Digital Perspectives Journal on Education
Volume 1, Issue 1, pp. 15-28.
e_ISSN: .....
https://journal.dyoqu.com/index.php/dpj
DOI.

How is Integrated Sustainability in Mathematics through the Adiwiyata Program?

Siti Muthmainah[1]*, Muhammad Syarifuddin[2], Rintan Mustika[3], Zulfa Khairunnisa[4]
[1] Nahdlatul Ulama University, Indonesia
[2]University of Lampung, Indonesia
[3,4]Raden Intan Lampung State Islamic University, Indonesia

*** Corresponding author:**
Siti Muthmainah, Nahdlatul Ulama University, Indonesia. mutmainahsity.sm@gmail.com

Article Info

Article history:

Received: April 04, 2025
Revised: May 10, 2025
Accepted: June 15, 2025

Keywords:

the supernatural program;
Contextual learning;
Environmental education;
Mathematical integration;
Continuing education;

Abstract

background: The Adiwiyata School Program and the Independent Curriculum promote sustainability in Indonesian schools, but its integration into mathematics education is still rarely examined. This study uniquely addresses this gap by investigating how sustainability themes enrich contextual mathematics learning at the elementary level.
Aims: It aims to evaluate how sustainability principles are integrated into mathematics learning in SD Negeri 1 Merbau Mataram and examine its impact on students' environmental attitudes and numeracy engagement.
Methods: A descriptive qualitative approach with a CIPP (Context, Input, Process, Product) evaluation model was used. Data was collected through classroom observations, interviews, and document analysis involving school leaders, teachers, and students.
Results: Findings show that 85% of lesson plans include local environmental content, and 85% of students demonstrate strong environmental awareness through math-related projects. Students apply measurement, data analysis, and fractions in real-world contexts such as hydroponics, composting, and recycling, which strengthen contextual understanding and problem-solving skills.
Conclusion: This study highlights how sustainability themes enrich mathematics education in Indonesian schools, supported by school policies, infrastructure, and community engagement. These findings offer insights into developing interdisciplinary teaching strategies and teacher training programs that integrate sustainability into mathematics learning. This contribution provides a practical model for other schools to simultaneously strengthen sustainability and numeracy.

To cite this article: Muthmainah, S., Syarifuddin, M., Mustika, R., Khairunnisa, Z. (2025). How is Integrated Sustainability in Mathematics through the Adiwiyata Program?. Digital Perspectives Journal on Education, 1(1), 15-28.
This article is licensed under a Creative Commons Attribution-ShareAlike 4.0 International License ©202x by the author

Introduction

The Adiwiyata School Program is an initiative of the Indonesian government that aims to promote environmental education and sustainable practices in schools (Sari & Nurizka, 2021; Rahman et al. 2023; Aeni et al., 2020). The main goal is to create conducive conditions for schools to become places of learning and awareness for the school community about the importance of environmental conservation. The implementation of this program is supported by Government Regulation No. 32 of 2013 and is included in the competency standards for primary and secondary education graduates in Indonesia (Paparang O. E. 2017; Kamil et al., 2020), making it a strong policy framework for the implementation of continuing education.

In practice, various studies have shown the positive impact of the Adiwiyata program on students' attitudes and behaviors towards environmental concern (Istiqomah et al., 2022; Larashati et al., 2022; Putri et al., 2025). (Sari et al., 2023) noted that students in Adiwiyata schools had an environmental attitude score of 3.92 (78.55%) and a behavioral score of 4.28 (85.65%), higher than non-Adiwiyata students This success was attributed to school policies, environmental

curriculum integration, community involvement, and effective facility management (Jannah et al., 2022). In line with this, the Independent Curriculum which emphasizes flexibility, project-based learning, and contextualization of materials also provides a great opportunity to integrate sustainability values into the subjects. This makes the Independent Curriculum a synergistic approach with the Adiwiyata Program in forming an environmentally conscious school culture. The learning process is not only theoretical but also encourages students to actively engage in environmental conservation practices adapted to the local context (Rahmadiani et al., 2019; Ismail et al., 2024).

However, although the effectiveness of integrating environmental education in the Adiwiyata program has been widely studied, research specifically evaluating the integration of continuing education principles in mathematics learning is still very limited. For example (Lestari et al., 2024; Prayogo et al. ,2024).

found that only 27% of mathematics teachers in Indonesia have ever included a sustainability context due to limited training and resources. In fact, mathematics has a strong potential to build students' understanding of sustainability through data analysis, measurement, and real-world problem-solving. (Lafuente-Lechuga et al., 2024) state that under 35% of the syllabus of European universities link mathematics to sustainability. However, some studies address these barriers to integration that include social, environmental, and economic dimensions. (Tesfamicael & Enge, 2024) note that although the Norwegian LK20 curriculum promotes sustainability, its use in math textbooks is still minimal and inconsistent. Teachers' limited cross-disciplinary skills, lack of resources, and low student engagement hinder effective sustainability-oriented mathematics learning both locally and globally. (Ika Sari et al., 2024; Negi, 2024).

