

Compost-Based Integrated Learning in IPAS for Environmental Sustainability and Responsible Behavior in Schools

Pembelajaran Terpadu Berbasis Kompos dalam IPAS untuk Keberlanjutan Lingkungan dan Perilaku Bertanggung Jawab di Sekolah

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ABSTRAK

Penelitian ini mengkaji implementasi pembelajaran terintegrasi berbasis kompos dalam IPAS sebagai pendekatan pembelajaran untuk mendorong keberlanjutan lingkungan dan perilaku bertanggung jawab di lingkungan sekolah. Penelitian ini bertujuan untuk menganalisis bagaimana integrasi aktivitas pengomposan ke dalam pembelajaran kelas mendukung pemahaman kognitif siswa, sikap terhadap lingkungan, serta perilaku berorientasi keberlanjutan. Penelitian ini menggunakan desain deskriptif kualitatif yang dilaksanakan di sebuah sekolah dasar yang menerapkan pembelajaran IPAS dengan tema lingkungan. Data dikumpulkan melalui observasi kelas, lembar kerja dan artefak belajar siswa, jurnal reflektif, serta catatan lapangan guru. Data dianalisis secara tematik menggunakan model analisis kualitatif interaktif untuk mengidentifikasi pola yang berkaitan dengan proses pembelajaran dan capaian pendidikan. Hasil penelitian menunjukkan bahwa pembelajaran terintegrasi berbasis kompos meningkatkan pemahaman siswa terhadap konsep ekologi, khususnya proses dekomposisi dan siklus hara. Siswa menunjukkan peningkatan keterlibatan, kolaborasi, dan tanggung jawab dalam pengelolaan sampah organik serta pemeliharaan kebersihan sekolah. Selain itu, aktivitas pembelajaran mampu menumbuhkan sikap peduli lingkungan dan mendorong siswa memandang sampah sebagai sumber daya yang dapat dimanfaatkan kembali. Penelitian ini menyimpulkan bahwa pembelajaran IPAS berbasis kompos secara efektif mendukung proses pembelajaran eksperiensial dan konstruktivistik serta selaras dengan prinsip Education for Sustainable Development (ESD). Dengan mengintegrasikan praktik keberlanjutan ke dalam pembelajaran formal, pendekatan ini menawarkan strategi pedagogis yang praktis dan dapat diterapkan secara luas untuk menumbuhkan keberlanjutan lingkungan dan perilaku bertanggung jawab di sekolah..

ABSTRACT

This study explores the implementation of compost-based integrated learning in IPAS as an instructional approach to promoting environmental sustainability and responsible behavior in school settings. The study aims to examine how the integration of composting activities into classroom instruction supports students' cognitive understanding, environmental attitudes, and sustainability-oriented behaviors. A qualitative descriptive design was employed in an elementary school implementing IPAS learning with environmental themes. Data were collected through classroom observations, student worksheets and learning artifacts, reflective journals, and teacher field notes. The data were analyzed thematically using an interactive qualitative analysis model to identify patterns related to learning processes and

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educational outcomes. The findings indicate that compost-based integrated learning enhances students' understanding of ecological concepts, particularly decomposition and nutrient cycles. Students demonstrated increased engagement, collaboration, and responsibility in managing organic waste and maintaining school cleanliness. In addition, the learning activities fostered positive environmental attitudes and encouraged students to perceive waste as a reusable resource rather than an environmental burden. The study concludes that compost-based IPAS learning effectively supports experiential and constructivist learning processes while aligning with the principles of Education for Sustainable Development (ESD). By embedding sustainability practices within formal classroom instruction, compost-based integrated learning offers a practical and transferable pedagogical strategy for fostering environmental sustainability and responsible behavior in schools.

1. INTRODUCTION

Environmental sustainability has become a central concern in contemporary education as schools are increasingly expected to function not only as learning spaces but also as environments that model responsible ecological behavior (Altassan, 2023; Okada, & Gray, 2023). Educational institutions generate various forms of waste, particularly organic waste derived from food consumption and plant maintenance (Haksevenler, et al., 2022; Leal Filho, et al., 2021). When poorly managed, such waste contributes to environmental degradation; however, when utilized effectively, it can become a valuable learning resource that supports sustainability-oriented education.

