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Green economy-based deep learning curriculum in Indonesia

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ABSTRACT

This study discusses the development and application of a green-economy-oriented deep learning curriculum, namely Literasi Ekonomi Hijau (Economy Green Literacy), in a Pusat Kegiatan Belajar Masyarakat (PKBM) in Indonesia. The program is designed to integrate Deep Learning with Environmental Sustainability Education to address local environmental issues, including waste management, water conservation, and the adoption of clean energy. Using a participatory, co-creational method, the course features hands-on projects in which learners work on environmentally sustainable initiatives such as upcycling household waste and organic farming. Findings emphasise the transformative effects on participants, including improved environmental understanding, practical skills, and community connectedness. The curriculum design encourages student-led learning and participation in local environmental solutions. This work examines the potential of merging innovative educational approaches and bottom-up sustainability initiatives to promote green economy thinking and the social innovation that follows. The study highlights the role of contextually relevant, interdisciplinary education in equipping the next generation to address environmental issues in a complex, interconnected world.

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ABSTRAK

Studi ini membahas pengembangan dan penerapan kurikulum deep learning (pembelajaran mendalam) berorientasi ekonomi hijau, yaitu Literasi Ekonomi Hijau (Economy Green Literacy) di sebuah Pusat Kegiatan Belajar Masyarakat (PKBM) di Indonesia. Program ini dirancang untuk menggabungkan Deep Learning dengan Pendidikan Keberlanjutan Lingkungan untuk menyelesaikan masalah lingkungan lokal, termasuk pengelolaan limbah, pelestarian air, dan adopsi energi bersih. Dengan menerapkan metode partisipatif dan kreasi bersama (co-creational), kursus ini menghadirkan proyek langsung di mana peserta didik mengerjakan proyek-proyek berkelanjutan di lingkungan seperti daur naik (upcycling) limbah rumah tangga dan pertanian organik. Temuan menekankan dampak transformatif pada peserta dalam hal peningkatan pemahaman lingkungan, keterampilan praktis, dan keterhubungan komunitas. Desain kurikulum mendorong pembelajaran yang dipimpin oleh siswa dan partisipasi dalam solusi lokal untuk lingkungan. Karya ini menginformasikan potensi penggabungan pendekatan pendidikan inovatif dan upaya keberlanjutan dari bawah ke atas (bottom-up) untuk mempromosikan pemikiran ekonomi hijau dan inovasi sosial yang mengikutinya. Studi ini menyoroti peran pendidikan interdisipliner yang relevan secara kontekstual untuk membekali generasi mendatang dalam mengatasi masalah lingkungan di dunia yang kompleks dan terhubung.

Kata Kunci: *ekonomi hijau; literasi lingkungan; pembelajaran berbasis masyarakat; pembelajaran mendalam*

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INTRODUCTION

In recent years, the concept of the green economy has gained broader global recognition in response to environmental challenges posed by climate change, resource depletion, and growing social inequality. An emphasis on sustainable development, environmental sustainability, carbon emission reductions, and social inclusivity characterizes a solution economy. The green economy emphasizes the efficient use of resources, renewable energy, and environmental considerations, thereby minimizing the business's ecological footprint or reducing its contribution to landfills (Odeyemi et al., 2024; Santoso et al., 2025). The term green economy refers to an economy that supports long-term growth while conserving the environment and improving social well-being (Adamowicz, 2022). On the global level, the movement towards a green economy is facilitated by governments and NGOs as well as international organizations like the Paris Agreement, which demands limiting greenhouse gas (GHGs) emissions and adhering to the Sustainable Development Goals (SDGs) (Adamowicz, 2022; Ali et al., 2021; Santoso et al., 2025).

At the local level, particularly in emerging economies such as Indonesia, the integration of green economy principles is increasingly important for addressing pressing local environmental issues and enhancing community well-being (Liu et al., 2021; Sungkawati, 2024). Indonesia, an archipelagic country with diverse ecosystems, faces environmental challenges, including deforestation, water and air pollution, and waste disposal (Permana et al., 2025; Wardana, 2022). Several regions in Indonesia, however, are already making good progress towards implementing green economy principles. For example, in Bali, local jurisdictions have implemented effective measures to control waste, such as the zero-waste concept, to reduce plastic waste through recycling and composting (Dekanić et al., 2025). Likewise, in several rural areas, villages have adopted sustainable agricultural practices, including organic agriculture and the use of renewable energy, notably solar energy (Dhonde et al., 2022). These case studies show that local communities can contribute to global sustainability goals through bottom-up initiatives.