Given the importance of integrating continuing education into all subject areas, including mathematics, and the current lack of research in this particular area, it became necessary to explore how sustainability principles are applied in mathematics learning. Therefore, this study seeks to answer the research question: How are the principles of sustainability integrated in mathematics learning in Adiwiyata schools? Based on this background, this study aims to evaluate the level of integration of sustainability principles in mathematics education in Adiwiyata schools that implement the Independent Curriculum. The main focus is to analyze the impact of the Adiwiyata program on student attitudes and behaviors in the context of continuing education, as well as identify supporting factors and challenges in its implementation. It is hoped that this research will make a practical contribution to the development of mathematics learning strategies that support the goals of continuous education and become a reference for the development of environmental education policies in Indonesia.

Method

Research Design

This study uses a descriptive qualitative approach with an evaluative study design based on the CIPP (Context, Input, Process, Product) model. This model was chosen because it provides a comprehensive evaluation framework for program implementation through four main components, namely context, inputs, processes, and products. This design refers to an evaluative approach developed by (Sappaile, 2025), which emphasizes the importance of analyzing environmental education practices. This research also refers to the guidelines of Qualitative Research Reporting Standards (SRQR) which are relevant to qualitative studies.

Data Analysis

The data were analyzed using the interactive model of Miles and Huberman (2014), which involved three concurrent activities: data reduction, data display, and conclusion-delineation/verification. This framework was chosen because it effectively accommodates the iterative nature of qualitative case study data and helps to systematically organize rich contextual

information. After open coding and thematic categorization, the findings were mapped to the four dimensions of the CIPP (Context, Input, Process, Product) evaluation model. This ensures that the analysis covers all relevant aspects of the school's sustainability-focused mathematics learning practices within the Adiwiyata Program.

To strengthen the validity and reliability of qualitative data, several strategies are implemented. Data triangulation is done by gathering information from a variety of sources, including classroom observations, in-depth interviews with teachers and principals, and analysis of relevant documents such as lesson plans and school policy statements. Member checks are conducted by sharing initial findings with key participants to confirm the accuracy of the interpretation and to get their feedback on any incorrect statements.

Additionally, audit trails are maintained by keeping detailed records of data collection procedures, coding decisions, and analytical memos, allowing for transparency and traceability throughout the research process. Peer briefings with fellow researchers further contribute to reducing potential researcher bias and increasing confidence in results. This joint strategy ensures that the findings credibly reflect the actual implementation and challenges of integrating sustainability values in mathematics learning through the Adiwiyata Program.

Participants

The subjects in this study were deliberately chosen to ensure the depth and relevance of the data obtained. The selection was carried out by considering the active involvement of participants in school activities related to the Adiwiyata program. The main participants included the principal, one teacher, and several students who were directly involved in the implementation of the Adiwiyata program at SD Negeri 1 Merbau Mataram. This selection is based on the consideration that they have direct experience in the implementation of continuing education, especially in the context of the Independent Curriculum.

Population and Sampling Methods (sample questions, assessment methods, and psychometric traits)

The population in this study includes all members of the SD Negeri 1 Merbau Mataram school community. However, due to the qualitative nature of this study, sampling was done deliberately, taking into account the informative contribution of each participant. The involvement of various elements of the school is expected to enrich the data and provide a comprehensive picture. This allows for a deeper understanding of the social and cultural dynamics of schools that influence program implementation. The focus is not on statistical representations but on the depth of understanding the context and practices that occur in the field.

Instrumentation

The instruments used in the study consisted of three main types: observation guidelines, semi-structured interview guidelines, and documentation studies, all of which were reviewed by experts and tested to ensure their validity prior to data collection. Observations are focused on learning activities, community engagement, and conditions that demonstrate sustainability principles. The interview gathers participants' views and experiences related to sustainability in learning. Documentation studies include analyzing lesson plans, school vision and mission, and records of environmental activities. The three instruments are designed to complement each other and strengthen the validity of the data through triangulation.

Procedures and if relevant, time frames

This research was conducted in the odd semester of the 2024/2025 school year starting with coordination and permission from the school, followed by observation of classroom activities and the school environment for two months; In-depth interviews, each lasting 30-45 minutes and being audio-recorded with the consent of the participants, were conducted in conjunction with the

collection of relevant documents to support the findings, and throughout the process all activities were carried out systematically and ethically to ensure transparency, consent, and confidentiality for all data collected.

Analysis Plan

The data were analyzed using the Miles and Huberman model, which consisted of three main stages: data reduction, data presentation, and conclusion drawn. After a general analysis, the data are classified into four components of the CIPP evaluation. Context analysis includes an evaluation of the school's vision, mission, and policies. Feedback assesses the readiness of resources such as teachers, students, and facilities. This process examines the implementation of learning and the integration of sustainability values in mathematics. This product evaluates the end result in terms of changes in students' attitudes, behaviors, and school culture.