Organic waste management through composting offers a practical and environmentally sound solution (Manea, et al., 2024; Al-Nawaiseh, et al., 2021). Composting involves the biological decomposition of organic materials into nutrient-rich fertilizer that can be reused for plant cultivation (Bhunia, et al., 2021; Sharma, et al., 2024). Within integrated science and social learning contexts, composting allows students to engage directly with ecological processes such as decomposition, nutrient cycles, and soil fertility, while also fostering social values including responsibility, cooperation, and environmental care (Marchal-Gaillard, 2024; Janney, et al., 2025). This experiential engagement strengthens the relevance of scientific concepts by situating them within real-life contexts.

Project-based and experiential learning approaches have been widely acknowledged for their ability to enhance students' conceptual understanding, problem-solving skills, and environmental awareness (Sundman, et al., 2025; Chang, et al., 2022). Learning activities that are contextual, hands-on, and student-centered encourage learners to take ownership of their learning and apply knowledge beyond the classroom (Bhardwaj, et al., 2025). Compost-based learning aligns with these pedagogical principles by promoting active participation, inquiry, and reflection, which are essential for developing sustainable behaviors.

Despite growing interest in environmental education, existing research on school-based composting largely focuses on environmental outcomes, such as waste reduction or school greening initiatives (Dos Santos, et al., 2022). Limited attention has been given to composting as an integrated instructional strategy embedded within formal classroom learning (McDonagh, et al., 2025). Moreover, few studies examine how composting activities can simultaneously address cognitive learning outcomes, character development, and student agency within an interdisciplinary curriculum framework.

To address this gap, the present study proposes Compost-Based Integrated Learning as an innovative instructional approach in IPAS education. The novelty of this study lies in conceptualizing composting not merely as an environmental practice or extracurricular activity, but as a structured pedagogical tool that integrates scientific inquiry, social responsibility, and learner autonomy through project-based learning. This approach positions students as active participants in solving real environmental problems within their school environment.

By embedding composting activities into classroom instruction, this study aims to contribute to the development of environmentally responsible behaviors, meaningful learning experiences, and sustainable school ecosystems. The findings are expected to provide empirical insights into the pedagogical value of compost-based learning and its potential to support interdisciplinary education that is adaptive, contextual, and sustainability-oriented.

2. METHOD

This study employed a qualitative descriptive design to explore the implementation and educational outcomes of compost-based integrated learning in IPAS. A qualitative approach was selected to capture students' learning experiences, behavioral changes, and environmental awareness within a natural

school context. The study did not aim to measure causal effects, but to examine learning processes and sustainability-oriented practices embedded in classroom instruction.

The research was conducted in an elementary school implementing IPAS learning with environmental themes. Participants included students and teachers involved in compost-based learning activities, selected through purposive sampling based on their active engagement in the program. Teachers functioned as facilitators, while students participated in integrated learning projects related to organic waste management and compost utilization.

The learning intervention adopted a project-based and experiential approach, integrating composting activities into IPAS instruction. Students engaged in collecting organic waste, sorting materials, managing compost containers, observing decomposition processes, and applying compost to school plants. These activities connected scientific concepts with social values such as responsibility, collaboration, and environmental care.

Data were collected through classroom observations, student worksheets and learning artifacts, reflective journals, and teacher field notes. Data analysis followed an interactive qualitative model, including data reduction, thematic coding, data display, and conclusion drawing. To enhance trustworthiness, data triangulation and peer discussion were applied, while ethical considerations included informed consent and participant anonymity.

3. RESULT AND DISCUSSION

Cognitive Outcomes of Compost-Based Integrated Learning

The implementation of compost-based integrated learning in IPAS showed a positive influence on students' cognitive understanding of ecological concepts. Classroom observations and analysis of student worksheets revealed that students were able to identify and explain basic scientific principles related to organic waste decomposition, nutrient cycles, and environmental balance. Learning activities that involved direct observation and practice enabled students to grasp abstract concepts more concretely.

Students demonstrated improved ability to connect theoretical knowledge with real situations in the school environment. For example, students were able to relate the decomposition process observed in compost containers to soil fertility and plant growth. This contextual learning experience helped students understand the relevance of scientific concepts beyond textbook explanations.

Observations during the learning process showed active interaction between facilitators and students in the implementation of compost-based integrated learning. Students demonstrated high levels of attention and engagement while participating in classroom discussions related to environmental themes and waste management concepts.



Figure 1. Classroom interaction during compost-based integrated IPAS learning activities

As illustrated in Figure 1, the learning process was characterized by direct interaction, dialogical communication, and student-centered facilitation. Students were not positioned as passive recipients of information but actively engaged in observing, listening, and responding to explanations related to environmental practices. This interaction reflects the application of experiential and constructivist learning principles, where knowledge is constructed through social interaction and contextual experience.