Although there have been efforts in the Indonesian educational system to introduce sustainability concepts, including environmental literacy and green skills, into the curriculum, Indonesia has not yet implemented a deep learning curriculum that integrates these elements. Existing educational systems place much of their emphasis on traditional educational approaches with little to no cultivation of the principles of the green economy (Dekanić et al., 2025). Extant works have examined the use of green economy education in vocational settings, but not the convergence of deep learning and sustainability objectives (Wardana, 2022).

There is increasing interest in Problem-Based Learning (PBL) models and sustainability at Indonesian schools (Handayani et al., 2020). Implementing deep learning demands a transformative curriculum design and inherently learner-centred teaching. Michael Fullan and Maria Langworthy, in their influential publication "*A Rich Seam: How New Pedagogies Find Deep Learning*", articulate six global competencies that form some of the cornerstones for this approach, and that are sometimes known as the '6 Cs': Character, Citizenship, Collaboration, Communication, Creativity, and Critical Thinking. These six competencies

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focus on the progressive nature of individuals, emphasizing adaptability, creativity, and social responsibility. Furthermore, the strategic use of digital technologies is a major driver of deep interactions and the availability of a wide variety of learning resources.

Furthermore, the use of deep learning in Pusat Kegiatan Belajar Masyarakat (PKBM) programs is vital, as it promotes active engagement with and reflection on real-world problems. One such PKBM program combined deep learning and green economy principles for waste management. Combining deep learning and green economy principles approach enabled learners to immerse themselves in the content, reflect on their actions, and work with others to build effective and lasting solutions (Diavati, 2023; Roussou et al., 2025). This kind of project demonstrates the scope of deep learning and the development of environmental care and problem-solving skills necessary to advance green economy targets at the local level.

The purpose of this research is to develop a deep learning curriculum on the green economy for PKBM in Indonesia in order to enhance environmental literacy and support a sustainable, eco-friendly local economy. By engaging young people in PBE and CL themes through local environmental challenges, the curriculum seeks to foster eco-literacy and community-based approaches aligned with the SDGs.

LITERATURE REVIEW

Deep Learning as a Pedagogical Approach

One path-breaking idea that could support the successful adoption of green economy principles in Indonesia is the use of deep learning in the education system. Deep learning in education aims to develop a deep conceptual understanding that transcends rote learning and promotes critical thinking, problem-solving, and collaboration (M Elbashbishy, 2024; Mthethwa-Kunene et al., 2022). This pedagogical perspective aligns with the aspirations of green economy education, as providing people with technical knowledge not only enables them to address issues but also fosters their ability to address complex environmental and social problems. By incorporating deep learning into green economy education, it is ensured that communities become aware of the significance of sustainable practices and how to apply them in their lives, thereby serving as a cornerstone of change.

Central to this approach are the six global competencies articulated by Fullan and Langworthy in the book "*A Rich Seam: How new pedagogies find deep learning"*, often referred to as the '6 Cs': Character, Citizenship, Collaboration, Communication, Creativity, and Critical Thinking. These competencies shift the focus from passive content absorption to a progressive process where individuals become adaptive, creative, and socially responsible (Bulkis et al., 2025). Within the green economy framework, these competencies are indispensable. Specifically, citizenship cultivates a profound sense of stewardship toward local ecosystems, while creativity and collaboration are fundamental for co-creating innovative solutions to practical challenges, such as waste management and energy conservation (Anthony Jr, 2024; Kiss et al., 2022). Furthermore, the strategic use of digital technologies within this framework promotes deep interactions and access to diverse learning resources, thereby enriching the learning ecosystem.