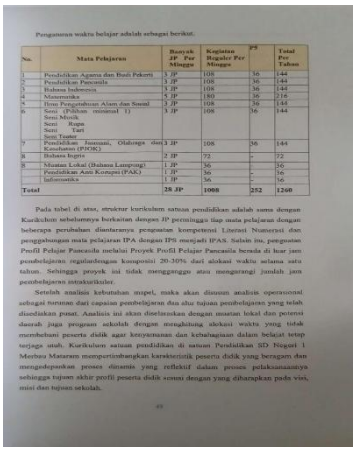
Scope and/or Limitations of the Methodology Used

The scope of this study was limited to one elementary school, so the findings could not be generalized to a broader context. In addition, because this approach is qualitative, potential bias in data interpretation is highly likely, especially since participants have diverse backgrounds and researchers actively participate in the data collection process. However, the case study approach used provides a rich and relevant contextual understanding. The results can be an initial reference for the development of an environmental education strategy based on the Independent Curriculum at the elementary school level.

Results and Discussion

Results

The results of the study show that SD Negeri 1 Merbau Mataram has successfully implemented the Adiwiyata Program as an integral part of contextual learning that instills sustainability values in all subjects, including mathematics. This integration is in line with the Independent Curriculum and is reflected in the school's vision and mission, which emphasizes the development of intellectually capable, environmentally conscious, and socially responsible students. Analysis of the documents shows that 85% of lesson plans (lesson plans) cover local environmental topics that are relevant to the context and daily needs of students. Observations show that about 90% of teachers integrate sustainability issues in lessons, while 80% of students actively participate in environmental activities. These institutional values are further translated into classroom practices that incorporate environmental sustainability into daily learning objectives (Nuzulia & Purnomo, 2019; Setiawan et al., 2024).



Pengaturan waktu belajar adalah sebagai berikut:

No.	Mata Pelajaran	Banyak JP Per Minggu	Kegiatan Regular Per Minggu	P5	Total Per Tahun
1	Pendidikan Agama dan Budi Pekerti	3 JP	108	36	144
2	Pendidikan Pancasila	3 JP	108	36	144
3	Bahasa Indonesia	5 JP	108	36	144
4	Matematika	5 JP	180	36	216
5	Ilmu Pengetahuan Alam dan Sosial	3 JP	108	36	144
6	Seni (Pilihan sesanal 1) Seni Musik Seni Rupa Seni Tari Seni Teater	3 JP	108	36	144
7	Pendidikan Jasmani, Olahraga dan Kesehatan (PJOK)	3 JP	108	36	144
8	Bahasa Inglis	2 JP	72	-	72
9	Muatan Lokal (Bahasa Lampung)	1 JP	36	-	36
	Pendidikan Anti Korupsi (PAK)	1 JP	36	-	36
	Informatika	1 JP	36	-	36
Total		28 JP	1008	252	1260

Pada tabel di atas, struktur kurikulum satuan pendidikan adalah sama dengan Kurikulum sebelumnya berkaitan dengan JP peminggu tiap mata pelajaran dengan beberapa perubahan diantaranya pengasatan kompetensi Literasi Numerasi dan penggabungan mata pelajaran IPA dengan IPS menjadi IPAS. Selain itu, pengasatan Profil Pelajar Pancasila melalui Proyek Profil Pelajar Pancasila berada di luar jam pembelajaran (gelombangan komposisi 20-30% dari alokasi waktu selama satu tahun. Sehingga proyek ini tidak menggangu atau mengurangi jumlah jam pembelajaran intrakurikuler.

Setelah analisis kebutuhan mapel, maka akan dimuat analisis operasional sebagai turunan dari capaian pembelajaran dan alur tujuan pembelajaran yang telah disediakan pusat. Analisis ini akan disebarkan dengan muatan lokal dan potensi daerah juga program sekolah dengan menghitung alokasi waktu yang tidak membebani peserta didik agar kenyamanan dan ketahagiaan dalam belajar tetap terjaga utuh. Kurikulum satuan pendidikan di satuan Pendidikan SD Negeri 1 Merbau Mataram mempertimbangkan karakteristik peserta didik yang beragam dan mengedepankan proses dinamis yang reflektif dalam proses pelaksanaannya sehingga tujuan akhir profil peserta didik sesuai dengan yang diharapkan pada visi, misi dan tujuan sekolah.

Figure 1. A curriculum structure that shows how the theme of environmental sustainability is embedded in all subjects, including mathematics. Diagram compiled by the research team based on the school curriculum document (2024).

Table 1. Summary of findings based on the CIPP model

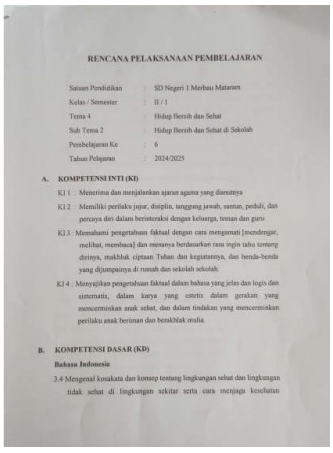
CIPP Components	Indicators	Key Findings	Interpretation
Context	Vision & Mission	Including "environmental insights" and "independence"	Demonstrate a strong commitment to continuing education
Input	Math Lesson Plan	85% of RPPs integrate local environmental contexts	Demonstrate the readiness of the thematic learning document
Process	Math Activities	Calculating hydroponic water volume and compost area	Clear integration of mathematical concepts with environmental practice
Result	Student Attitudes	85% of students scored >4 (on a scale of 1–5) on environmental attitudes	Learning has a positive impact on students' awareness and attitudes

Context

The school's vision and mission explicitly promote environmental awareness and independent learning, forming a strong foundation for sustainability education. This institutional commitment is reflected in the school's day-to-day culture and policies that encourage environmentally responsible behavior.

