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Integrating Green Skills into the Malaysian TVET Curriculum: A Systematic Review of Literature

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Abstract

This study meticulously and comprehensively reviews the crucial integration of generic green skills into the Malaysian TVET curriculum, underlining its critical importance in pursuing sustainable development goals. Using robust PRISMA guidelines, the review rigorously synthesises the existing literature to uncover and highlight key challenges, necessary elements, and best practices for effective integration of green skills. In-depth analysis uncovers a pronounced need for sufficient training, limited curriculum flexibility, and pervasive resource constraints as significant barriers. At the same time, it identifies indispensable competencies such as sharp analytical thinking, increased environmental awareness, and cutting-edge technological literacy as crucial for nurturing sustainability within Malaysia's burgeoning green economy. The article culminates with an inspiring proposed framework dedicated to embedding green skills within the TVET system, aimed at significantly enhancing workforce readiness for the dynamic demands of green jobs.

Keywords: Green Skills, TVET, Systematic Review of Literature, Sustainability, PRISMA, Malaysia

Introduction

For this reason, the 21st century has brought an increasing global awareness of the urgent need for sustainable development in light of emerging environmental challenges such as climate change, resource depletion, and ecosystem degradation. With the increasing number of countries embarking on sustainable development, it was more or less realised that education, particularly technical vocational education and training, plays a vital role in providing the workforce with relevant skills for green economic growth. In Malaysia, the integration of green skills is indispensable in the TVET curriculum for the implementation of sustainability in the country and its aspiration to transition to a green economy, supported by

country policies similar to the Malaysian Green Technology Master Plan 2017 - 2030, the Twelfth Malaysian Plan (2021-2025), among others.

Green skills are a set of competencies that involve knowledge, abilities, values, and attitudes that would help people contribute to the management and conservation of sustainable environments. According to Pavlova (2012), this is increasingly essential to fostering a technological shift toward sustainable industries. Furthermore, the need to equip workers with green skills has increasingly been crucial for attaining the United Nations' SDGs on Quality Education, Decent Work and Economic Growth. Green skills are essential in TVET both for their technical capability and for nurturing environmental awareness and building resistance and adaptability in the workforce.

Due to national strategies such as the 2017 - 2030 National Green Technology Master Plan, Malaysia has opted for ambitious goals such as creating 200,000 green jobs by 2030. However, the effective inclusion of green skills into the Malaysian TVET curriculum faces many challenges. Despite such policy initiatives, current TVET programmes in Malaysia are more biased toward the formation of technical skills rather than green competencies, leading to a skills gap between graduates who are expected to join the rapidly growing green economy.
Hence, this pivotal study aims to reveal the current status of integration of green skills within the Malaysian TVET curriculum, decipher the critical components essential for embedding these competencies, and design a robust framework that boldens the alignment of the curriculum with global sustainability benchmarks. The impetus driving this research stems from the stark realisation that despite the critical importance of green skills in propelling economic growth and championing environmental preservation, Malaysia's integration efforts have unfolded in a piecemeal fashion, lacking a cohesive policy framework, as highlighted by Bushra et al. (2018). Indeed, numerous studies underscore the urgency of weaving green skills into TVET systems. For instance, in spotlighting select examples, Pavlova (2012) emphasises that green skills transcend mere technical prowess, encapsulating attitudes and values quintessential for a sustainable lifestyle. In contrast, UNEVOC for TVET illuminates that the seamless infusion of green skills into education would substantially elevate the employability of graduates in burgeoning green sectors such as renewable energy, waste management, and sustainable construction when woven into curricula (Ramli et al., 2022).).). However, the Malaysian TVET system faces formidable challenges in embedding these competencies. Chief among these obstacles is the rigid curriculum that fails to accommodate innovative content areas like sustainability due to its inherent lack of flexibility (Nooriza et al., 2024).

In addition, educators face persistent problems of inadequate training and limited resources, which impede their ability to impart greening skills effectively. As Ibrahim et al. (2020) articulate, there is a glaring disconnect between TVET institutions and industry requirements to bestow practical workplace applications of green skills. These formidable barriers can be overcome by adopting a comprehensive strategy that incorporates curriculum reform, enhanced teacher training, and fortified alliances between TVET institutions and industries. This research aims to bridge existing knowledge gaps through an exhaustive analysis of the literature, producing tangible and actionable strategies to integrate green skills into the TVET curriculum, a significant step towards realising Malaysia's long-reaching sustainability aspirations.

