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Advancing green skills in Indonesian Higher Education: roles, barriers, and transformative strategies

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ABSTRACT

This article aims to provide a critical analysis of green skills development in higher education institutions (HEIs) in Indonesia. This critical analysis is conducted because HEIs are still experiencing obstacles in developing students' green skills. It is important to recognize that developing students' green skills is an indispensable prerequisite for obtaining new qualifications that are crucial in this era. The purpose of this article is to comprehensively examine the roles, challenges, and strategies of HEIs in Indonesia in developing students' green skills. This study uses a qualitative research methodology, focusing on exploring the perspectives of seven informants through in-depth interviews. The informants were selected through non-probability sampling, a method carefully applied to ensure the collection of high-quality information relevant to the research objectives. The study's findings indicate that HEIs play a crucial role in developing students' green skills through curriculum transformation, contextual learning, and collaboration with the workplace. Furthermore, these findings also contribute to the growing literature on green skills in higher education and offer practical recommendations for strengthening sustainability-oriented policies and practices in Indonesian universities. However, challenges such as limited educator capacity, lack of technical guidance, and lack of collaboration with the workplace persist.

INTRODUCTION

An environmentally sound economic transformation requires green skills. Significant technological, regulatory, and industrial changes have driven a paradigm shift in development towards a more sustainable model (Shamzzuzoha et al. 2022; World Bank 2023). Global agreements such as the Paris Agreement, alongside countries' commitments to net-zero emissions targets, have firmly established sustainability as a key pillar of 21st-century development. This has a direct impact on the global labour market, which is increasingly demanding a workforce with green competencies and skills relevant to the green economy.

At the same time, demand for green jobs continues to increase significantly. According to the International Labour Report, the transition to a green economy could generate over 103 million

new jobs worldwide by 2030, primarily within the renewable energy, sustainable construction, green agriculture, and waste management industries (ILO 2023a; ILO 2023b). In the clean energy sector alone, investments could generate around 14 million new clean jobs (IEA 2019). Indeed, the economic potential of green investments is estimated to be seven to ten times higher than that of conventional investments (Chau 2022; IARCF 2022; World Economic Forum 2023; World Economic Forum 2024). In Southeast Asia, the ASEAN Centre for Energy predicts that the renewable energy sector will generate over 6 million new jobs within the next two decades (ASEAN 2023).

In the face of these dynamics, higher education institutions (HEIs) play a vital role in supporting the achievement of sustainable development (SDGs) (Chankseliani & McCowan 2021; Mokski et al.

2023; Bui, Bui & Pham 2024). Since 1970, HEIs have recognised sustainability as part of their responsibility (Žaleniene & Pereira 2021). Today, 113 HEIs from 39 countries spanning six continents have joined the International Sustainable Campus Network (ISCN) to drive real change in sustainable education, research, and HEIs' operations (ICSN 2025). This demonstrates that HEIs are responsible not only for sustainability practices but also for equipping students with green knowledge, skills, and competencies (Paeradigms 2024). In this way, individuals can contribute to developing a green economy and practise sustainable actions in other areas of their lives (ILO 2022).

In Indonesia, developing green skills among students is becoming increasingly crucial amid a high open unemployment rate. According to data from the Central Statistics Agency, the open unemployment rate in Indonesia is 4.76% (BPS 2024). This is due to uneven employment (ESCAP 2017) and a mismatch between student competencies and industry needs (Rahayu & Hosizah 2021). This situation certainly requires large-scale reskilling and upskilling. Furthermore, it is estimated that the number of green jobs in Indonesia will increase from 0.63 million today to over 1 million by 2050 (Bappenas 2019; Bappenas 2023). However, without an HEI system that is ready to respond, the skills gap will be a major obstacle to seizing these opportunities.

Strengthening green skills in HEIs is not only a response to labour market needs; it also serves as a driver of broader social and environmental change. As agents of change, students must be prepared to become not only productive workers but also global citizens who can make ethical decisions, think systemically and act sustainably in their professional and personal lives (ILO 2023a; ILO 2023b). Therefore, developing green skills in HEIs is a necessity in the era of climate crisis and global economic transformation, not just a strategic choice.

Although the discourse on sustainability has become a global agenda, with many HEIs around the world showing a real commitment to implementing the principles of the SDGs, the implementation of these principles remains very uneven geographically. Most initiatives and practices aimed at developing green skills and sustainability competencies remain centred in developed regions such as Europe, North America,

and parts of East Asia (Bizerril et al., 2018; Filho et al., 2018). This reflects an imbalance in the capacity of HEIs to address sustainability challenges equally around the world. Furthermore, achieving the SDGs requires collective action.