Input

Teachers have developed lesson plans that contextualize mathematics in local environmental problems, demonstrating readiness for thematic and project-based learning. As many as 85% of the lesson plans analyzed showed the integration of the local environmental context into math activities such as measuring volume, area, and unit conversion. These findings show that teachers have begun to adapt teaching materials in line with the thematic approach in the Independent Curriculum. However, most documents do not explicitly include ESD-based assessment indicators (Education for Sustainable Development), resulting in a gap between activities and measurement of learning outcomes.



RENCANA PELAKSANAAN PEMBELAJARAN

Satuan Pendidikan : SD Negeri 1 Merbau Mataram
Kelas / Semester : II / 1
Tema 4 : Hidup Ilersih dan Sehat
Sub Tema 2 : Hidup Ilersih dan Sehat di Sekolah
Pembelajaran Ke : 6
Tahun Pelajaran : 2024/2025

A. KOMPETENSI INTI (KI)

KI 1 : Menerima dan menjalankan ajaran agama yang dianutnya
KI 2 : Memiliki perilaku jujur, disiplin, tanggung jawab, santun, peduli, dan percaya diri dalam berinteraksi dengan keluarga, teman dan guru
KI 3 : Memahami pengetahuan faktual dengan cara mengamati [mendengar, melihat, membaca] dan menanya berdasarkan rasa ingin tahu tentang dirinya, makhluk ciptaan Tuhan dan kegiatannya, dan benda-benda yang dijumpainya di rumah dan sekolah sekolah.
KI 4 : Menyajikan pengetahuan faktual dalam bahasa yang jelas dan logis dan sistematis, dalam karya yang estetis dalam gerakan yang mencerminkan anak sehat, dan dalam tindakan yang mencerminkan perilaku anak beriman dan berakhlak mulia.

B. KOMPETENSI DASAR (KD)

Bahasa Indonesia

3.4 Mengenal kosakata dan konsep tentang lingkungan sehat dan lingkungan tidak sehat di lingkungan sekitar serta cara menjaga kesehatan

Figure 2. Sample lesson plan (RPP) that integrates hydroponic cultivation to teach volume and unit conversion in mathematics. Documents collected and analyzed by the author during the lesson plan review (2024); verified by the teacher participants for the accuracy of the content.

Process

Observation and lesson execution show that in math lessons, students engage in activities that require them to measure length, volume, and area, such as hydroponic planting, managing

compost, or designing a garden using plastic bottles. These scenarios help students connect mathematical ideas to real-life situations, making concepts such as unit conversion and geometry easier to understand. For example, they calculate the water requirements for a hydroponic system and plan the planting area by applying a measurement formula. Through this practice, they not only develop their cognitive abilities but also foster a sense of responsibility towards environmental sustainability, as reflected in the fact that around 85% of students show strong environmental awareness, with an average attitude score of 4.2 out of 5 (Batiibwe, 2020; Sari et al., 2022).

Figure 3. Student-managed compost areas are used for hands-on measurement and waste management activities in math classrooms. Photos taken by researchers during classroom observation; Student participation is documented with parental and school consent.

Figure 4. Crafts made by students from recycled plastic bottles to apply the concepts of geometry and recycling. Documented by the researcher during project-based learning sessions; ethical approval obtained from the principal.

Figure 5. A hydroponic system designed and maintained by students to practice measuring water volume and growing area. Captured by the research team during project activities; with the consent of students and teachers.

Supporting Facilities

Adequate facilities and infrastructure, such as clean toilets, healthy cafeterias, inorganic waste separation areas, and hydroponic support systems, strengthen the implementation of sustainability programs. The availability of these facilities allows project-based learning to be maintained across grade levels and subject areas. Students are taught to apply numerical skills directly, such as calculating the number of plastic bottles needed for ecobricks or determining the crop of vegetables sold to the community. These real-life numerical applications not only reinforce mathematical concepts but also expose students to the economic and social dimensions of sustainability, including recycling practices, efficient resource management, and understanding the product value chain (Bramwell-Lalor et al., 2020; Balseca Inca., 2023).

Figure 6. Teacher toilet facilities that reflect school hygiene standards and environmental sustainability practices. Photographs taken by the author during the audit of environmental facilities; validated by the school management.

Figure 7. Student toilet facilities are well maintained to support a clean and healthy learning environment. Images documented by the research team during infrastructure observations; verified by the school administration.

Figure 8. Healthy cafeterias promote nutritious food choices and waste reduction among students. Photos taken during school lunch break observations; Arrested with permission from staff and students.

Figure 9. The waste sorting area is used to support recycling activities and numeracy skills in counting recyclable materials. Documented by researchers during school environmental audits; consent is obtained from the teachers and students involved.