This paper explores the systematic literature review approach, meticulously employing the PRISMA method to dissect and evaluate existing studies on the integration of green skills into TVET programmes globally and specifically in Malaysia. This comprehensive study is dedicated to uncovering and addressing gaps, overcoming challenges, and highlighting exemplary practices. It aims to support the proposal with a robust framework for enhancing the Malaysian TVET curriculum, effectively equipping the workforce to drive sustainable economic growth.

Methodology

The following section elaborates on the SLR approach adopted for this study based on the PRISMA guidelines to ensure replicability, transparency, and rigour in identifying, screening, and analysing research relevant to the stated review question on integrating generic green skills into the Malaysian TVET curriculum.

This study uses a systematic review approach to the current literature on the integration of green skills within the TVET framework in Malaysia. Systematic literature reviews can be appropriate to synthesise knowledge, highlight gaps, and provide comprehensive information on complex research areas. Therefore, the PRISMA guidelines were applied to frame the review process that covers the stages of identification, screening, eligibility, and inclusion.

Comprehensive data were retrieved from several academic databases: Scopus, Web of Science, Google Scholar, and SpringerLink. The keywords used in the search included a combination of "Green Skills," "TVET," "Sustainability Education," "Malaysia," "Curriculum Integration" and "Green Economy." Subsequently, the search was filtered to ensure that only peer-reviewed journal articles, conference proceedings, and dissertations published between 2010 and 2024 were considered. This period is considered because it will allow the researcher to capture the recent status of integrating green skills within educational systems. Inclusion criteria were established to ensure the relevance and quality of the reviewed studies.

Inclusion Criteria:

- Studies published in English.
- Research focussing on the integration of green skills in TVET.
- Articles that discuss frameworks or models relevant to curriculum development.
- Studies conducted in Malaysia or involving Malaysian contexts.

Exclusion Criteria:

- Non-peer-reviewed articles, opinion pieces, and editorials.
- Studies not related to TVET or green skills.
- Articles focussing solely on technical skills without addressing sustainability components.

The PRISMA flow diagram is used to visually represent the systematic review process. This includes the number of records identified, selected, and excluded, and the final selection of studies included in the review. Initially, a total of 250 records were identified through the database search. After removing duplicates and irrelevant studies, 50 articles were evaluated for eligibility, resulting in 30 studies being included in the final review, as illustrated in Table 1.

Table 1
PRISMA Flow Diagram

Phase	Description	Records Included/Excluded
Identification	Records identified by searching the database (n = 250)	Records excluded according to title / abstract review (n = 50)
Screening	Records after the removal of duplicates (n = 200)	Records excluded for irrelevance (n = 150)
Eligibility	Eligibility for full-text articles (n = 50)	Full-text articles excluded for reasons (n = 20)
Inclusion	Studies included in qualitative synthesis (n = 30)	Studies included in the final synthesis (n = 30)

Data extraction was carried out using a structured form that captured study objectives, research design, key findings and implications for the integration of green skills into TVET. Descriptive data was synthesised to identify common themes, trends, and gaps. Thematic analysis focused on the recurring challenges and best practices reported in the studies. Two independent reviewers participated in the selection and selection process to ensure the reliability and validity of the systematic review. Discrepancies between the reviewers were resolved through discussions until a consensus was reached. This approach minimises bias and improves the credibility of the findings.

Review of the Systematic Literature

This section presents an SLR on the incorporation of generic green skills into the TVET curriculum in Malaysia. The review critically discusses existing studies that highlight gaps, challenges, and avenues to embed green competencies within TVET courses. The SLR will be based on the PRISMA guidelines that ensure a structured and transparent process for identifying, screening, and evaluating the literature. It will culminate in actionable recommendations to develop a comprehensive framework for integrating green skills into the TVET curriculum in Malaysia.