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Central to this approach are the six global competencies, which transition learners from passive content absorption to becoming adaptive, socially responsible agents. Within the green economy framework, these competencies are operationalized at the micro level when learners apply Critical Thinking to diagnose specific local environmental issues (Hadiapurwa et al., 2026). Creativity and Collaboration are subsequently manifested through co-creational projects, such as converting used oil into aromatherapy candles or building vertical gardens from plastic waste (Santoso et al., 2025). Furthermore, Communication skills are refined as learners actively engage with and persuade their neighbors to adopt sustainable practices, such as composting (De Feo & Ferrara, 2024). At the macro level, the systematic cultivation of these competencies entails a transformative shift in the community's role from passive observers to active catalysts of social and ecological change (Hadjichambis et al., 2024). This development ensures that bottom-up sustainability initiatives are not only technically viable but also culturally rooted, effectively bridging the gap between global environmental policies and tangible local action.

The Role of Pusat Kegiatan Belajar Masyarakat (PKBM)

Community-based educational institutions, such as the Indonesian PKBM, play a critical role in raising the ecological literacy of non-formal learners in the community and equipping them with the knowledge and skills to address local environmental issues. Drawing on the participatory learning model "from, by, for, and in the community", PKBM represents a unique opportunity to incorporate green economy principles and deep learning strategies into the curriculum. The flexibility of PKBM enables the development of culturally appropriate educational programs that address the local needs of local communities (Anwar & Shawmi, 2023; Iskandar et al., 2024). In rural areas with limited access to formal education, PKBM has also effectively disseminated information to residents on sustainable practices, including organic farming, waste management, and water conservation (Teane, 2021; Zikargae et al., 2022). This type of education provides people with practical tools for taking charge of their immediate environment.

Consequently, PKBM serves as an ideal ecosystem for implementing a green economy-based deep learning curriculum due to its inherent adaptability and close-knit community structure (El-Shaer, 2025; Gao, 2022). PKBMs offer the flexibility required to design context-specific projects such as local waste processing or renewable energy initiatives that are central to deep learning. This setting allows learners to engage in meaningful, real-world problem-solving that directly impacts their surroundings, thereby bridging the gap between abstract global sustainability goals and concrete bottom-up initiatives (Bonoff et al., 2024; Demssie et al., 2023). By serving as catalysts for social and ecological transformation, PKBMs empower learners to become active agents of change, translating global environmental policies into tangible local actions.

METHODS

The study is qualitative and employs a case study design to develop a rich understanding of the phenomenon in its real-world context. This design concentrates on the processes

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employed and the meanings ascribed by participants. A case study design was considered appropriate to permit an in-depth investigation of the process of developing a green economy-based deep learning curriculum in a specific context. This approach provides a comprehensive description of how the program interacts with the specific context and local community knowledge. The research site is a PKBM in Bandung Regency, West Java. The site was selected using purposive selection based on two main considerations: the PKBM's track record in implementing environmental or green education-based training programs, which indicates initial awareness and capacity for sustainable issues; and the presence of active community participation in the teaching and learning process, aligning with the principle of "from, by, for, and in the community".

This selection ensures that the research site is information-rich, providing substantial information relevant to the research purpose. To obtain a comprehensive perspective, the research participants included PKBM managers, tutors, and learners. Managers were included to provide perspectives on the vision, mission, policies, and managerial challenges in curriculum development. Tutors and facilitators were involved to understand the implementation of the curriculum and learning strategies, and to examine their experiences facilitating deep learning and the green economy. Finally, learners explored their learning experiences, understanding of the material, changes in awareness, and the application of knowledge in everyday life.

Data Collection and Analysis

The data collection techniques were designed to obtain rich, varied data through participatory observation, in-depth interviews, and document analysis. First, researchers conducted participatory observation by directly observing learning sessions, tutor-learner interactions, and hands-on training relevant to the green economy and deep learning. This observation focused on delineating class dynamics, the level of student participation, and the real-time integration of the curriculum, with students observed across three core learning sessions and two community project activity sessions. Second, semi-structured in-depth interviews were conducted with PKBM managers, tutors, and learners to investigate their perceptions, experiences, challenges, and expectations regarding the curriculum. These interviews provided researchers with subjective perspectives and in-depth insights into the meaning of participants' actions. Third, a documentation study was performed to compile and review available texts, including the current syllabus, learning modules, teachers' manuals, activity reports, photographs, and field notes. This documentary analysis offered context and additional evidence to support the findings derived from observations and interviews.