Result

In summary, these findings suggest that the success of the program is supported by institutional commitment (context), adequate teacher readiness and learning facilities (input), and students' active participation in real-life sustainability projects (processes). Achievements in the product dimension are evident in the improvement of students' environmental awareness and practical numeracy skills. However, there is still room for improvement in strengthening assessment instruments and ensuring equitable implementation across all grades.

Discussion (Based on the CIPP Evaluation Model)

Context: School Policies and Culture Supports Sustainability Education

The implementation of sustainability education at SD Negeri 1 Merbau Mataram is not spontaneous but starts from a strong institutional commitment that is reflected in the vision, mission, operational policies, and culture that prioritizes environmental values. The school has embedded environmental themes in planning documents such as vision-mission statements and lesson plans (RPPs). These findings are in line with (Sari & Nurizka, 2021), who emphasize the importance of institutional commitment to the success of the Adiwiyata program. A proactive school culture fosters ecological awareness among students and supports the creation of a learning ecosystem that is aligned with the principles of the SDGs (UNESCO, 2020). However, despite this robust policy framework, implementation at the classroom level is still highly dependent on individual teachers' initiatives. Without sustained and systematic policy support, this practice risks fading if there is a change in leadership or key actors.

Input: Learning Resources and Instructional Tools

Teachers at this school have developed lesson plans that integrate environmental themes into math teaching, with 85% of lesson plan documents reflecting this approach. In addition, learning facilities such as hydroponic gardens, waste banks, and composting areas provide concrete support for project-based learning. Nevertheless, not all teachers have strong interdisciplinary instructional design skills. This echoes the findings of (Lestari et al., 2024), who highlight that a lack of interdisciplinary training and relevant learning resources can hinder the integration of sustainability in mathematics. Therefore, the continuous professional development of teachers should target not only mastery of mathematical content but also thematic and project-based contextual teaching strategies.

Process: Implementation of Contextual Mathematics Learning

Classroom practice shows that teachers successfully connect mathematical concepts including fractions, measurements, unit conversions, and data analysis—with everyday

environmental activities. Students engage in tasks such as calculating water needs for hydroponics, creating ecobricks, designing a recycling garden, or weaving filter fabrics. These examples illustrate project-based learning that fosters critical thinking, problem-solving, and environmental awareness (Inca Balseca et al., 2023; Bramwell-Lalor et al., 2020).

Technology integration further enriches the learning process. By using QR codes in school parks, students access scientific information, identify patterns, classify data, and connect quantitative information with qualitative—strengthening digital literacy and numeracy skills. This approach makes abstract mathematics concepts more relevant to everyday life, improving numeracy especially for young learners (Rico et al., 2021; Ranissa et al., 2024). However, variation persists among classrooms: lower-grade teachers sometimes default to traditional methods, highlighting the need for teachers' readiness and creativity to maintain consistent quality.

Illustration Activities:

Figure 11. Creating plant pots out of plastic bottles, captured by math teachers during Grade 4 project-based learning; photo documentation verified through lesson plan notes and student consent forms.

Figure 12. Building ecobricks, photographed by Adiwiyata coordinators during sustainability workshops; this activity is approved as part of the school's official environmental program and ethically validated.

Figure 13. Using QR codes in the school garden, picked up by ICT teachers during integrated science-mathematics sessions; supervised by the principal and reported in the school's ESD (Education for Sustainable Development) annual report.

Each activity develops concrete math skills, such as estimation, spatial reasoning, and basic budgeting, while building ecological awareness.

Product: Impact on Students and School Culture

The evaluation showed that students showed increased understanding of mathematical concepts through environment-based activities and showed a high level of ecological awareness (average score of 4.2 out of 5). These results are consistent with (Rico et al. 2021; Ranissa et al.

2024; Pokharel 2020), who highlight that contextual learning strengthens students' conceptual mastery and engagement. At the school level, environmental projects have become an integral part of the school's identity and shape students' daily behaviors. However, student competency assessment still relies on conventional methods and has not included sustainability indicators. Developing authentic assessment tools that measure cognitive and affective aspects simultaneously in the context of ESD (Vansdadiya & Vasoya, 2023) remains an important challenge.

Conclusion of the Discussion

In conclusion, mathematics teaching based on sustainability education at SD Negeri 1 Merbau Mataram is well implemented in all dimensions of context, input, process, and product. To ensure long-term success, systemic measures are needed to strengthen teacher capacity, design interdisciplinary assessments, and institutionalize cross-disciplinary sustainability learning in curriculum structures and academic supervision frameworks.

Research Contributions

The study makes a meaningful contribution to educators, curriculum developers, and policymakers concerned with sustainability and mathematics education. By demonstrating how sustainability values can be effectively instilled into math lessons through real-life environment projects, these findings offer practical insights to improve students' numeracy, critical thinking, and ecological literacy simultaneously.

For teachers, this study highlights concrete examples of contextual, project-based activities that make abstract mathematical concepts more real and relevant to everyday life. For schools and education administrators, this research underscores the importance of aligning school policies, infrastructure, and community engagement to support a sustainability-oriented learning environment.

For policymakers, the results serve as evidence to support curriculum integration policies that encourage interdisciplinary learning, ensuring that sustainability education is not treated as a separate subject but is woven across core academic content. Overall, this paper serves as a reference for developing thematic learning models that promote students' problem-solving skills while fostering environmentally responsible attitudes and behaviors, helping schools contribute to broader sustainable development goals.

