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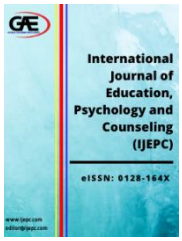

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CHARACTERISING INSTITUTIONAL PRACTICES FOR GREEN SKILLS INTEGRATION IN MALAYSIAN TVET HIGHER EDUCATION

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Abstract:

The global shift towards sustainability underscores the imperative for educational systems to integrate green skills, encompassing environmental literacy, ethical decision-making, systems thinking, green innovation, and sustainable leadership. Technical and vocational education and training (TVET) institutions in Malaysia are the central platforms that foster these competencies. This qualitative exploratory study aims to characterise institutional practices integrating green skills at two prominent Malaysian TVET higher education institutions: Kolej Komuniti Kuala Langat (KKKL) and Politeknik Nilai. Using a systematic document analysis of 25 institutional artefacts from 2021 to 2024, guided by the Code of Practice for TVET Programme Accreditation (COPTPA), UNESCO's Education for Sustainable Development (ESD) competencies, and the International Labour Organization's (ILO) Green Skills Framework, this study identifies five core green skill domains: environmental literacy, sustainability-oriented cognitive skills, practical green work skills, green entrepreneurship, and ethical professionalism. Institutional practices differ significantly, with KKKL emphasising digital and technical integration, including smart energy systems and automation, whereas Politeknik Nilai prioritises community-based environmental literacy and experiential co-curricular engagement. This research provides actionable insights into developing a coherent and scalable national framework for systematically embedding green skills in Malaysia's TVET higher education landscape.

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Keywords:

Green Skills, Green TVET, Sustainability Education, MQF 2.0, Malaysia, Institutional Practices, Environmental Literacy, ESD

Introduction

The worsening global environmental crisis, which includes climate change, loss of biodiversity, pollution, and lack of resources, has made sustainability a top priority for schools worldwide. People are starting to realise the importance of education in solving these problems, especially when looking at them through the lens of the Sustainable Development Goals (SDGs). Education is no longer just a way to get a job; it is now the key to changing the way people think, act, and build systems that support sustainability. In this situation, "green skills" have become necessary for people who want to work in a green economy (ILO, 2019). Green skills include a wide range of cognitive, technical, and behavioural skills, such as awareness of the environment, thinking about systems, making ethical decisions, developing innovative green solutions, and being a leader who cares about the environment (UNESCO 2020).

These skills help people to make a real difference in protecting the environment and working well in new green industries. Technical and Vocational Education and Training (TVET) institutions that focus on both technical skills and preparing students for the job market are in a unique position to help people acquire green skills. Malaysia is a rapidly industrialised country with plans for sustainability. It has adopted a green agenda through several strategic frameworks. The National Energy Transition Roadmap (NETR), National Industrial Master Plan 2030 (NIMP 2030), and Higher Education Transformation Roadmap (HETR) emphasise the importance of sustainability and green human capital. In this context, TVET institutions are crucial for developing a workforce that is technically skilled, environmentally responsible, and morally upright.

Research Gap and Rationale

Although policies and international agreements stress the need for green skills, Malaysian TVET institutions still struggle to implement them. Previous studies have predominantly concentrated on theoretical frameworks, curriculum development objectives, or overarching policy coherence (Zulkifli et al., 2023; Kamarudin et al., 2023). Nonetheless, there is a paucity of understanding regarding institutional practices, co-curricular strategies, and integrated mechanisms that significantly impact the delivery and experiential acquisition of green skills in practical contexts. The absence of empirical evidence hinders efforts to replicate or augment successful practices within the TVET ecosystem.

This study aims to address this gap by conducting a comparative analysis of two Malaysian TVET higher education institutions that exhibit significant sustainability engagement, (KKKL) and Politeknik Nilai. This study systematically examines institutional artefacts to clarify how green skills are contextualised, implemented, and reinforced within actual institutional environments.

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Problem Statement

Conceptualising Green Skills

To help the economy and society move towards a more sustainable future, people must learn green skills. The ILO (2019) puts them into two main groups: there are two kinds of green skills: (a) general green skills, such as environmental literacy and systems thinking, and (b) job-specific skills needed in green fields, such as renewable energy, sustainable agriculture, and building homes that use less energy. UNESCO's ESD competency framework from UNESCO (2020) builds on this idea by including learning to know (cognitive skills), learning to do (practical application), and learning to be (values and attitudes). These frameworks all agree that green skills encompass more than just technical knowledge. They also include general skills, such as critical thinking, ethical decisions, adaptability, and the ability to collaborate with others to solve problems. In education, this means adopting a holistic approach that considers not only what is taught, but also how it is taught, the institution's culture, and how the institution interacts with the community.