Data analysis was carried out thematically following the stages adapted from Miles et al. book "*Qualitative data analysis: An expanded sourcebook"*, comprising data reduction, data presentation, and conclusion drawing/verification. The process began with data reduction, which involved choosing, abstracting, and centering on select portions of observations, interviews, and documentation. Subsequently, the reduced data were presented in narrative, matrix, or display form to ensure readability and pattern recognition. Finally, conclusions were drawn from emerging patterns and validated by comparison with existing literature and other data. This analysis was conducted iteratively to identify patterns, themes, and relationships that characterize the dynamics of PKBM curriculum development and

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implementation. The validation of findings was achieved through the triangulation of sources (managers, tutors, and learners) and methods (observation, interviews, and documentation) to enhance the credibility of the findings.

RESULTS AND DISCUSSION

Results

Mapping Local Potential and Issues as the Foundation of Contextual Curriculum

The essential initial step in developing this green economy-based deep learning curriculum is a comprehensive mapping of local potential and identification of specific environmental issues faced by the community around the PKBM. Based on two weeks of intensive participatory observation at PKBM and in-depth interviews with 10 key informants (including three PKBM managers, two community leaders, and five active-learning residents), it was identified that the village has several significant potentials that can be integrated into the curriculum.

The identified local potentials include household waste processing. Although not yet formally organized, several households have undertaken simple initiatives to sort wet and dry waste and to use food scraps for small-scale animal feed, indicating initial awareness and independent practice. Another potential is water resource conservation, where the presence of natural springs and traditional irrigation channels demonstrates local wisdom in managing water resources, and the community also has knowledge of the water cycle and the importance of maintaining river cleanliness. However, the mapping results also revealed pressing environmental challenges. One such challenge is the need to process household waste, specifically cooking oil residue, into a more useful product, especially since most heads of households operate food businesses based on fried cassava (kicimpring). Additionally, environmental pollution is evident, with a clear accumulation of plastic and household waste at several points along the river that crosses the village, degrading water quality and the surrounding ecosystem.

A PKBM manager (P1) stated,

> "*Our community actually has a passion for protecting the environment, but often does not know how or does not have adequate tools to process waste or farm more environmentally friendly. This is where we see the role of PKBM*,"

Identification of these potentials and issues is the main foundation for ensuring that the curriculum developed is not only academically relevant but also contextually aligned with the real needs of students and the community, in line with Bronfenbrenner's development ecology principles at the microsystem and mesosystem levels, which emphasize the importance of the immediate environment in the transformative learning process.

This green-economy-based immersive learning curriculum was designed through a highly participatory approach that fully embraced the principle of co-creation. This process began with a series of "Citizen Learning Curriculum Forums" that involved PKBM managers, two main tutors, and seven learner representatives from diverse backgrounds. In this forum, they collectively formulated learning objectives, identified relevant materials, and selected

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learning methods that best suited the learners' characteristics and capacities. A tutor (T1) emphasized,

> "*We do not dictate, but facilitate the ideas of the learners. This curriculum is truly the result of mutual agreement, so their sense of ownership is very strong,*"

Table 1. Green Economy-Based Deep Learning Curriculum Stages

Num	Stages	Description
1	Stage 1: Community Forum	PKBM Staff, Tutors, and Learners discuss curriculum design and educational goals.
2	Stage 2: Co-creation of Curriculum	Collaboratively define learning objectives, plan curriculum design, and involve stakeholders.
3	Stage 3: Curriculum Design	Define learning objectives, select educational materials, and choose appropriate teaching methods.

Source: Research 2025

According to **Table 1,** this principle of co-creation is crucial for two main reasons. First, it fosters a sense of ownership; learners perceive that the curriculum is the result of their contributions rather than something imposed from above, thereby increasing their motivation and engagement. Second, it ensures relevance by adapting materials and methods to learners' life experiences, local wisdom, and real needs, thereby making the curriculum contextual and directly applicable.