Implications

1) Theoretical ImplicationsThis research strengthens the contextual learning framework in primary education by adding sustainability as a core context in mathematics teaching (Roswita, 2020; Baharullah et al., 2022). By showing that environmental projects can reinforce the concept of numeracy, this study enriches perspectives on constructivist approaches and double representation theory in mathematics learning. 2) Practical Implications, these findings show that integrating environmental themes does not reduce the achievement of core mathematics competencies but rather improves students' critical thinking skills (Mumu et al., 2020). This highlights the potential for teachers to use real-life environmental projects—such as composting, hydroponics, and recycling—as a meaningful and contextual learning medium.

Recommendations for Policies and Practices

1) For Teachers: Teachers are encouraged to design and implement project-based learning that integrates environmental problems into mathematics lessons (Roswita, 2020). This approach supports active learning, collaboration, and real-world problem-solving. 2) For Schools: Schools should develop internal policies and flexible schedules that support cross-disciplinary integration based on sustainability themes. Building a learning community and encouraging collaboration among teachers across subjects is an important step. 3) For Policy Makers: This research can serve

as a reference for developing a project-based thematic curriculum that embeds environmental education at the national level. Continuous professional development for teachers is needed to design interdisciplinary assessments and develop numeracy-based ESD learning resources.

Research Contributions

This research makes an important contribution by showing that thematic approaches that integrate environmental issues with subjects such as mathematics can create more meaningful learning. It illustrates how sustainability education can move beyond raising awareness to active problem-solving through mathematical reasoning. This interdisciplinary experience helps students see the relevance of academic content in addressing real-world problems. Through the implementation of contextual environmental projects, the school not only delivers the curriculum effectively but also equips students with 21st-century skills that include collaboration, data literacy, and ecological awareness. These skills are increasingly important as students face global challenges such as climate change, resource depletion, and environmental degradation.

Limitations

Although the implementation of the Adiwiyata program is going well, there are still some limitations, such as the low level of understanding and involvement of lower-class students in protecting the environment and understanding mathematical concepts in environmental activities. Some programs are not applied equally across all classes. There are also no regular extracurricular activities to support students' math and ecology skills. Therefore, the development of more systematic thematic learning programs and teacher training in integrating cross-curricular content is an important step forward. Providing professional development focused on interdisciplinary pedagogy will empower teachers to make stronger and clearer connections between mathematics and sustainability in their daily teaching practices.

Suggestions (Recommendations for Further Research)

1) Implementation in Other Primary Schools:
It is suggested that future research replicate this research in other primary schools, including those that have not yet implemented the Adiwiyata program, to explore the broader application and effectiveness of interdisciplinary sustainability-based learning models in diverse educational settings. 2) Quantitative and Longitudinal Evaluation: Researchers are encouraged to conduct studies using quantitative or mixed method approaches to evaluate the long-term impact of the integration of Education for Sustainable Development (ESD) in mathematics lessons. This should include measurements of students' improved numeracy skills, shifts in ecological awareness, and their ability to make informed decisions over time. 3) National Development and Testing of Learning Modules, future projects should focus on designing, piloting, and refining environment-themed mathematics learning modules that can be integrated into the national curriculum. These modules should include context-based formative assessments and teaching resources that accommodate environmental challenges and local cultural contexts. 4) Strengthening Collaborative Teacher Training Further research can examine the effectiveness of collaborative professional development models, such as lessons, peer coaching, or school-based workshops. Such training aims to build the capacity of teachers to design and deliver interdisciplinary lessons that connect sustainability issues with core math content, fostering numeracy and environmental literacy among students.

Conclusion

Based on the findings and discussions presented, it can be concluded that the expectations outlined in the Introduction to evaluate the integration of sustainability principles in mathematics education in Adiwiyata schools implementing the Independent Curriculum have been met. The case of SD Negeri 1 Merbau Mataram shows that combining the Adiwiyata program with the Independent Curriculum strengthens interdisciplinary learning and instills sustainability in

mathematics. Schools should prepare clear guidelines and train teachers regularly, while policymakers need to provide resources and build community support to ensure sustainability and foster environmental awareness in math learning.

The integration of environmental projects into math lessons, such as calculating compost volume, analyzing waste data, and measuring hydroponic systems, has been shown to contextualize abstract concepts, making learning more meaningful and relevant to students' daily lives. By embedding sustainability themes into numerical activities, students gain a deeper appreciation of how mathematics can be applied to address environmental challenges. In addition, these activities also encourage critical thinking, problem-solving, and the application of math skills in real-life situations—core aspects of continuing education.

This research confirms that environmental education and mathematics are not mutually exclusive but can complement and reinforce each other through project-based and contextual approaches. The integration of real-life environmental problems into mathematics allows students to see the relevance of what they learn in class. It also encourages active engagement, as students apply mathematical reasoning to solve real problems in their environment. The study also highlights that school policies, infrastructure, and community participation are critical in supporting such integration.

