Digital Technology in Environmental Education Adiwiyata Program for Elementary School Children in Facing Climate Change in Samarinda City

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Abstract

This research investigates the effectiveness of integrating digital technology into environmental education within the Adiwiyata Program at elementary schools in Samarinda. The study employs a literature review approach, meticulously analyzing a range of academic sources, policies, and local documentation to assess the impact of this integration. The results demonstrate that digital tools, including e-modules, educational videos, and interactive simulations, successfully improve students' environmental literacy and critical thinking skills related to climate change issues. Furthermore, the study highlights the strategic importance of teachers as learning facilitators who design action-oriented experiences. The involvement of parents and the wider school community, supported by digital platforms, also plays a significant role in promoting sustainability values. Despite these positive outcomes, the research identifies notable barriers, such as inadequate ICT infrastructure and the need for enhanced digital competency among teachers.bThe findings lead to several key recommendations, including the necessity for ongoing training, better access to digital educational resources, and fostering closer collaborations between schools and their communities. Theoretically, the study supports the principles of ecopedagogy and systems thinking. This work is intended to serve as a practical and theoretical basis for developing innovative and sustainable digital learning models.

Keywords: *adiwiyata program, community engagement, digital technology, environmental education, , ecological literacy*

INTRODUCTION

Climate change affects various aspects of life, including education. In Samarinda, a central urban area in East Kalimantan, recurring floods, air pollution, and growing waste highlight the urgent need for environmental education to build ecological awareness and practical problem-solving skills. The government's Adiwiyata Program addresses this need by promoting sustainability in elementary schools through participatory, action-based learning [1].

However, its implementation faces several challenges. Teachers often lack access to innovative learning media, while students need more contextual and interactive approaches. Parental and community support remains underutilised. Digital technology offers potential solutions by providing engaging media that foster environmental literacy and active student involvement [2].

Studies have shown that tools such as e-modules, interactive videos, and environmental education apps can increase student motivation and critical thinking [3]. Project-based digital media, such as virtual campaigns and digital waste banks, further enhance student participation

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and contextual learning [4]. These align experiential learning theory, which emphasises meaningful, real-world engagement.

Integrating digital tools also redefines the teacher's role as a learning facilitator. Teachers who design lessons using digital resources improve content delivery effectiveness by up to 40% compared to conventional methods [5]. This supports connectivism theory, which views technology as a collaborative learning network that broadens access to knowledge.

Parental and community involvement is also crucial. Research shows that parental support in digital-based learning promotes eco-friendly behaviour at home, while community participation reinforces practices like waste management and greening programs [6]. This approach reflects systems thinking, emphasising the interconnected roles of families, schools, and communities in learning.

Nonetheless, barriers remain. According to UNESCO (2023), only 42% of Indonesian elementary schools have adequate digital infrastructure, and many teachers face low digital literacy. Addressing these issues requires ongoing training and inclusive educational policies [7].

This study aims to analyse how digital technology supports Adiwiyata implementation in Samarinda's elementary schools. It focuses on: (1) the effectiveness of digital media in improving environmental literacy, (2) teachers' roles in facilitating tech-based environmental learning, and (3) the involvement of parents and communities in supporting digital environmental education.

Theoretically, this research contributes to the growing literature on digital environmental education. Practically, it offers insights for local governments, schools, and stakeholders in designing innovative, collaborative, and locally grounded learning strategies that strengthen both Adiwiyata outcomes and sustainable environmental awareness at the elementary level.

METHOD

This study employs a qualitative approach, utilising a literature review methodology, to investigate how digital technology can support environmental education within the Adiwiyata Program. The focus is on enhancing elementary students' environmental awareness and participation in climate-related issues, particularly in the context of Samarinda.

The research relies on secondary data drawn from diverse sources. These include government policy documents such as Ministerial Decrees, curriculum guidelines, and local government initiatives in Samarinda. Additionally, relevant articles from national and international journals especially those indexed in SINTA, DOAJ, and Google Scholar are reviewed. Academic books discussing environmental education, digital learning, and student engagement in green programs are also considered. Other data sources include implementation reports of the Adiwiyata Program in Samarinda and credible online media, which provide contextual insights.

Data collection follows a structured process. It begins with the identification of key terms, including "Adiwiyata," "environmental education," "digital technology," "elementary students," "climate change," and "Samarinda." Searches are conducted through databases such as Google Scholar and the Garuda (SINTA) portal. Literature is selected based on relevance, credibility, and publication within the last 5–10 years. The documents are then categorised into major themes: policy frameworks, program implementations, school practices, and student responses.