In Indonesia, a developing country facing significant ecological challenges and with considerable potential for a green economy, the development of green skills within the HEIs system continues to be hindered by systemic and institutional barriers. Currently, there is no national policy framework that comprehensively integrates green skills into HEIs' curricula (ILO 2018). Consequently, there is no roadmap to guide the structured and SDGs of green skills across all levels and fields of HEIs.

Furthermore, HEIs in Indonesia still tend to be disciplinary, rather than interdisciplinary, in its approach to addressing complex and systemic sustainability issues. Research and community service activities related to environmental issues remain limited to specific institutions and have yet to become a key part of the national academic agenda. The synergy between education, research, and collaboration with industry is crucial in developing a comprehensive and relevant ecosystem for green competencies.

Limited human resources, weak partnerships with businesses, and a lack of institutional awareness of the urgency of the sustainability transition exacerbate this situation. Conversely, the limited preparedness of curricula and educators to adopt Education for Sustainable Development (ESD) principles means that HEIs in Indonesia is not optimally equipped to respond to the needs of a future green economy workforce (Paeradigms, 2024; UNESCO, 2022).

These issues create a gap between the global commitment to sustainability and local HEIs' practices in Indonesia. Without an active and strategic role from HEIs, Indonesia's efforts to transition to a green economy will be hindered by a lack of skills and an unprepared workforce. Therefore, an in-depth empirical study is required to systematically understand the role, challenges, and strategies of HEIs in developing green skills. This will enable the design of more adaptive, contextual, and transformative strategies in response to future challenges.

METHODS

This research is systematically structured into four main subsections: Research Design, Informant Selection, Data Collection, and Data Analysis. This methodological structure aims to provide a clear overview of the research process and ensure transparency in field data collection, resulting in valid and scientifically accountable findings.

Research Design

This is a qualitative study that focuses on exploring the opportunities, challenges, and strategies for developing green skills in Indonesian HEIs. Using the perspectives of academics and practitioners, this research provides the main point of departure in exploring their experiences through in-depth interview techniques. With this approach, it is hoped that the research will be able to build a rich contextual understanding of the empirical reality of green skills development, as well as make important contributions to the development of HEIs' policies and practices that are more adaptive to SDGs.

Informant Selection

The in-depth interviews involved seven informants from a range of backgrounds: experts, companies, and NGO. Non-probability sampling

was used to select informants who fulfil certain criteria, thereby ensuring the quality and relevance of the information collected (Wutich & Bernard 2024). The selection criteria were that the informants had knowledge and experience of HEIs' praxis and understood the needs and skills required for green jobs. Based on these criteria, seven informants were involved in this study. This aligns with Dukes' (1984) recommendation that qualitative research should involve 3–10 participants. Table 1 describes the research informants.

Data Collection

This study collected data through semi-structured, in-depth, individualised interviews. The researcher designed three main questions. The first question related to opportunities for HEIs in developing learners' green skills. The second related to the challenges faced by HEIs in developing learners' green skills. The third question was about the strategies that HEIs could adopt to develop learners' green skills. These three questions were posed to the informants before the interviews. This was done not only to limit the topic of conversation, but also to help the informants share their knowledge.

Table 1. Informant background

Interviewee code	Activities	Experience	Institution	City	Interview Process
Interviewee AA	Lecture	15 years	State University	Yogyakarta	Offline interview
Interviewee AB	Lecture	18 years	Private University	Surabaya	Offline interview
Interviewee AC	Lecture	23 years	Private University	Bali	Offline interview
Interviewee AD	CEO	7 years	Small Business Unit	Solo	Video conference
Interviewee AE	HRD	8 years	Local company	Semarang	Video conference
Interviewee AF	HRD	11 years	International Company	Jakarta	Video conference
Interviewee AG	Analyst	16 years	NGO	Jakarta	Video conference

The interview process for this study was conducted in two ways: directly and via Zoom meetings. The online interviews were conducted due to the informants' limited availability in terms of both time and distance. Each interview lasted 45–60 minutes and was recorded with the participants' consent. To ensure the quality of the information provided, the researcher informed the participants before the interview began that all answers given were solely for research purposes and that there were no right or wrong answers. This aligns with the opinion of Smith, Flower, and Larkin (2009)

that informants are the authority on their own experiences.