Table 2. Green Economy-Based Deep Learning Curriculum Units

Num	Units	Description
1	Curriculum Unit: Green Economy Principles	Principles of a green economy and sustainable practices.
2	Curriculum Unit: Local Environmental Issues	Focus on local environmental challenges and solutions.
3	Curriculum Unit: Household Waste Processing	Techniques for processing household waste efficiently.
4	Curriculum Unit: Renewable Energy Education	Education on renewable energy sources and their application.

Source: Research 2025

The core materials in the resulting curriculum include four main units (see **Table 2**), designed to be interrelated and tiered. The first, Introduction to Green Economy Principles (Unit 1), provides a basic understanding of the green economy, resource efficiency, renewable energy, and the circular economy, with examples relevant to everyday life, such as reducing water consumption at home to enhance resource efficiency. The second, Identification and Mapping of Local Environmental Problems (Unit 2), trains learners to conduct simple observations and interviews in their environment to identify problems such as waste, water pollution, or unsustainable agricultural practices, serving as the first step toward encouraging critical thinking and problem-solving. The third unit, Making Household Waste Processing (Unit 3), consists of direct practice in processing household waste, specifically used cooking oil, into

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aromatherapy candles. The fourth unit, Household-Scale Renewable Energy Education (Unit 4), introduces the concept of simple solar energy for household lighting.

This participatory curriculum design aligns with prior research emphasizing that community involvement in non-formal curriculum development is essential to enhancing the program's relevance, effectiveness, and sustainability. This participatory curriculum design aligns with prior research, which emphasizes that community involvement in non-formal curriculum development is essential to enhancing the program's relevance, effectiveness, and sustainability (Caldana et al., 2023; Essomba et al., 2022; Simac et al., 2021).

Implementation of Deep Learning Through Project-Based Learning (PjBL) and Reflection

The learning model consistently applied employs PjBL and Experiential Learning. In this approach, tutors act as facilitators and mentors rather than one-way teachers. Learners are divided into small groups (typically four to five people). They are given the freedom to identify specific environmental problems in their surroundings, design innovative solutions, implement these solutions in real-world projects, and present the results to fellow learners or the wider community.

Examples of projects successfully initiated and completed by learners include the creation of vertical gardens from plastic waste, in which a group of residents transformed hundreds of used plastic bottles into vertical garden structures planted with vegetables on PKBM walls and residents' houses, thereby addressing plastic waste while increasing local food security. Another group focused on household waste processing, specifically on converting industrial household waste, such as used cooking oil, into aromatherapy candles. Furthermore, several residents employed environmentally friendly agricultural practices, such as growing vegetables and composting kitchen waste, which they presented in subject activities, demonstrating deep learning in communication and creativity.

Figure 1. Implementation of Deep Learning Through PjBL and Reflection
Source: Research 2025

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In addition to the project in **Figure 1**, learning is also interspersed with structured weekly reflection activities. In these sessions, learners openly discuss their experiences during the project, the challenges faced, and the lessons learned, both from successes and failures. One learner (WB1) shared,

> "*From the compost project, I not only learned how to make it, but also realized that the waste at home can be a blessing if processed. We also learned how to convince neighbors to process their waste,*"

This reflection is essential for facilitating deep understanding, metacognition, and the internalization of sustainability values, thereby transforming the experience into meaningful learning.

The Impact of Transformation on Learners and Communities

The implementation of this curriculum has had significant, multidimensional impacts on students and the wider community. Firstly, it led to an Improvement in Environmental Literacy, as students gained not only knowledge of the environment and the green economy but also the capacity to understand problems in their context critically. They can now diagnose the underlying issue, assess the broken system, and develop sustainable solutions. Secondly, there was an improvement in practical skills, as evidenced by a substantial increase in the ability to turn waste into compost, establish simple irrigation systems, and screen educational videos, as documented in witness accounts and community project reports. Thirdly, the program fostered Increased Self-Confidence and Agency; interviews showed that learners felt more confident in voicing environmental issues and proposing solutions. One resident (WB2) shared,

> "*Before, I would just keep quiet when I saw people littering. Now, I dare to reprimand them nicely and invite them to join the composting project,*"

The most obvious impact was the Initiation of Independent Environmental Activities outside of PKBM study hours. For instance, several residents independently formed a "Village Waste Bank" group, conducted home-scale hydroponic training, and participated in anti-plastic campaigns in local markets. This demonstrates the transfer of knowledge and skills from the PKBM microsystem to the family and community mesosystem, as articulated in Bronfenbrenner's Developmental Ecology Theory.