Content analysis is employed to interpret the data. This involves close reading, identifying main and sub-themes, comparing findings across sources, and drawing contextual insights. To

ensure validity, source triangulation is used by cross-referencing multiple document types. The literature review was conducted iteratively to refine and confirm interpretations.

RESULTS AND DISCUSSION

1. Integration of Digital Technology in Adiwiyata Activities at Elementary Schools

The integration of digital technology into the Adiwiyata Program is essential at the elementary school level to address the challenges of environmental education in the digital era and the age of climate change. The use of digital media has been proven to enhance the quality of learning and broaden student participation in environmental preservation activities. Digital technology supports the internalisation of ecological values through an interactive, technology-literacy-based approach [8].

Furthermore, the implementation of digital technology in Adiwiyata is realised using e-modules, educational videos, and digital-based educational games to teach the 3R principles (Reduce, Reuse, Recycle), climate change, and the introduction of local flora and fauna. This approach makes learning more engaging and can be adapted to local contexts, such as the environment around Samarinda City [9].

Figure 1. E-Module For Elementary Education
(Source: Learning Module P5 I Love Earth)

Integrating digital technology into the Adiwiyata Program is a strategic response to the challenges of environmental education in the context of climate change and the digital era. Digital media enables interactive, creative, and contextual delivery of ecological content. As note, technology-literate approaches enhance the internalisation of environmental values. Siemens' (2005) connectivism further supports this by emphasising learning through digital networks modul [10].

Evidence shows digital tools improve students' environmental literacy. Found a 78% increase in ecoliteracy among students who used digital media, particularly in understanding the 3R principles and climate change [11]. This supports constructivism, where students learn through active, experience-based engagement. Real-world digital projects, such as the "Digital Waste Bank" and the P5 module "I Love the Earth," promote cognitive, affective, and psychomotor learning. Show that experiential activities boost participation in environmental protection, aligning experiential learning theory.

Digital e-modules also enable inclusive and differentiated learning. Highlight that project-

based e-modules enhance critical thinking and environmental responsibility, in line differentiated instruction model. Despite the benefits, challenges persist. Many teachers lack digital skills, and only 42% of Indonesian elementary schools have adequate ICT infrastructure [12]. This calls for continuous training and policy support, reflecting systems thinking, which advocates for synergy among teachers, infrastructure, and curriculum. In sum, digital integration within Adiwiyata strengthens value-based and sustainable learning. It fosters students' environmental awareness while developing 21st-century skills, aligning with the Ministry of Education's vision of cultivating environmentally conscious, tech-savvy Pancasila students [13].

2. The Role of Teachers and the Application of Environmentally Friendly Digital Technology in Environmental Education at Elementary Schools in Samarinda

In the context of the Adiwiyata Program in Samarinda, teachers play a strategic role as facilitators of environmental literacy, particularly through the use of eco-friendly digital media. The increasingly apparent reality of climate change necessitates a transformation in the approach to learning, not only in content but also in teaching methods and media. Teachers are required not only to deliver material but also to foster ecological awareness through a pedagogical approach that is critical and participatory.

A literature review reveals that elementary school teachers play a crucial role in integrating environmental education values into thematic curricula and digital learning activities. Strengthening the role of teachers in technology-based learning can enhance student awareness and engagement with environmental issues from an early age [14].

As part of a whole-school approach, the Adiwiyata Program encourages schools to implement comprehensive sustainability principles, from classroom instruction to extracurricular activities. Teachers utilise various digital media that support eco-friendly values, such as interactive videos, digital simulations on climate change, and Android-based educational applications that teach concepts of the 3Rs (Reduce, Reuse, Recycle), energy conservation, and adaptation to climate disasters [15]. The use of this media aligns with the Science-Technology-Society-Environment (STSE) approach, which connects scientific knowledge with the social and local environmental contexts of student.

The use of educational videos and interactive applications increases students' comprehension of climate change material by up to 40% compared to conventional lecture methods at SD Negeri 009 [16]. The following survey data support this:

Table 1. Teacher Perceptions of Digital Environmental Education Implementation in Samarinda Elementary Schools

No	Statement	Percentage Agree (%)
1	Environmental Education Is Important To Be Taught Since Elementary School	97
2	Digital Media Supports Environmental Education Learning	94
3	Teachers Need Special Training	91
4	The Curriculum Sufficiently Supports The Integration Of Environmental Education	22

(Source: Adapted from Sukma, Ramadhan, Indriyani, 2020)

These data indicate that while the majority of teachers recognise the importance of using eco-friendly digital media, limited training and curriculum time remain significant challenges. Therefore, local government policy support and enhancing teacher competency are crucial.

