation. In theoretical teaching, biological concepts relevant to waste management are connected to local wisdom practices. For example, when discussing ecosystems and material recycling, teachers teach how local communities use composting techniques to manage organic waste. In practical activities, students are directly involved in waste management based on local wisdom, such as making compost from organic waste and reusing materials that can be recycled. Collaborative projects involve students combining biological sciences with local wisdom practices, such as creating a school garden with compost produced from organic waste that they process themselves. Student understanding is evaluated continuously through tests, observations, and questionnaires, the results of which are used to improve and develop local wisdom integration programs in biology learning.

From the test results, as many as 75% of students showed a good to excellent understanding of waste management concepts taught through a local wisdom approach. This reflects the approach's success in enhancing students' theoretical understanding of sustainable waste management practices. According to interviews with madrasa heads, integrating local wisdom through composting and waste recycling methods has had a positive impact. This practice reduces the volume of organic waste thrown away and produces compost used for madrasa landscaping or sold to support school environmental activities. In addition, effective waste management has improved the cleanliness and comfort of the madrasah environment, which was often disturbed by unpleasant odours. Observations of student activities show a high level of participation in waste management practices. Most students are active in separating organic and inorganic waste, making compost, and collecting waste for recycling. This shows that a learning approach involving local wisdom increases students' theoretical understanding and motivates them to participate actively in actual practice.

The local wisdom of Bandung Regency, such as using natural materials for composting and recycling and keeping the environment clean, has been well integrated into the learning curriculum at MA Aliyah Al-Jawahir. These practices are not only locally relevant but also support environmental sustainability at the local level. Concrete examples are using coffee shells to make wickerwork or cooking vegetables for compost, reflecting local wisdom in using natural resources wisely (Wahyurini et al., 2019). Integrating local wisdom from Bandung Regency in biology learning at MA Aliyah Al-Jawahir has effectively overcome the madrasa environment's waste crisis. By using a triangulation method of data from various sources, this research provides a comprehensive picture of the success of this approach in increasing students' understanding and involvement in sustainable waste management practices. Integrating local wisdom in biology learning at MA Al-Jawahir has proven to have a significant positive impact. Students understand biology material better and develop practical skills and a positive attitude towards the environment. Most students demonstrate good to excellent understanding and involvement in waste management, which in turn helps create a cleaner and healthier school environment. This research shows that integrating local wisdom in education improves the quality of learning and provides a sustainable solution to overcoming the waste crisis. This approach can be replicated and further developed in various educational institutions to encourage environmental conservation through education based on proven local values. The results of this research can inspire other educational institutions to adopt a similar approach to preserve the environment locally and sustainably.

CONCLUSION

This research reveals that integrating local wisdom in biology learning at MA Al-Jawahir significantly impacts overcoming the waste crisis. By linking local wisdom values such as

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cooperation, ngamumule, sabilulungan, and sampurasun in waste management practices, students learn biological theory and apply it practically. The composting and recycling methods have proven effective in reducing organic waste and increasing the cleanliness and comfort of the madrasah environment. Data shows that most students (75%) have a good understanding of biology, with learning results showing that 8.3% of students obtained poor results, 16.70% fair, 50% good, and 25% perfect. This shows that this approach successfully increases students' understanding of biological concepts through direct application in everyday life. The economic benefits of selling compost also help finance other environmental activities at the madrasah and provide additional income for the students involved. Plans to develop and expand this practice, as well as involve more students and the community, demonstrate the madrasa's commitment to supporting sustainable environmental conservation. Overall, this research proves that integrating local wisdom in education can provide effective and sustainable solutions to environmental problems through Bandung Regency regional regulations, which support environmental preservation through the active participation of educational institutions.

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