The Need for Green Skills in TVET

In the wake of an unstoppable tide of global trends centred on sustainable development, nations worldwide are compelled to revolutionise their educational paradigms, focussing on embedding green skills into the academic curriculum. These essential green skills encompass a powerful blend of competencies, knowledge, and attitudes pivotal to practising sustainability and fostering environmental stewardship, dramatically steering the workforce toward thriving in the burgeoning green job sector. Consequently, the inclination towards integrating green skills in education has been an unrelenting ascent, as countries ardently pursue alignment with the illustrious United Nations Sustainable Development Goals. Among these are SDG 4, which emphasises quality education, and SDG 8, which advocates decent work and economic growth. Indeed, this is yet another sphere where Technical and Vocational Education and Training (TVET) holds unparalleled relevance, given its laser focus on cultivating precise, industrially pertinent skills and knowledge that seamlessly transition into varied industries, notably those at the heart of the green economy, including renewable energy, efficient waste management, and sustainable construction. However, despite the evident promise within the fabric of TVET programmes in diverse nations, the process of skill

greening needs to be reviewed, with progress flickering inconsistently, particularly in emerging countries such as Malaysia.

Review Methodology

A total of databases, including Scopus, Web of Science and Google Scholar, were exploited for this review, using specific keywords such as "Green Skills", "TVET", "Sustainability Education", "Curriculum Integration" and "Malaysia". For this review, studies were considered in the period 2010 to 2024. The studies included in this SLR focused on peer-reviewed journal articles, conference papers, and theses. The number of studies remaining after removing duplicates was 30, which underwent the inclusion and exclusion process for in-depth analysis.

Thematic analysis of SLR Results

Global Best Practices in Integration of Green Skills

Several nations have taken the initiative to incorporate green skills into their TVET systems. Germany effectively developed green skills competencies thanks to its dual education system, which combines classroom learning with industry training. This approach has allowed students to acquire skills for sustainable industries. Cabral & Dhar 2019, discussed how Australia has included sustainability competencies in its TVET curriculum, equipping graduates for the green job market. These exemplary practices support collaboration between industry and education, adaptable curricula that consider the ongoing professional development of educators, and the alignment of TVET programmes with evolving industry needs. However, despite these advancements, developing countries still need to work on embedding green skills into their TVET systems, mainly due to financial, infrastructure and policy challenges.

Current state of integration of green skills in Malaysia

Several nations are incorporating green skills into their TVET systems. Germany's dual education system, which combines classroom learning with industry training, effectively develops green competencies for sustainable industries. Cabral & Dhar 2019 noted that Australia included sustainability competencies in its TVET curriculum, preparing graduates for the green job market. These practices improve the collaboration between industry and education, adaptable curricula, and alignment with industry needs. However, developing countries need financial, infrastructure and policy help to embed these skills.

Critical elements of Green Skills Integration

Key Aspects of Integrating Green Skills A systematic literature review identified several essential elements for effectively incorporating green skills into Malaysia's TVET curriculum. These elements represent some of the competency requirements faced by industries dealing with environmental challenges as they shift towards sustainability. Pavlova (2012) notes that developing such competencies allows students to create innovative solutions to meet the evolving demands for sustainability. Additionally, technological literacy is crucial in the realm of green technologies. As industries move gradually towards sustainable operations, the demand for TVET graduates who can efficiently use advanced technologies to minimise environmental impact increases significantly. Integrating technological literacy is vital to ensure that TVET education remains in sync with industry trends. Ecological awareness also plays a central role, highlighting the need to incorporate sustainability topics within the courses, which is central to the TVET programmes. By addressing such issues, students learn

about the ecological impacts of their professional actions, encouraging responsible decision-making and sustainability in their future careers. Ibrahim et al. (2020) further point out that the review underscored the need for flexibility in the programme courses.
For example, updating the TVET curriculum to include new crucial topics such as climate change mitigation and green technologies is essential to keep the education content relevant amid evolving industrial needs. With flexibility, these programmes can be updated and improved to train students for new green jobs.