The positive impact of this curriculum in promoting collective action and community-level transformation closely aligns with Sterling's argument that sustainability education must be transformative and actively develop communities' capacity to act collectively to address challenging issues (Marouli, 2021; Ruiz-Mallén et al., 2022). This indicates that PKBM, with its ecological and socially dynamic perspectives, could catalyze social and ecological transformation between global sustainability policy and local action.

Discussion

The incorporation of deep learning principles into the green economy curriculum represents a disruptive educational approach that may significantly transform how communities in Indonesia address environmental and socioeconomic challenges. One of the key elements of

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this model curriculum that makes it so innovative is its focus on participatory, PjBL. Engaging students in the search for local environmental problems, in the development of solutions, and in the implementation of those solutions promotes learning and a sense of responsibility for one's own learning and for one's community. This is particularly imperative in Indonesia, where many areas continue to face urgent environmental challenges, including waste management, deforestation, and water pollution (Sungkawati, 2024). By designing a curriculum grounded in the green economy and deep learning, the PKBM program redefines education from a passive form of receptivity to an active, participatory, and localized process situated firmly in culture and place.

Additionally, deep learning in this curriculum is essential for fostering soft skills, including critical thinking, creativity, and collaboration. These skills are in perfect harmony with the requirements of a green economy, for which creative responses to environmental challenges are essential to achieving sustainability. By using deep learning approaches to the curriculum, students will not only learn about sustainable practices but also be taught to think critically about them and their consequences for the world, and, in doing so, develop solutions to sustainability challenges. The transition from theoretical education to practical application enables students to address environmental issues using contemporary technologies and methods.

The successful implementation of the curriculum in PKBM indicates that educational programs should be tailored to the demands of the local community. The community-based approach means that the curriculum is not only academically pertinent but also culturally relevant and directly related to the community's environmental issues (Mpuangnan & Ntombela, 2024; Smith et al., 2022). Localisation of household waste management and water harvesting facilitates the connection between abstract environmental concerns and the immediate environment. The participatory design of curriculum fosters a sense of ownership among learners and enhances motivation to deepen their understanding of the subject and to participate in solving environmental issues. This ownership not only enriches the learning experience but also provides learners with the impetus to put their newly acquired knowledge into practice, thereby generating lasting change through community-level interventions.

An important finding from this research is that local learning centers, such as PKBM, are essential to leading curricular innovations. These facilities, which can align with local contexts and interests, are well-suited to developing green economy curricula that emphasize sustainability, community involvement, and empowerment. PKBM's success in integrating deep learning with green economy principles underscores the potential of NFE models to promote local solutions to global problems. However, the effectiveness of the online app also relies on community leaders and educators, as well as Learners' engagement. The participatory process for jointly developing the curriculum ensures that participants do not feel they are being instructed from above. Rather, they are in control and therefore more responsible for taking collective action.

CONCLUSION

The development of a green economy-based deep learning curriculum within PKBM offers a promising approach to addressing Indonesia's environmental challenges through education.

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By combining deep learning principles with the green economy, the curriculum equips learners with both the knowledge and practical skills needed to address local environmental issues. The program's success lies in its participatory approach, which ensures that the curriculum is contextually relevant and engages the community in meaningful ways. This model of education fosters not only environmental literacy but also critical thinking, problem-solving, and collaborative skills that are essential for creating sustainable, community-driven solutions.

The findings of this study underscore the potential of deep learning to advance education on the green economy. As Indonesia continues to face significant environmental and social challenges, integrating deep learning with green economy principles into the educational framework could play a pivotal role in preparing future generations to engage with and solve these problems. This innovative approach has the potential to serve as a model for other regions in Indonesia and beyond, illustrating the power of combining modern educational technologies with grassroots sustainability initiatives to drive lasting change.

AUTHOR'S NOTE

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