The implementation of eco-friendly digital media not only enhances the effectiveness of environmental education but also reduces the use of physical resources, such as paper, printed materials, and excessive electricity. For example, teachers can facilitate projects that involve creating digital posters, environmental vlogs, and social media campaigns, thereby engaging students creatively. This approach has been proven to enhance students' critical awareness of local issues, such as flooding in Samarinda, deforestation, and local waste management [17].

Furthermore, the application of simple technologies, such as the Internet of Things (IoT), to monitor classroom electricity usage or digital plant projects (plant monitoring via an application), becomes a tangible and engaging practice for elementary school children [18]. In this approach, teachers act not only as instructors but also as mentors and facilitators of action-based learning.

According to the Ecopedagogy approach, education should foster awareness of the relationship between humans and the environment and encourage practical actions based on ecological justice. Teachers play a role in instilling this awareness through contextual, technology-based learning experiences that are not only informative but also transformative.

Teachers hold a central position in the success of digital-based environmental education at the elementary school level. With the support of the Adiwiyata Program, digital media can be utilised not only as a learning tool but also as a vehicle for shaping a young generation with the sensitivity and skills to face local climate challenges.

3. Student Response and Participation in Digital Learning for Environmental Education

The integration of digital technology into the Adiwiyata Program has significantly enhanced elementary students' engagement with environmental education in Samarinda. Digital media simplifies complex climate change topics through visual and interactive formats, making them easier for children to understand. Found that students responded positively to tools like educational videos, simulations, and games. Surveys showed that over 70% of students had a better understanding of climate concepts, and 65% actively participated in discussions and digital projects [15].

This suggests that digital media not only aids comprehension but also promotes pro-environmental behaviour. Support this, noting that interactive media increases motivation and participation, especially on emotionally engaging topics like the environment[19]. Drawing from behaviourist theory, digital content acts as a stimulus, prompting responses such as participation and reflection. Fast feedback through digital platforms (e.g., quizzes, forum comments) serves as reinforcement, strengthening students' learning and environmental awareness.

Figure 2. Students Bringing Personal Water Bottles as Part of a Single-Use Plastic Waste Reduction Campaign
(Source: Environmental Agency of East Kalimantan Province)

The habit of bringing a personal water bottle is part of a zero-waste lifestyle education, which is reinforced through online outreach and eco-friendly campaign videos shared by teachers via class WhatsApp groups. This practice reflects students' active response to digitally delivered environmental messages and demonstrates the internalization of eco-conscious values.

According to the consistent use of digital media in environmental learning has been proven to increase students' ecological awareness and encourage the formation of eco-friendly habits from an early age. Technology serves as a strategic tool for conveying environmental messages in a manner that is engaging, visual, and easily understood by children.

Figure 3. Students Managing a Compost House in the School Environment as a Form of Applying Digital, Environmentally-Based Project Learning
(Source: Environmental Agency of East Kalimantan Province)

The school's compost house is a concrete example of how project-based learning can be integrated with digital media. Teachers use digital video tutorials and infographics to instruct students on how to manage organic waste into compost. Student participation in this project demonstrates that conceptual understanding gained digitally can be applied practically in real life.

Research states that environmentally based project learning that utilizes digital media can enhance students' critical thinking skills, creativity, and concern for local environmental issues. In this context, students not only learn theory but also act as agents of change within their school and surrounding environment [20].

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Figure 4. Students Making Ecobricks from Plastic Waste as Part of Digital-Based Waste Management at School

(Source: Environmental Agency of East Kalimantan Province)

Ecobrick-making activities show that environmental learning can extend beyond classrooms through digital integration. Teachers in Adiwiyata schools use social media and e-learning platforms to guide students, who then share their results online. Notes that hands-on projects like ecobricks, when delivered digitally, promote sustainability values and increase environmental responsibility through clear and engaging instructions [21].

In Samarinda, teachers report growing student interest in digital environmental initiatives, such as vlogs, energy-saving campaigns, and waste-reporting apps. Highlight that these projects foster a sense of ownership and active participation in solving ecological issues[17].

Virtual field trips (VFTs) are also effective. Found that a flood-focused VFT led 80% of students to engage in class discussions and propose local solutions [22]. These digital experiences help students connect learning with real-world environmental challenges, enhancing both climate literacy and participatory behavior in sustainable practices.