Identified Gaps in the Literature
The literature review has revealed a series of deep and pervasive gaps in the ongoing efforts to weave green skills seamlessly into the tapestry of Malaysia's TVET curriculum, with a glaring lack of flexibility at the core of the curriculum being the most prominent. Currently, most TVET curricula are embedded in rigidity, overly fixated on acquiring traditional hard skills, thus erecting formidable barriers to the seamless integration of new vital competencies attuned to the difficulties of sustainability. This institutional and curricular intransigence severely handicaps the agility required to quickly adapt to the growing demand for green economy skills, leaving graduates ill-equipped as they compete for emerging opportunities accentuated by a global shift toward sustainability. This inflexibility hits the bullseye, particularly within industries undergoing tempestuous and revolutionising technological shifts towards sustainability. Another critical chasm lies in the need for educator training within the TVET ecosystem.
Many educators must be more aware of the knowledge and tools required to deliver peerless capabilities within an environmentally conscious framework. They perceive themselves as needing to improve their pursuit of sustainability objectives. The review reveals, for example, that educators are disabled from instilling green competencies in their pedagogical practices due to a void in professional growth opportunities targeting this avenue. This shortfall severely undermines educational quality and dampens graduates' potential to meet and exceed the expectations of employers navigating the green sector. Compounding these challenges is a pronounced disconnect between academic institutions and industry, delineating a stark divide between the skills imbued by TVET programmes and the evolving necessities of the labour market.
Consequently, TVET graduates find themselves theoretically prepared, yet practically underprepared for dynamically transforming industries with sustainability at their core. This chasm could be bridged through solidified industry partnerships that meticulously align curriculum content with corporate needs, offering students invaluable hands-on exposure through internships and apprenticeships. Despite Malaysia's growing policy affirmations to champion sustainability, the pragmatic installation of green skills needs to be more cohesive and in disarray at the institutional echelon. The literature records that, while national policies promoting green development are abundant, they frequently stall at transforming into concrete strategies operational at the grassroots within TVET establishments to bolster green development. This dissonance between policy intent and procedural execution stymies the potential potency of TVET programmes, hindering the thorough preparation of students for a sustainable future. Thus, an urgent call manifests for reinforced policy scaffolds, delivering unequivocal guidelines on funding architectures that ensure the comprehensive infusing of green skills within an educational paradigm. It mandates a holistic modus operandi from re-designing the curriculum, enhancing teacher experience, fostering closer industrial synergies, and fortifying policy advocacy. This will narrow these divides, culminating in a rejuvenated

Malaysian TVET framework that seamlessly integrates with the nation's green ethos, preparing graduates to tackle the burgeoning demands of the green economy.

Discussion

Integrating Green Skills into the TVET curriculum is critical in Malaysia's economic growth and sustainability pursuit. This discussion synthesises the findings of the systematic review of the literature and relates theoretical frameworks to practical challenges observed in the current state of Malaysia's TVET system.

This discussion draws on theoretical insights from the Ecological Modernisation Theory and the UNEVOC framework, both of which support the role of education in driving sustainable development and preparing a workforce compatible with the green economy. However, the review indicated noticeable gaps in practice in realising these theoretical ideals fully. Ecological modernisation theory postulates that economic growth and environmental sustainability go together with adopting green technologies and practices. Assuming this theoretical approach, the Malaysian TVET system should emphasise green skills within educational curricula. However, it is indicated in the review that, currently, Malaysia's TVET programmes are highly loaded with traditional technical skills and therefore need more flexibility to incorporate sustainability-related competencies.

The rigid nature of the present curriculum limits flexibility in responding quickly to the changing needs of industries, particularly those undergoing green transitions. Therefore, the misalignment between theory and practice is considered one of the most prominent barriers to achieving the goals set by the Malaysian Green Technology Master Plan and the 12th Malaysian Plan. One of the key findings of the review was the inflexibility of the curriculum. Currently, existing TVET programmes are driven by a dynamic curriculum that needs to reflect the dynamism in the green industries. For example, while these industries are gradually beginning to move and adjust to the technologies of going green, the demand for graduates also changes to go green by adopting technologies involving renewable energy systems and waste management.