Looking ahead, the findings of this study open up opportunities for the development of thematic and interdisciplinary learning models that not only improve academic performance but also foster students' ecological and social responsibility. Future research could explore broader implementation in other schools and examine the long-term impact on students' environmental attitudes and math skills. In addition, structured teacher training programs that focus on interdisciplinary integration and the development of continuous learning resources will be key to expanding the application of continuing education in various fields of study.

Aknowledgment

The author expresses his sincere gratitude to the principal, teaching staff, school committee, and the entire community of SDN 1 Merbau Mataram for their invaluable support and cooperation during the research process. Their openness and active participation provided rich insights that greatly increased the depth of this research. Gratitude was also expressed to the Faculty of Tarbiyah and Teacher Training of UIN Raden Intan Lampung for the academic guidance and research facilitation, which contributed significantly to the successful completion of this research.

Author Contributions Statement

All authors actively contributed to each stage of this research. Siti Muthmainah is responsible for conceptualizing, writing the original draft, and overseeing the entire project. Muhammad Syarifuddin handles the methodology, conducts formal analysis, and prepares visualizations. Rintan Mustika conducts investigations, manages data curation, and contributes to manuscript review and editing. Zulfa Khairunnisa provides resources and oversees project administration. Together, the authors design the research, systematically collect and analyze the data, compile the background, discussion, and conclusions, critically review the content of the manuscript, make substantive and technical revisions, and approve the final version for publication. This collaborative effort demonstrates the authors' collective responsibility and commitment to ensuring the quality and credibility of research results.

References

Aeni, Nur, Nursalam Nursalam, and Idawati Idawati. "Adiwiyata implementation in understanding environmental education." *Indonesian Journal of Primary Education* 4.2 (2020): 184-196. https://doi.org/10.17509/ijpe.v4i2.29432

Baharullah, Satriani, S., Arriah, F., & Hidayah, A. (2022). The implementation of the Independent Learning curriculum through the application of a project-based learning model to improve student learning outcomes in mathematics learning. *MaPan*, *10*(2), 334–347. https://doi.org/10.24252/mapan.2022v10n2a6

Batiibwe, MSK (2020). Developing mathematical thinking through an activity-based heuristic approach: cases make connections between patterns, sequences and graphs. https://doi.org/10.5281/ZENODO.3692059

Bramwell-Lalor, S., Kelly, K., Ferguson, T., Hordatt Gentles, C., & Roofe, C. (2020). Project-based learning for environmental sustainability actions. *South African Journal of Environmental Education*, *36*. https://doi.org/10.4314/sajee.v36i1.10

Ika Sari, G., Winasis, S., Pratiwi, I., Wildan Nuryanto, U., & Basrowi. (2024). Strengthening digital literacy in Indonesia: Collaboration, innovation, and sustainability education. *Social Sciences & Open Humanities*, *10*, 101100. https://doi.org/10.1016/j.ssaho.2024.101100

Inca Balseca, CL, Inca Balseca, EG, Morocho Orellana, JC, Morocho Caiza, AF, Coronel Maji, FM, & Silva Godoy, LF (2023). Project-based learning (abp) in mathematics teaching in the context of computer programming. *Journal of namibian studies*, *34*. https://doi.org/10.59670/jns.v33i.830

Ismail, K., Rohmah, M., Rahmadani, R., Liana Sari, N., & Azmiyati, A. (2024). Analysis of the adiwiyata program in the implementation of green economy learning to foster ecological literacy in east oku. *Journal of balance sheets: journal of accounting education and economics*, *8*(2), 207–227. https://doi.org/10.31851/neraca.v8i2.16755

Istiqomah, H., Sugiono, S., & Erviana, L. (2022). Analysis of student response and environmental awareness in the implementation of the adiwiyata program at sdn jatimalang. *Scientific journal of elementary schools, 2(1), 20-26.* https://doi.org/10.21137/sjes.2021.1.1.4

Jannah, F., Fahlevi, R., Sari, R., Radiansyah, R., Zefri, M., Akbar, D. R., Shofa, G. Z., & Luthfia, G. A. (2022). Improving environmental awareness through the adiwiyata program for primary school students. *Journal of geographic (environmental geography of wetlands),* *3*(1), 1. https://doi.org/10.20527/jgp.v3i1.5096

Kamil, P.A., Putri, E., Ridha, S., Utaya, S., Sumarmi, & Utomo, D.H. (2020). Promoting environmental literacy through green projects: a case study in adiwiyata schools in banda aceh city. *Iop conference series: earth and environmental sciences*, *485*(1), 012035. https://doi.org/10.1088/1755-1315/485/1/012035

Lafuente-Lechuga, M., Cifuentes-Faura, J. by Faura-Martínez, U. (2024), "Teaching sustainability in higher education by integrating mathematical concepts", *International Journal of Sustainability in Higher Education*, Vol. 25 No. 1, pp. 62-77. https://doi.org/10.1108/IJSHE-07-2022-0221

Larashati, Larashati, and Annisa Nur Khasanah. "Analysis of Attitudes towards the Environment in Students of Adiwiyata and Non-Adiwiyata Schools." *Jurnal Penelitian Pendidikan IPA* 8.5 (2022): 2247-2252. 10.29303/jppipa.v8i5.1534