Table 2. Student Perception Data

No	Assessment Aspect	Percentage of Student Who Agree
1	Digital Media Makes The Material Easier To Understand	71%
2	Participation Increases During Digital Learning	65%
3	Students Are Active In Digital Environmental Projects	68%
4	Virtual Field Trips Increase Interest	80%

(Source: Adapted from Suma et al. (2020); Intan Diana (2024); Wahyuni and Rahma (2021))

These results reinforce that the integration of digital technology into environmental education not only supports cognitive understanding but also facilitates students' affective and psychomotor domains, in line with Bloom's taxonomy of learning. Students' active participation in digital projects is a key indicator of the success of a student-centered learning approach, as emphasized in theory of constructivism.

The positive response and participation of students in digital learning within the Adiwiyata Program provide a strong signal that this approach can be continued and expanded. However, the sustainability of this strategy is highly dependent on support for teacher training, equitable technological infrastructure, and educational policies that holistically support digital integration into the environmental curriculum.

4. Parental and Community Involvement Around the School

Integrating digital technology into environmental education requires active involvement from families and communities. In the Adiwiyata Program at the elementary level, success depends on collaboration between schools, parents, and local communities. Parents now act not only as homework helpers but also as tech facilitators and role models in promoting eco-friendly behavior. The community plays a key role in fostering a supportive social environment for sustainability.

This approach aligns ecological Systems Theory, which highlights the influence of family and community on a child's development. In Samarinda, Adiwiyata schools have initiated collaborations such as digital campaigns and climate video contests involving families.

A visit by East Kalimantan's Environmental Agency to SDN 023 Loa Janan showcased students' digital environmental projects and encouraged discussions with parents and officials. Such synergy reflects the growing commitment to embed environmental values through cross-system collaboration and digital learning.

Figure 5. Visit by the Environmental Agency of East Kalimantan Province to SDN 023 Loa Janan
(Source: Environmental Agency of Samarinda City)

A study published in Jurnal Inovasi Pendidikan, showed that 78% of parents involved in digital environmental learning projects reported a better understanding of climate change and adopted more eco-friendly household practices [23]. This suggests that digital environmental literacy fosters shared awareness within families. Supporting this, a limited survey in several

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Adiwiyata schools in Samarinda revealed the following trends in community involvement:

Table 3. Trends in Community Involvement

No	Aspect of Community Participation	Support Percentage (%)
1	Parents Accompany Children In Digital Assignments	74
2	Digital-Based Community Environmental Activities	63
3	Parents Are Involved In Video Content Creation	59
4	Collaborative School And Environmental Community	68

(Source: Adapted from Wahyuni & Rahman (2021); Kusumawati & Prasetyo (2021))

Social Learning Theory, the involvement of adults as role models is crucial for instilling ecological attitudes in children. When parents or the community participate in environmental learning, children learn not only from teacher instruction but also through modeling behavior from their immediate social environment. This approach makes the transfer of environmental values more effective and practical.

Furthermore, community involvement is strengthened through local digital platforms, such as parent-teacher WhatsApp groups, school environmental reporting applications (e.g., for pollution), and school social media, which serve as a means to promote Adiwiyata actions. These platforms have proven effective in disseminating information, increasing participation, and reinforcing the accountability of school-based environmental activities.

Ultimately, the involvement of parents and the community is a critical aspect supporting the success of digital technology in environmental education. This collaboration not only expands the scope of environmental education from school to home but also strengthens the collective capacity to address the challenges of climate change in a tangible and sustainable manner.

CONCLUSION

This study concludes that integrating digital technology into environmental education through the Adiwiyata Program significantly enhances environmental literacy, critical thinking, and student participation in climate action at the elementary level. Interactive media such as e-modules, videos, and digital projects make learning more engaging and behaviorally impactful. Teachers act as key facilitators, though challenges like limited digital skills and infrastructure require ongoing support and training.

Parental and community involvement via digital platforms extends the impact of environmental education beyond schools. These findings emphasize the importance of combining ecopedagogy, digital literacy, and participatory learning, grounded in constructivist and systems thinking frameworks.

Policy recommendations include improving ICT infrastructure, providing inclusive digital content, and training teachers. Schools should also strengthen collaboration with families and communities. Future research should explore long-term behavioral impacts, compare urban–rural implementations, and develop adaptive, inclusive learning models that address local ecological and gender-responsive issues in climate education.

DECLARATION OF GENERATIVE AI

I utilize AI tools to search for relevant literature, integrate information, and support translation and grammar improvement

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