Furthermore, by integrating these competencies through curriculum reform, graduates could enter the green job market with more preparation. This rigidity affects the employability of TVET graduates and limits Malaysia's ability to develop a sustainable workforce, supporting its objectives for a green economy (Pavlova, 2012). Another critical factor in such a translation from theory into practice is the contribution of educators. In general, the results of this review indicate that a significant portion of TVET educators need more training and resources to provide training in green skills effectively. Educators are at the centre of embedding greener competencies within the curriculum; however, without proper support, their contributions are crippled.

Ibrahim and Saqib talk about how any deficiency in professional development and systematic training programmes causes a lack of linkage between curriculum content and needs related to industry sustainability. This calls for continuous professional development programmes in sustainability education to empower educators to offer appropriate quality and relevant training. Furthermore, there need to be more industrial partnerships in the review. Theoretical frameworks are created on the basis that education outcomes should align with the industry's requirements for easy absorption of students into the job market upon completion of studies. Still on the ground, what is recognised is the need for more collaboration between TVET institutions and industries in Malaysia; therefore, there needs to be a match between the skills taught in TVET and those required for the job market.

All this will ensure that strengthening partnerships with industries keeps curriculum content relevant and current to address the skill gap and improve employability. This calls for much-needed collaboration in apprenticeships and co-designed training modules, crucial for engaging students in practical exposure to green technologies. The other area where theory and practice differ is policy support. Although there are firm policy commitments towards green development in Malaysia, its implementation at the institutional level needs to be more cohesive. The UNEVOC framework advocates for harmonious policies integrating sustainability into the TVET education system.
However, the findings revealed that while there are supportive national policies for the integration of green skills in Malaysia, there need to be clear guidelines, funding, and monitoring mechanisms at the ground level to ensure effective implementation. The incoherence of policy and practice further diverts TVET institutions from assimilating their programmes with the national sustainability agenda.

Proposed framework for integrating green skills in Malaysia's TVET curriculum
Based on the identified gaps and the insights derived from the discussion, a comprehensive framework is proposed to guide the integration of green skills into the Malaysian TVET system. This framework seeks to align theoretical principles with practical strategies, ensuring a cohesive approach to embedding sustainability within TVET education.

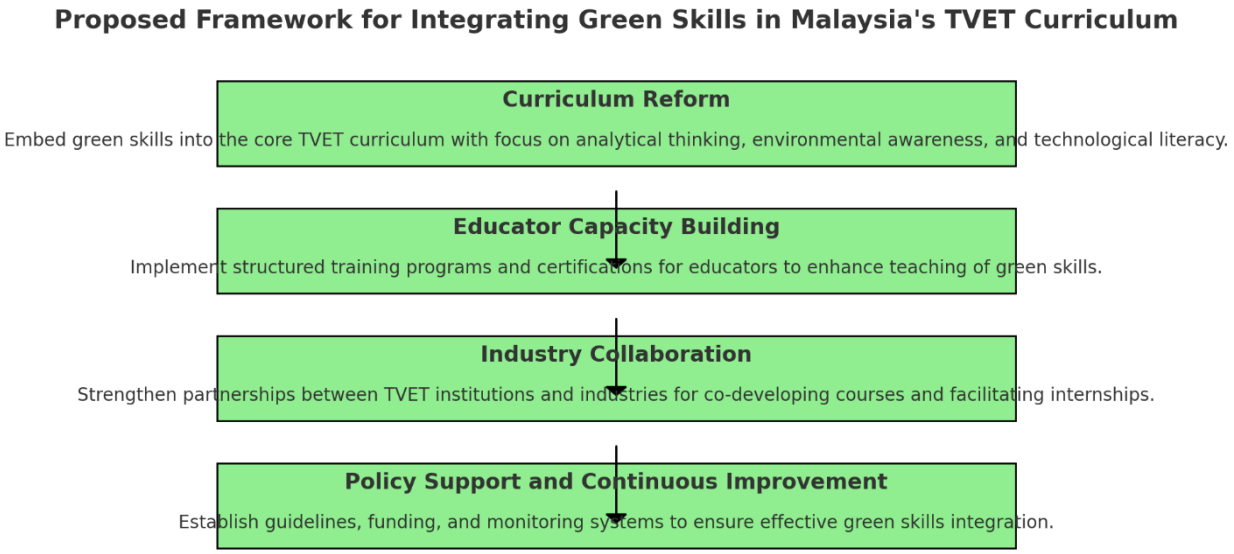
*Curriculum reform. The first pillar of the framework focusses on curriculum reform***.** To produce graduates prepared for the green economy, the curriculum must be updated to include competencies in analytical thinking, problem solving, environmental awareness, and technological literacy. This can be achieved through collaborative curriculum development workshops that involve stakeholders from industry, academia, and policy making. Integrating sustainability concepts into existing technical courses, rather than creating separate subjects, will ensure a seamless transition to a green-orientated curriculum.