Green Skills in TVET Systems

People worldwide have praised TVET institutions for their ability to prepare people for green jobs. The European Centre for the Development of Vocational Training (CEDEFOP, 2020) states that TVET can help the green transition by making all of its programs more sustainable, using learner-centred teaching methods, and working with businesses to give students real-world experience. Germany, South Korea, and Finland have successfully integrated green skills into their education systems using modular curricula, simulation laboratories, and project-based learning. The focus of TVET reforms in Malaysia has been on ensuring that the programs are useful for finding work, that they give students skill-based credentials, and that they use technology. Sustainability is now part of COPTPA (2019), which cuts across all areas. However, this method is still not consistently used. Some institutions have begun utilising green modules or collaborating with clean technology firms; however, a standardised, national-level green skills framework for Technical and Vocational Education and Training (TVET) remains absent.

Ways That Institutions Can Strengthen Students' Learn Green Skills

Research indicates that effective green skill development requires multilevel integration.

i. Integration into the curriculum: Adding green topics to core and elective subjects with learning goals that are in line with sustainability.
ii. Outside institutions, CSR campaigns, student-led projects, green competitions, and sustainability clubs give students a chance to use what they have learned in real life.
iii. Governance and Leadership: The institution's commitment to sustainability goals, which is often demonstrated through participation in green metrics or internal policies.
iv. Partnerships: Working with NGOs, businesses, and government agencies makes it easier to learn by doing so and come up with new ideas.

This study employs these categories as interpretive frameworks to examine institutional practices at the KKKL and Politeknik Nilai.

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Methodology

Research Design

This study employed a qualitative exploratory case study design, appropriate for exploring contemporary phenomena within real-life contexts where the boundaries between context and subject are not evident (Yin, 2018). This design enabled an in-depth understanding of how the two selected Malaysian TVET higher education institutions, KKKL and Politeknik Nilai, integrate green skills into their institutional structures, curriculum, and co-curricular practices.

Case Selection Criteria

KKKL and Politeknik Nilai were selected based on the following criteria. Active participation in the UI Green Metric World University Rankings reflects a commitment to environmental and sustainability principles. Availability of documented sustainability-related institutional artefacts between 2021 and 2024. Representational diversity in terms of geographic location, program offerings, and institutional orientation (technical vs. community-focused). This selection ensured a contrastive yet complementary case comparison to reveal the range and variation in green skill integration practices within the Malaysian TVET ecosystem.

Data Collection

The primary data consisted of 25 institutional artefacts collected from both the KKKL and Politeknik Nilai from 2021 to 2024. These documents include the following.

i. Course syllabi and program structures
ii. Green activity reports and sustainability events documentation
iii. Institutional self-reports for Green Metric submissions
iv. Student project summaries and co-curricular participation logs
v. Press releases and website-based sustainability updates

Secondary data sources included the following:

i. National policy frameworks such as NETR, NIMP 2030, HETR
ii. International competency standards (UNESCO ESD, ILO Green Skills) Greening Curriculum Guidance: Teaching and Learning for Climate Action UNESCO, 2024
iii. Institutional quality assurance and curriculum audit reports

Data Analysis

A systematic document analysis approach was adopted, structured around coding protocols derived from the following three key frameworks.

i. Code of Practice for TVET Programme Accreditation (COPTPA), especially domains related to ethical leadership, cognitive development, and practical skills.
ii. UNESCO Education for Sustainable Development (ESD) Competency Framework: Focusing on critical thinking, problem solving, and sustainability ethics.
iii. ILO Green Skills Framework: Including both generic and occupation-specific green competencies.

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NVivo 14 software was used to code the textual and tabular data. A total of 146 nodes were initially generated and thematically grouped into five overarching green skill domains:

1. Environmental Literacy
2. Cognitive Sustainability Skills
3. Practical Green Work Skills
4. Green Entrepreneurship
5. Ethical Professionalism

Several qualitative validation strategies were adopted to ensure trustworthiness.

i. Triangulation across data sources and frameworks
ii. Expert peer reviews by sustainability education scholars
iii. Audit trail documentation for analytic transparency
iv. Member checking with institutional stakeholders for selected interpretations

This robust methodology facilitates a grounded and credible understanding of institutional practices.