Data Analysis

In this study, data analysis refers to the Miles and Huberman model. This includes reducing the data through condensation, data display, and drawing and verifying conclusions (Miles, Huberman, Saldana, 2014). Data condensation was achieved by reading the transcripts and summarising the findings in accordance with the research objectives. The power display process involved presenting quotes based on certain themes. Finally, conclusions were drawn and verified by

providing a brief analysis based on the research questions and findings.

Research Ethics

The following essay will provide a comprehensive overview of the key principles and considerations relevant to research ethics. The research ethics were carried out by sending a request letter to each resource person to provide information related to the research topic. Informed consent is a prerequisite for ensuring that the research process is conducted responsibly, ethically, and correctly. Furthermore, research ethics are implemented to ensure the anonymity of sources, thereby facilitating the comprehensive conveyance of existing findings and ensuring a meaningful contribution to the problem under study.

RESULTS AND DISCUSSION

This section presents the key findings of the research into the role of HEIs in developing students' green skills. Based on the interviews, it was identified that HEIs play a key role in developing the green competencies of the younger generation. The findings are divided into three categories: the contribution of HEIs to building green skills; the challenges faced by educational institutions in this process; and the strategic opportunities that can be maximised to strengthen sustainability-oriented learning.

HEIs and Students' Green Skills

It is evident that HEIs play a pivotal role in the development of students' skillsets. It was asserted by all interviewees that HEIs have the capacity to function as a key driver in accelerating green understanding, knowledge, and skills in students. Interviewee AA, for instance, alluded to the fact that the process has been undertaken by means of a curriculum reorientation that is more open to sustainability issues. "We initiated the incorporation of sustainability themes into various courses, including those which are not directly related to environmental issues".

Furthermore, Interviewee AB added that the process has become more evident with the provision of projects or learning materials that are relevant to social and environmental issues. Within the scope of this initiative, students partake in a variety of environmental projects, encompassing domains such as eco-friendly packaging design, eco-friendly building design, sustainable agricultural system

development, and community training. This process serves to refine students' competencies in environmental sustainability.

The above statements by academics are corroborated by interviewees AE and AF, who consider that HEIs have begun to adapt their learning outcomes to meet the evolving needs of the green job market, including industrial waste management, energy efficiency, the circular economy and product design. They also value the curriculum's focus on developing green competencies. "We see that graduates are now more environmentally aware, and we have to admit that this is thanks to the revised curriculum" (Interviewee AE). "Students have started to understand that certain jobs require outputs that support sustainability more effectively" (Interviewee AF).

Furthermore, the AG added that this process is strengthened by collaboration and research in HEIs. As a sustainability expert, he believes that this research and collaboration has impacted the dynamics, orientation, and direction of HEIs, which is now more concerned with developing students' green skills. 'The dynamics of HEIs have brought about changes in the demand for quality and green skills among students. He believes that current work practices in HEIs have been adapted to meet the needs of a more environmentally friendly industry.

These findings indicate that HEIs are gradually transforming their educational practices to align with the growing demand for green competencies in the labour market. This finding supports Holden, Linnerud, and Banister (2017), who argue that integrating sustainability into curricula contributes to the development of environmental knowledge, attitudes, and skills. The findings also reinforce the argument that HEIs play a strategic role in advancing the SDGs through education, research, and community engagement (Abo-Khalil, 2024). The increasing integration of sustainability themes reflects a broader global trend in higher education, where institutions are repositioning themselves as agents of sustainable development rather than merely providers of academic qualifications.

Furthermore, the involvement of students in real-world sustainability projects demonstrates that green skills are developed not only through theoretical instruction but also through experiential learning. Consistent with Sern (2020), these

projects cultivate technical and transversal green skills, including design thinking, communication, leadership, and problem-solving. Such experiences encourage students to critically evaluate environmental challenges and develop contextual solutions, thereby strengthening their readiness for emerging green jobs.

Barriers Faced by HEIs

In practice, however, HEIs encounter various obstacles in their attempts to implement effective sustainability principles with a view to improving students' green skills. A review of the extant literature reveals a paucity of research focusing on the integration of diverse learning outcomes within an environmental perspective. Despite the fact that the curriculum has granted HEIs greater flexibility to develop contextualised learning programmes, the majority of educators are not yet accustomed to integrating teaching materials with sustainability issues. "We still find that educators lack the experience and insight to link subject matter with environmental issues" (Interviewee AA). "Some educators are still unable to translate learning objectives to develop students' green skills" (Interviewee AB).