Building teacher capacity the second pillar emphasises the need to build teacher capacity. To truly revolutionise the educational landscape in sustainability, it is imperative to establish continuous professional development programmes that rigorously augment educators' prowess in imparting sustainability-related knowledge. These initiatives must encompass 'train-the-trainer' programmes alongside comprehensive certifications in sustainability education, providing educators with robust capabilities. Furthermore, facilitating access to cutting-edge resources, including advanced digital simulations and highly interactive tools, will empower educators to communicate the intricacies of green technologies in a proficient manner. Investing strategically in teacher training ensures that TVET instructors are capable and exemplary champions in delivering impactful green skills content with utmost efficacy.

*Strengthening industry collaboration The third pillar focusses on strengthening industry collaboration***.** Establishing industry advisory boards at TVET institutions will help align training programmes with market needs. Joint curriculum design initiatives, internships, and apprenticeships will provide students with practical experience applying green skills. Public-private partnerships can also be leveraged to secure funding and resources for green skills training, further enhancing the capacity of TVET institutions to provide relevant education.

Support of policy and continuous improvement: The final pillar of the framework addresses policy support and continuous improvement. A national framework for green skills must be developed to provide clear guidelines for integrating sustainability into TVET curricula. This framework should include benchmarks for curriculum content, educator training, and industry collaboration. Furthermore, establishing a monitoring and evaluation system will ensure that institutions remain responsible for integrating green skills. Providing incentives, such as grants and funding, for institutions that successfully combine sustainability will encourage widespread adoption.

Leveraging technology to integrate green skills: Integrating technology into TVET programmes is essential to overcome resource limitations. E-learning platforms and virtual labs can teach green skills, allowing students to gain practical, cost-effective experience with sustainable technologies. A blended learning approach that combines online learning with hands-on training can enhance the learning experience while optimising resource use.
The proposed framework provides a structured approach to integrating green skills into Malaysia's TVET curriculum. As depicted in Figure 1, this framework addresses the gaps identified in the systematic review by aligning curriculum reform, educator training, industry collaboration, and policy support. The holistic approach ensures that Malaysia's TVET graduates have the skills to thrive in the green economy, thus supporting the sustainability



goals of the nation.
Figure 1: Proposed framework for integrating green skills into Mlaaysia's TVET curriculum
By implementing this framework, Malaysia can transform its TVET system into a driver of sustainable economic growth, bridge the gap between policy and practice and prepare its workforce for the challenges of a rapidly evolving green industry landscape.

Conclusions

The review emphasises the integration of green skills into Malaysia's TVET curriculum to align with national sustainable goals. Challenges include rigid curriculum, inadequate teacher training, limited industry collaboration, and fragmented policies, all of which hinder green skill teaching and graduate employability in green sectors. Analytical thinking, problem

solving, environmental awareness, and technological knowledge are vital competencies. The study proposes reforming the curriculum, improving educator training, expanding industry partnerships, and strong policy support to embed green skills effectively. This aligns Malaysia's TVET with global best practices, such as those in Germany and Australia, making it a central factor for sustainable economic growth. Implementing this framework prepares the workforce for sustainability goals, supports Malaysia's green future, and promotes resilience. This study improves the understanding of the integration of green skills into Malaysia's TVET curriculum. It addresses the gaps in identifying challenges and solutions for green skills education. The research presents a framework for sustainable vocational education, aligned with global standards and local needs. It advises policymakers and educators on curriculum flexibility, teacher training, and industry collaboration for green job readiness. These insights support Malaysia's goal of sustainable economic growth and a environmentally conscious workforce.

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