Results

Overview of Activities by Institution

The findings reveal that both institutions actively promote green skills but do so through distinct approaches. Tables 1 and 2 map the selected activities to green skill elements using categories adapted from UNESCO and ILO frameworks.

Table 1: Selected Green Skill Activities – Kolej Komuniti Kuala Langat (KKKL)

Activity	Green Skill Domain
Smart Eco PV Boat Project	Energy Efficiency, Teamwork
Solar Panel Installation & Knowledge Transfer	Green Tech Applications
Urban Farming & Composting	Sustainable Resource Management, SDGs
Innovation Challenge: Eco Products	Green Innovation, Lifecycle Assessment
Technopreneur Talk Series	Green Entrepreneurship, Communication Skills
KNX Smart Building Automation Course	Digital Green Tech, Industry Adaptability

Table 2: Selected Green Skill Activities – Politeknik Nilai

Activity	Green Skill Domain
CSR Go Green & Innovation from Waste	Circular Economy, Sustainable Agriculture
Program Back to Nature	Stakeholder Engagement, Teamwork
Biotechnology in Green Tech Webinar	Environmental Literacy, Climate Adaptation
3R Campaign (Reduce, Reuse, Recycle)	Waste Management, Community Engagement
Green Adventure & Eco Design Competition	Leadership, Creativity, Ethical Conduct
Green Classroom Activities	Systems Thinking, Communication

Green Skills and Sustainability Practices at Kolej Komuniti Kuala Langat: Case Studies

Kolej Komuniti Kuala Langat (KKKL) has embedded sustainability and green skills development into its educational and community programmes. Through collaborative projects

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with academia, industry, and the community, the KKKL demonstrates how Technical and Vocational Education and Training (TVET) institutions contribute to Malaysia's green transition. The following six case studies document the key initiatives.

Case 1: Smart Eco-PV Boat Project

On 28 April–30, 2024, KKKL collaborated with Universiti Teknologi Malaysia (UTM), Bank Islam Malaysia Berhad, and Lembaga Kemajuan Ikan Malaysia (LKIM) in Mersing, Johor. The project upgraded 21 traditional fishing boats into Smart Eco-PV Boats powered by solar photovoltaic (PV) systems. Involving 180 participants from 13 institutions (including KKKL's Director, five lecturers, and eight students from the Electrical Technology programme), the project reduced fuel dependency for fishermen while providing students with practical skills in PV system design and installation (Kolej Komuniti Kuala Langat [KKKL], 2024a).

Case 2: Solar Panel Installation and Knowledge Transfer

On 6–7 September 2024, KKKL hosted a knowledge transfer program on solar PV installation at its Gazebo and Urban Farming site. The initiative brought together 33 lecturers and students, guided by the SEDA-accredited academic expert Kolej Komuniti Beaufort and industry advisor Litar Abadi Engineering. The programme combined theory and hands-on PV installation, strengthened practical competencies, and bridged academic–industry collaboration (KKKL, 2024b).

Case 3: Urban Farming and Composting

On 7 September 2024, KKKL launched its Urban Farming and Composting Programme in conjunction with Maybank Islamic Global CR Day. The event included tree planting, food bank support for 20 students, and the installation of solar panels. The initiative involved Maybank Islamic's CSR team, KKKL staff, students, and community members, reinforcing the integration of social and environmental sustainability (KKKL 2024c).

Case 4: Innovation Challenge – Eco Products

The KKKL's annual Innovation Competition (INNOCOMP) has become a platform for sustainable product development. In May 2023, student teams designed eco-friendly innovations, including a solar-charged hydroponic system, recycled material products, and green teaching tools. In September 2024, 54 products were showcased and assessed by six judges from academia and industry. The competition enhanced creativity, entrepreneurial green skills, and alignment with the Sustainable Development Goals (SDGs), particularly SDG 4 (Quality Education) and SDG 9 (Industry, Innovation, and Infrastructure) (KKKL, 2023; 2024d).

Case 5: Technopreneur Talk Series

On 10 May 2023, KKKL co-organised the Technopreneur Talk Series with the Universiti Pendidikan Sultan Idris (UPSI) and Universiti Kebangsaan Malaysia (UKM). Hosted at UPSI, the seminar featured Stockholm University, the Department of Polytechnic and College Community Education, and UPSI. The event exposed KKKL students and lecturers to green entrepreneurship and sustainability-driven innovation, highlighting the importance of equipping TVET graduates with entrepreneurial competencies (KKKL 2023).