In addition to the lack of understanding, interviewee AC mentioned that the absence of technical guidelines or learning modules to direct teachers in integrating ESD into subjects was also a barrier. 'So far, we have been tending to work alone, and there has been no forum to facilitate the exchange of good practices between teachers. Consequently, most integration efforts remain incidental and unstructured. According to interviewee AG, this situation means that students are less able to align their ideas with today's needs and demands. "For example, solar panel technology, electric motor technology, and organic waste management technology are constantly evolving. However, the materials taught are sometimes stagnant and do not keep up with the latest developments. Consequently, graduates enter the industry with outdated knowledge and skills" (Interviewee AG).

Meanwhile, interviewee AF attributed this to educators' lack of practical experience or involvement with environmental issues and green industries. He pointed out that educators only teach the theory of the circular economy, waste management, and renewable energy, and have never

been directly involved in real projects or case studies in the field. Consequently, the knowledge they impart to students tends to be distant from the actual challenges they will face in the workplace and wider society.

These findings suggest that curriculum reform alone is insufficient to ensure successful green skills development. The effectiveness of sustainability education largely depends on educators' competencies and their ability to contextualise learning materials. This finding is consistent with previous studies (Pavlova, 2017; Tilbury et al., 2003), which emphasise that educators are central actors in translating sustainability principles into meaningful educational experiences. Without adequate pedagogical support, sustainability integration risks becoming fragmented and inconsistent across institutions.

Another challenge identified by participants relates to the gap between educational content and rapidly evolving green technologies. Interviewee AG observed that topics such as solar energy systems, electric vehicles, and circular economy practices are evolving faster than curriculum updates. As a result, students may graduate with knowledge that no longer reflects current industry needs. This finding highlights a persistent mismatch between higher education and labour market expectations. Similar concerns have been raised by Filho et al. (2018), who argue that sustainability-oriented education must remain dynamic and responsive to technological innovation. Continuous curriculum renewal and professional development opportunities for educators are therefore essential to ensure the relevance of green skills education.

Opportunities for HEIs

SDGs is pivotal in ensuring the well-being of current generations without compromising the future. The interviews with the interviewees demonstrated a consensus that the development of green skills strategies must be comprehensive and cross-sectoral, rather than partial. Therefore, interviewee AB posited that the learning process must be meticulously designed to facilitate students' recognition of the ecological and social realities that surround them, thereby enabling them to develop relevant and sustainable solutions.

Interviewees AA and AC proposed the enhancement of the transdisciplinary approach to learning. It is their contention that collaboration

between courses and study programmes can engender cross-field innovations that serve to further strengthen students' skills. According to AG, "a key proponent of this initiative, the efficacy of the collaboration is enhanced by the incorporation of practitioners into the educational process". This integration enables students to develop the practical skills necessary to successfully transition into the contemporary world of work.

These findings reflect the growing recognition that sustainability challenges cannot be addressed through single-discipline perspectives. Consistent with Michel et al. (2020) and Singer-Brodowski (2023), transdisciplinary education promotes systems thinking, collaboration, and problem-solving competencies that are essential for sustainability transitions. By exposing students to multiple perspectives and real-world challenges, HEIs can better prepare graduates for the complexity of green jobs.

Participants also highlighted the importance of stronger partnerships between HEIs and industry. Such collaboration enables students to gain practical experience and better understand workplace expectations. The findings support the Triple Helix framework proposed by Etzkowitz and Zhou (2018), which emphasises collaboration among universities, industry, and government as a driver of innovation and sustainable development.

Meanwhile, guest speaker AD believes that HEIs have the resources to act as incubators for green entrepreneurs. He noted that students often have creative ideas, but are not systematically supported in realising their innovations. "There are many good ideas from students". However, without support from the HEIs, such as green business training or access to seed funding, these ideas will never leave the drawing board. He therefore suggested that HEIs should provide space, training, and opportunities for students to develop green skills. This finding suggests that green entrepreneurship initiatives can complement traditional educational approaches by providing students with opportunities to apply sustainability principles in business and social innovation contexts. Previous studies have similarly found that university-based entrepreneurship ecosystems can stimulate green innovation and create new employment opportunities within emerging sustainable sectors (Cedefop & OECD, 2015).