Lestari, S.P., Nurapriani, F., & Kusumaningrum, D.S. (2024). Integrate the principles of sustainable development in mathematics learning to stimulate sustainable skills in future generations. *Journal of Industrial Systems Engineering*, *13*(1), 1–10. https://doi.org/10.26593/jrsi.v13i1.7167.1-10

Mumu, J., Prahmana, R.I., Sabariah, V., & Tanujaya, B. (2020). *Students' environmental awareness through a scientific approach in teaching mathematics*. https://doi.org/10.1088/1742-6596/1657/1/012056

Negi, SK (2024). Exploring the impact of virtual reality and augmented reality technology in sustainability education on green energy and sustainability behavior change: a qualitative analysis. *Produria computer science*, *236*, 550–557. https://doi.org/10.1016/j.procs.2024.05.065

Nuzulia, S., Sukamto, S., & Purnomo, A. (2020). The implementation of the independent adiwiyata program in instilling environmental awareness in students. *SOCIO-DIDACTIC: Journal of Social Science Education*, *6*(2), 155-164. https://doi.org/10.15408/SD.V6I2.11334

Paparang, O. E. (2017). Participation of school members in carrying out the adiwiyata program at SMA Negeri 9 Lempake Samarinda. *State Administration Journal*, *5*(2), 5922-5933.

Prayogo, Wisnu, et al. "Environmental education practices in Indonesia: A review." *Journal of Sustainable Infrastructure* 3.1 (2024). https://doi.org/10.61078/jsi.v3i1.27

Pokharel, JK (2020). Pedagogical practice in teaching – learning mathematics at the secondary level in schools. *Multidisciplinary Journal*, *3*, 43-50. https://doi.org/10.3126/RUPANTARAN.V3I0.31740

Putri, Ravika Febriza Martias, and Efni Cerya. "Comparison of Environmental Attitudes of Students Attending Adiwiyata Schools and Non-Adiwiyata Schools." *JRTI (Jurnal Riset Tindakan Indonesia)* 10.1 (2025): 111-118. 10.29210/30036095000

Rahmadiani, R., Utaya, S., & Bachri, S. (2019). Ecological literacy of adiwiyata and non-adiwiyata high school students. *Journal of education: theory, research, and development*, *4*(4), 499. https://doi.org/10.17977/jptpp.v4i4.12306

Rahman, Ainur, et al. "implementation of the adiwiyata school in improving the quality of public elementary school education." *al-ishlah: jurnal pendidikan* 15.4 (2023): 5440-5448. https://doi.org/10.35445/alishlah.v15i4.2299

Ranissa, S., Sintia, E., Andhika, M. Y., & Wahyudi, A. (2024). Benefits of technology integration in mathematics learning in elementary schools. *Journal of education UNIGA*, 175-175.*18*(02). https://doi.org/10.52434/jpu.v18i2.41758

Rico, A., Agirre-Basurko, E., Ruiz-González, A., Palacios-Agundez, I., & Zuazagoitia, D. (2021). Integrating mathematics and science teaching in the context of education for sustainable development: design and implementation of a pilot teaching-learning sequence on air quality with pre-service elementary school teachers. *Sustainability*. https://doi.org/10.3390/SU13084500

Roswita, W. (2020). The Adiwiyata program-based school management model can create an environmentally oriented school. *Journal of Management Development*. https://doi.org/10.1108/JMD-01-2019-0005

Sappaile, B. I. (2025). Evaluation of the adiwiyata school program at the upt spf sdn bawakaraeng complex in makassar city. *Pendas: scientific journal of basic education*, *10*(01), 223-237. DOI: https://doi.org/10.23969/jp.v10i01.23342

Sari, A.P., & Nurizka, R. (2021). *Implementation of adiwiyata school at sd negeri serayu, yogyakarta*. *Sec. 7*.

Sari, TSR, Pambudi, DS, & Lestari, NDS (2022). The development of learning tools for sequence and series using outdoor learning methods to improve students' mathematical communication skills. *Axiom Journal*. https://doi.org/10.24127/ajpm.v11i4.6185

Setiawan, R., Jone P. Sodusta, D., Salsabila Firdausyi, M., Zakia Zamania, Z., Novitasari, K., Budi Amanda, K., & Octavia Arianto, R. (2024). Implementation of the hero waste application to increase environmental awareness of mi at-taufiq students in the merdeka curriculum. *Edustream: journal of basic education*, *8*(1), 44–50. https://doi.org/10.26740/eds.v8n1.p44-50

Tesfamicael, S.A., & Enge, O. (2024). Revitalizing sustainability in mathematics education: the case of the new norway curriculum. *Education*, *14*(2), 174. https://doi.org/10.3390/educsci14020174

UNESCO. (2020). *Education for sustainable development: A roadmap*. Paris: UNESCO Publications. Taken from https://unesdoc.unesco.org/ark:/48223/pf0000374802

Vansdadiya, R., & Vasoya, N. H. (2023). Beyond the classroom walls: activity-based learning for real-world math experiences. *Asian journal of education and social sciences*. https://doi.org/10.9734/ajess/2023/v43i1930