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Case 6: KNX Smart Building Automation Course

In response to the demands of Industry 4.0, KKKL introduced courses on KNX Smart Building Automation, an international standard for energy-efficient building control. The Certified KNX Basic Course (6 February–9, 2024) at KKKL Training Center involved seven participants from Politeknik Sultan Salahuddin Abdul Aziz Shah. Additionally, an introductory webinar on 15 November 2023 attracted 55 participants, including lecturers from KKKL and Kolej Vokasional Sultan Abdul Samad (KKKL, 2023; 2024e).

Discussion

Through these six initiatives, the KKKL exemplifies how TVET institutions can embed sustainability into education. These projects highlighted renewable energy applications, urban farming, eco-product innovation, green entrepreneurship, and smart building technologies. Collectively, they strengthened generic green skills, fostered industry-academia collaboration, and supported Malaysia's green economic transition.

Green Skills and Sustainability Practices at Politeknik Nilai: Case Studies

Politeknik Nilai (PNS) has advanced its role as a green campus by embedding sustainability into its curriculum, student activities, and community engagement. The following six case studies highlight how the PNS will cultivate generic green skills and sustainability practices in 2024.

Case 1: CSR Go Green & Innovation from Waste

On 25 April 2024, the PNS organised a CSR Go Green program at Pantai Teluk Kemang, Port Dickson. The event involved 45 participants from the Diploma in Retail Management, led by lecturers and program coordinators. Activities included a guest lecture by the SWCorp officer on circular economy and SDGs strategies, beach cleaning, and an eco-innovation challenge using waste materials. The program fostered leadership, communication, and teamwork among students while raising environmental awareness (Politeknik Nilai, 2024a).

Case 2: Program Back to Nature

On 28 September 2024, students from the Diploma in Logistics and Supply Chain Management (class DLS3A) organised a "Back to Nature" programme at Pantai Saujana, Port Dickson. This mini-project, part of the Principles of Management course, includes outdoor games and environmental activities that nurture teamwork, project management, and communication skills. The event also fostered environmental appreciation and strengthened social bonds among participants (Politeknik Nilai, 2024b).

Case 3: Biotechnology in Green Tech Webinar

On 18 October 2024, the PNS co-hosted an online webinar entitled "Perkembangan Bioteknologi dalam Teknologi Hijau" via Google Meet. The keynote speaker highlights how biotechnology supports green technology and reduces environmental impacts. The participants included students, lecturers, and community members interested in sustainable science. The programme enhanced knowledge of biotechnology's role in achieving environmental sustainability (Politeknik Nilai, 2024c).

Case 4: 3R Campaign (Reduce, Reuse, Recycle)

On 2 May 2024, the Department of Commerce organised a 3R campaign involving staff and students. Activities included the collection of recyclable materials, such as paper, plastic, and

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aluminum, and creative projects that reuse waste materials. The initiative strengthened responsibility, creativity, and awareness of sustainable waste management practices among the participants (Politeknik Nilai, 2024d).

Case 5: Green Adventure & Eco Design Competition

On 21–22 September 2024, four students represented PNS at the GREEN Action for Environment (ENcEm) Innovation Competition 2024 held at Politeknik Tun Syed Nasir Syed Ismail, Johor. Their project, GreenBeats, a recycling mobile app, won first place in the Digital & IoT categories. The competition showcased digital creativity, environmental innovation, and alignment with SDG 12 (Responsible Consumption and Production) (Politeknik Nilai, 2024e).

Case 6: Green Classroom Activities

From 2 April to 2 May 2024, students enrolled in the Green Technology Compliance course (DUG30023) participated in three sustainability activities.

- Fun Classroom Green Games (2 April 2024) – Quizzes and puzzles to raise awareness of green technology.
- Innovation Talk: "Let's Recycle Waste Properly to Protect the Earth" (24 April 2024) – a guest lecture by SWCorp on waste management and recycling.
- 3R Campaign (2 May 2024): Hands-on recycling and creative reuse of waste materials.

These structured classroom activities enhanced students' green literacy and cultivated awareness of sustainable practices in everyday life (Politeknik Nilai 2024d).

The six case studies illustrate how PNS integrates sustainability education with experiential learning. By embedding CSR projects, eco-design competitions, webinars, and classroom-based green activities, the institution develops technical and generic green skills. These initiatives align with Malaysia's national sustainability agenda and strengthen TVET's role of TVET in the green economic transition.

Cross-Institutional Comparison

A comparative synthesis was conducted, and the results are summarised in Table 3.