The presence of facilitators guiding the learning process further strengthened student participation and learning focus. Such learning dynamics indicate that compost-based integrated learning effectively fosters student engagement, environmental awareness, and meaningful learning experiences within the IPAS classroom.

Furthermore, student learning artifacts indicated that learners increasingly used scientific terminology appropriately and accurately. Reflective responses showed that students could describe cause-

and-effect relationships within ecological systems, suggesting a deeper level of conceptual understanding. This indicates that compost-based activities supported meaningful learning rather than surface-level memorization.

Overall, the findings suggest that experiential composting activities enhanced students' cognitive engagement and promoted a more comprehensive understanding of integrated science concepts within IPAS learning.

To clarify the cognitive outcomes observed during the implementation, a summary of key findings is presented in Table 1.

Table 1. Cognitive Outcomes of Compost-Based Integrated Learning

Cognitive Aspect	Observed Indicators	Learning Outcome
Concept understanding	Ability to explain decomposition and nutrient cycles	Improved conceptual clarity
Knowledge application	Linking composting to plant growth	Contextual learning achieved
Scientific reasoning	Use of cause-effect explanations	Higher-order thinking skills
Concept integration	Connecting science concepts with environmental issues	Integrated understanding

As shown in Table 1, compost-based integrated learning supported students' cognitive development by strengthening conceptual understanding, application skills, and scientific reasoning within real environmental contexts.

Behavioral Changes and Student Engagement

The implementation of compost-based learning also resulted in observable behavioral changes among students. Classroom observations indicated increased student participation and enthusiasm during learning activities. Students actively engaged in collecting organic waste, sorting materials, and maintaining compost containers, demonstrating a strong sense of involvement in the learning process.

In addition to increased participation, students showed improved responsibility toward waste management. Students became more consistent in separating organic and non-organic waste and demonstrated greater care in maintaining cleanliness around composting areas. These behaviors suggest that learning activities influenced students' daily habits and attitudes toward environmental responsibility.

Collaborative behaviors also emerged during the learning process. Students frequently worked in groups, shared tasks, and assisted peers during composting activities. Such interactions promoted teamwork, communication, and shared problem-solving, which are essential components of integrated and student-centered learning.

Overall, compost-based learning encouraged positive behavioral changes by fostering active engagement, responsibility, and collaboration among students within the IPAS learning environment.

A summary of behavioral changes observed during the implementation is presented in Table 2.

Table 2. Behavioral Changes and Student Engagement

Behavioral Aspect	Observed Behavior	Impact on Learning
Student participation	Active involvement in composting tasks	Increased engagement
Responsibility	Proper waste sorting and compost maintenance	Improved discipline
Collaboration	Teamwork and peer support	Enhanced social skills
Learning ownership	Initiative in completing tasks	Student agency strengthened

Table 2 highlights that compost-based learning positively influenced students' behaviors by encouraging responsibility, collaboration, and active participation in learning activities.

Environmental Impact and Sustainability Awareness

From an environmental perspective, compost-based integrated learning contributed to improved school cleanliness and sustainability practices. Organic waste generated within the school was effectively processed into compost, reducing waste accumulation and improving waste management practices within the school environment.

Teachers reported visible improvements in the cleanliness and aesthetic quality of school grounds. Compost produced through learning activities was used to support school gardening programs, resulting in greener learning spaces and healthier plants. These outcomes indicate that learning activities had a direct and tangible impact on the school environment.

In addition, students' reflective journals revealed increased environmental awareness and positive attitudes toward sustainability. Students expressed a growing understanding of the importance of waste management and environmental care, as well as a sense of responsibility toward maintaining a clean and healthy school environment.

Overall, compost-based learning not only supported academic learning but also contributed to environmental improvement and sustainability awareness among students, reinforcing the role of schools as agents of sustainable development.

A summary of environmental impacts and sustainability awareness is presented in Table 3.

Table 3. Environmental Impact and Sustainability Awareness

Environmental Aspect	Observed Outcome	Sustainability Contribution
Waste management	Reduction of organic waste	Cleaner school environment
School greening	Use of compost for plants	Improved school ecology
Student awareness	Positive attitudes toward sustainability	Environmental responsibility
Resource utilization	Waste viewed as reusable resource	Sustainable mindset developed

As shown in Table 3, compost-based integrated learning effectively supported environmental sustainability by improving waste management practices, enhancing school ecology, and fostering students' sustainability awareness.