On the other hand, we emphasize the growing awareness of the importance of incorporating the SDGs into the educational outcomes process at HEIs. Interviewees AA and AB stated that HEIs has greatly benefited from the incorporation of sustainability themes into various academic activities. According to Olzhebayeva & Kozhirova (2025), integrating sustainability principles into academic activities improves learning quality and influences students' daily behaviour. Therefore, it is not surprising that the 2019 Association for the Advancement of Sustainability in Higher Education (AASHE) report mentioned that around 1000 institutions in 40 countries had committed to advancing the SDGs through outreach, education, and research (Brennen 2022).

Furthermore, environmentally friendly packaging design projects, sustainable agricultural developments and student involvement in local communities are tangible manifestations that can develop students' green skills. This aligns with Sern's (2020) findings that several general green skills are important for various green industries, including design, communication, waste management, energy, urban planning, management, leadership, finance and procurement. Hands-on engagement develops technical competence and hones social sensitivity, enhancing critical thinking when designing contextualised sustainability solutions (Cheng 2019). Therefore, as Filho et al (2018) pointed out, HEIs should operate as centres of knowledge and reflection that foster critical thinking, rather than merely as teaching institutions that transfer knowledge. Moreover, as a microcosm of society, HEIs need to support the acceleration and success of the SDGs (Barth & Burandt 2013; Larsson & Holmberg 2018; Purcell, Henriksen & Spengler 2019).

In the contemporary academic landscape, numerous HEIs are dismantling traditional academic silos and establishing multidisciplinary research centres and programmes with the aim of fostering collaboration and creativity (Collins et al. 2018). Research findings suggest that this is because green skills development is no longer positioned as a complementary agenda, but as part of the institution's strategic orientation. This finding is consistent with the findings of an ESCO analysis, which indicated that 46.28% of the 3008 jobs analysed involve green skills, which are deemed to

be critical for SDGs (Lagorio et al. 2024). This situation necessitates the implementation of targeted training and development programmes by HEIs, meticulously designed to address the identified fields and skills.

The potential for enhancing green education in HEIs is considerable, provided that collaborative, interdisciplinary and reality-based strategies are employed. The opinions of interviewees AB, AA, and AC emphasise that a transdisciplinary approach can facilitate the development of cross-cutting skills that are indispensable in responding to the complexity of global environmental challenges. This perspective is further substantiated by the findings of Michel et al. (2020) and Singer-Brodowski (2023), who emphasise the pivotal role of transformative and transdisciplinary educational approaches in nurturing sustainability thinking.

The importance of close collaboration between HEIs, industry, and professional practitioners was emphasised by AG interviewees. This close collaboration is not only a supporting strategy but a prerequisite to ensure the development of students' green skills. This collaborative approach serves to reinforce the concept of the 'triple helix' (university, industry, and government), which is considered increasingly crucial in driving sustainability innovation (Etzkowitz & Zhou 2018).

This research makes an important contribution to the understanding of the role of HEIs in developing students' green skills through a qualitative approach based on the experiences of practitioners, academics, and industry players in Indonesia. This research demonstrates that HEIs has the capacity to cultivate students' green skills to a significant extent. To ensure this, HEIs must implement effective strategies to strengthen green skills through curriculum development, the enhancement of educators' capacities, cross-sector collaboration, and the strengthening of the green entrepreneurship ecosystem on HEIs.

Nevertheless, the present study is not without its limitations, the most significant of which is the absence of student involvement in the research process. Further studies are recommended to incorporate a quantitative approach and to involve a greater number of educational institutions from a variety of regions in order to obtain a more extensive and representative mapping. In addition, it is recommended that students be involved to

confirm green education practices in HEIs in Indonesia.

CONCLUSION

This research confirms that HEIs play a strategic role in building students' green skills through curriculum transformation, project-based contextual learning, and active partnerships with industry. The integration of sustainability issues into various courses and practical activities has been demonstrated to be an effective strategy in promoting graduates' readiness to face the demands of a green economy. Nevertheless, the primary challenges persist in relation to the limited capacity of educators, the absence of technical guidance, and the inadequate cooperation and collaboration with the world of work. Consequently, endeavours to integrate sustainability learning frequently prove to be partial and inconsistent. The findings suggest that strategies to strengthen green skills should be designed holistically, taking a transdisciplinary approach, and that collaboration with relevant stakeholders should be increased in order to strengthen the green entrepreneurship ecosystem and encourage the growth of social-ecological innovation.

CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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