Table 3: Green Skills Integration – Cross-Institutional Mapping

Green Skills Domain	KKKL	Politeknik Nilai	Remarks
Environmental Literacy	Digital-oriented	Community-oriented	Both cover SDGs, biodiversity, and energy awareness
Cognitive Sustainability Skills	Systems automation	Ethical & experiential	More structured in KKKL, more participatory in PNS
Practical Green Work Skills	Renewable systems	Recycling & farming	Technical in KKKL; hands-on and behavioral in PNS
Green Entrepreneurship	Technopreneur model	Circular business	Both encourage project-based business ideation
Ethical Professionalism	Engineering ethics	Stakeholder conduct	Embedded in both formal and informal educational contexts

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Thematic Insights

Theme 1: Institutional Orientation Matters

KKKL's orientation as a technology-heavy institution led to digital-technical integration of green skills, while Politeknik Nilai's community-driven model emphasised experiential learning and civic engagement.

Theme 2: Co-Curricular Programs as Key Vehicles

Across both institutions, impactful green competencies were often delivered via co-curricular initiatives ranging from tree-planting campaigns to hackathons and awareness.

Theme 3: Emergence of Cross-Domain Competencies

Initiatives that fused ethical professionalism, innovation, and leadership were observed, particularly through student-led solar projects and green start-up explorations, thus validating multidimensional skill development.

Theme 4: Alignment with COPTPA and HETR Goals

The observed practices show the operationalisation of COPTPA's cognitive, affective, and psychomotor outcomes. Moreover, student projects aligned with HETR's goals of graduate employability, social impact, and sustainability readiness.

Conclusion

This study aims to characterise how green skills are incorporated into two Malaysian TVET higher education institutions, KKKL and Politeknik Nilai. Using a qualitative case study approach and analysing 25 institutional artefacts over three years, this study identified five key areas of green competencies environmental literacy, sustainability-focused cognitive skills, practical green work skills, green entrepreneurship, and ethical professionalism displayed across various institutional practices. The results demonstrate a dual-implementation model. KKKL focuses on integrating technical skills in green areas through digital platforms, automation systems, and renewable energy modules. Conversely, Politeknik Nilai emphasises experiential learning and community participation through co-curricular activities, CSR events, and environmental advocacy. Both institutions have aligned their efforts with national and international sustainability frameworks, including COPTA, UNESCO's ESD, and the ILO's Green Skills. The integration of green skills in these institutions supports broader national strategies such as the National Energy Transition Roadmap (NETR), National Industrial Master Plan 2030 (NIMP 2030), and Higher Education Transformation Roadmap (HETR), reinforcing the role of TVET in preparing a future-focused, green-skilled workforce.

Policy Recommendations

Based on the insights obtained, the following recommendations were proposed to augment the integration of green skills in Malaysia's TVET sector: First, the formalisation of the National Green Skills Framework is imperative. Although policy guidelines are currently in place, there is a necessity for a comprehensive operational framework that amalgamates COPTPA, UNESCO's ESD competencies, and ILO Green Skills standards into program accreditation processes, course learning outcomes, and institutional quality assurance mechanisms. Second, we recommend the establishment of an institutional repository dedicated to green practices. TVET institutions should systematically document and share best practices through a national digital repository managed by MOHE. Such a resource would facilitate benchmarking, foster

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peer learning, and diminish redundant effort. Third, incentivising green co-curricular activities and community projects is essential.

Developing funding mechanisms and recognition frameworks to support sustainability-focused student initiatives and community engagement will promote experiential learning that complements formal curriculum. Fourth, there is an urgent need to enhance the capacity of educators in sustainability pedagogy. This can be achieved through CPD programs, regional workshops, and certification schemes focused on green pedagogy, thereby equipping educators with the requisite knowledge and pedagogical skills. Fifth, integrating green metrics into institutional performance evaluation is vital. Indicators such as energy consumption reduction, waste management success, and sustainable procurement should be incorporated into KPIs and the Green Metric reporting system to effectively monitor progress. Lastly, fostering industry-institution collaboration in green innovation is paramount.

Establishing structured platforms that enable cooperation with green technology companies, NGOs, and government entities on applied projects, internships, and co-developed training programs will better align educational outcomes with evolving green workforce demands. Strengthening these strategic areas will enable Malaysia to cultivate a more cohesive, inclusive, and scalable ecosystem for green skill development, aligning educational objectives with national aspirations for sustainability and economic competitiveness.

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