Compost-Based Learning and Education for Sustainable Development (ESD)

The findings of this study demonstrate that compost-based integrated learning in IPAS effectively enhances students' environmental awareness, responsibility, and engagement in sustainable practices. The increased student participation in waste management and composting activities reflects the effectiveness of learning approaches that integrate knowledge with real environmental action (Gan, 2023; Yusuf, & Fajri, 2022). This result supports the core principles of Education for Sustainable Development (ESD), which emphasize learning that fosters sustainability values through practice and social responsibility.

Consistent with previous studies, this research confirms that sustainability education is more effective when students are actively involved in addressing real environmental problems rather than passively receiving theoretical information (Almulla, & Al-Rahmi, 2023; Al-Barakat, et al., 2025). The observed improvements in students' attitudes toward waste management and school cleanliness indicate that compost-based learning successfully translated sustainability concepts into everyday behavior.

Unlike many earlier studies that positioned composting as an extracurricular or environmental campaign, this study demonstrates that composting can be systematically embedded within formal classroom instruction. This integration strengthens the role of schools as agents of sustainable development and supports the implementation of sustainability-oriented learning within interdisciplinary curricula.

Overall, the findings suggest that compost-based IPAS learning aligns strongly with ESD goals by integrating environmental knowledge, social responsibility, and practical action in a structured instructional framework.

Experiential Learning and Cognitive Development in IPAS

The cognitive improvements observed in this study support the principles of Experiential Learning Theory, which emphasizes learning through direct experience, reflection, and application (Siregar, et al., 2025; Ramadhani, & Andriani, 2024). Students' improved understanding of decomposition, nutrient cycles, and environmental balance indicates that hands-on composting activities facilitated deeper conceptual learning.

The results are consistent with previous research showing that project-based and experiential environmental learning enhances students' ability to connect scientific concepts with real-life contexts (Zhang, & Ma, 2023; Zhang, et al., 2024). Through observing composting processes and applying compost to plants, students engaged in a learning cycle that involved experience, observation, and reflection, thereby strengthening knowledge retention and comprehension.

This study further demonstrates that experiential learning in IPAS can be effectively implemented using locally available resources and authentic environmental issues. The learning process became more meaningful as students interacted directly with their environment, reinforcing the relevance of scientific knowledge to everyday life.

Thus, compost-based learning functions as an effective experiential learning strategy that supports cognitive development while promoting sustainability-oriented understanding.

Constructivist Learning, Student Agency, and Behavioral Outcomes

The findings also align with Constructivist Learning Theory, which emphasizes that knowledge is actively constructed through interaction, collaboration, and reflection (Almulla, 2023; Zawawi, et al., 2024). Students' ability to explain ecological processes using their own understanding suggests that learning occurred through active meaning-making rather than passive reception of information.

The collaborative nature of composting activities encouraged peer interaction, shared problem-solving, and collective responsibility (Zawawi, 2023; Banihashem, et al., 2022). These interactions contributed to the development of student agency, as learners took ownership of both the learning process and environmental outcomes within their school context.

Compared to previous studies that primarily emphasized environmental outcomes such as waste reduction, this study highlights broader educational impacts, including behavioral change and character development. The observed increases in responsibility, cooperation, and environmental care suggest that compost-based learning supports both academic and socio-emotional development.

Overall, this study positions compost-based IPAS learning as a structured constructivist approach that integrates cognitive learning, behavioral change, and sustainability values, offering a practical and transferable model for interdisciplinary and student-centered education.

4. CONCLUSION

This study concludes that compost-based integrated learning in IPAS is an effective approach to promoting environmental sustainability in school settings. The integration of composting activities into classroom instruction enhanced students' understanding of ecological concepts, fostered positive environmental attitudes, and encouraged responsible behaviors related to waste management and school cleanliness.

The findings indicate that compost-based learning supports experiential and constructivist learning processes. Through direct engagement, reflection, and collaboration, students actively constructed knowledge and connected scientific concepts with real environmental contexts, resulting in deeper conceptual understanding and increased learning relevance.

In addition, this study demonstrates the relevance of compost-based IPAS learning to the principles of Education for Sustainable Development (ESD). By embedding sustainability practices within formal instruction, this approach promoted learner agency, social responsibility, and interdisciplinary learning outcomes aligned with sustainability-oriented education.

Despite its positive findings, this study is limited to a specific school context and learning duration. Future research is recommended to examine long-term impacts across diverse educational settings and to employ quantitative or mixed-method approaches for broader generalization. Overall, compost-based integrated learning offers a practical and transferable instructional model for fostering environmentally responsible and sustainability-oriented education in schools.

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