

Infusing Holistic Green Curriculum in Education for Sustainable Development in Malaysian Higher Education Institutions

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ABSTRACT

Sustainable development is a defining challenge of the 21st century, requiring the holistic integration of environmental, social, and economic dimensions. While Malaysian Higher Education Institutions (HEIs) have made strides in operational green campus initiatives, a significant disparity remains regarding curricular depth and the systematic integration of Climate Change Education (CCE). This study investigates the current state of Education for Sustainable Development (ESD) in Malaysia and proposes a framework for a Holistic Green Curriculum. The research utilized a two-part methodology; an analysis of ESD subjects and learning outcomes across 10 different Malaysian universities, followed by participatory research with experts to develop innovative strategies for holistic green curriculum for ESD. Findings indicate that most investigated HEIs relegate sustainability to general core subjects, often lacking explicit CCE components. This frequently results in a superficial understanding of sustainability, particularly regarding social and economic pillars. To bridge this gap, the study proposes a tripartite model for a Holistic Green Curriculum. The first component, Learning Outcomes, aligns with international policies and encompass cognitive, affective, and psychomotor domains across all sustainability dimensions. The second component, Learning Approaches, advocates for student-centered, experiential, and indigenous-knowledge-based pedagogy. The third component, Learning Environment, emphasizes expanding education beyond the classroom through site visits, sustainability campaigns, and the strategic use of AI. This shift is essential for cultivating climate-ready graduates capable of navigating the global climate crisis.

Keywords: Education for Sustainable Development (ESD), Holistic Green Curriculum, Climate Change Education (CCE), Malaysian Higher Education, Sustainability Dimensions.

INTRODUCTION

Our lives should be shaped by sustainability from an early age, and it is considered one of the biggest issues of the 21st century. Zhang et al. [1] stated that sustainability meets human requirements without damaging natural resources, encouraging responsible everyday actions. Sustainable development serves the demands of the current generation without compromising the needs of future generations, according to the Brundtland Commission Report in [2]. Zhang et al. [1] also suggested that sustainable development (SD) should balance social development, environmental protection, and economic progress. Sustainability focuses on meeting human needs while preserving social, economic, and environmental systems. To achieve it, at the global level, the United Nations aspired to achieve 17 sustainable development objectives (SDGs) by the year 2030, called SDG 2030. These 17 goals cover all three sustainability elements, and 93 nations have committed to adopting SDG 2030 to promote economic growth, social inclusion, and environmental conservation. In the policy document, it was stated that all stakeholders, notably educational institutions, must infuse Sustainable Development (SD) values in society to safeguard the biosphere and living things from development-related destructions to achieve the 17 goals. The issues of environmental, social, and economic sustainability constitute the essential foundations of

sustainable development, necessitating their thorough application and integration to fulfill the core objectives inherent in the sustainability concept [3].

In 2015, during the COP 21 United Nations Climate Change Conference held in Paris, France, a total of 196 nations reached a consensus on the Paris Agreement, which stands as a legally binding international treaty addressing the pressing issue of climate change [4]. This accord represents the most consequential international agreement since the Rio Earth Summit of 1992. All nations have pledged to maintain the global average temperature below 2°C above pre-industrial levels and to restrict the increase to 1.5°C in order to alleviate the effects of climate change [5]. Palinkas [6] cited that there are profound and interrelated repercussions, encompassing swift environmental decline, such as the melting of ice, rising sea levels, and extreme weather phenomena; extensive social dislocation, with over 45 million individuals displaced due to weather-related events in 2024; and considerable economic impact, including losses exceeding USD 4.5 trillion attributed to extreme occurrences over a span of thirty years. The consequences of these issues pose significant risks to the sustainability and sustainable development of the world.

The impact of the climate crisis, caused by climate change, underscores the need to recognize its effects on our environment and to integrate this understanding with the goals and aspirations of SDG 2030 in order to achieve sustainability across environmental, economic, and social dimensions.

Youths, especially undergraduates, are the backbone of every nation because they will become the future leaders and professionals who will significantly shape their respective countries and the world. Education has served as a catalyst for inspiring action among the younger generation in this rapidly evolving world. Thus, they need to be well exposed to climate change via education, and one of the most effective paths to educate these undergraduates to be sensitive towards climate change is through education for sustainable development (ESD) subject(s) that are usually offered in higher education institutions all over the globe, including Malaysia.

Undergraduates, who are the nation's future leaders and professionals, must be well-versed in climate change issues in higher education. The ESD curriculum must penetrate the transformational green curriculum, which incorporates sustainability, ecological consciousness, and social responsibility. Students should learn to lead the future, not just to adapt for the sake of getting excellent grades in the ESD-related subject.

The educational dimension is crucial in cultivating and instilling the essential values of sustainability within learners, enabling them to develop mindsets and character aligned with the principles of sustainability and sustainable development, beginning within the classroom environment. The educational framework encourages individuals to engage in thoughtful decision-making and to act, both independently and collectively, to make societal change and protect the planet. It equips individuals across generations with the knowledge, competencies, perspectives, and abilities necessary to confront challenges such as climate change, biodiversity loss, resource overconsumption, and inequality that impact the well-being of humanity and the planet [7].

Malaysian higher education green curriculum policy is largely based on the National Green Technology Policy, which integrates green technology and sustainable practices to raise environmental awareness and promote environmental responsibility. While Malaysian higher education institutions (HEIs) focus on green initiatives like campus sustainability policies, they are still lacking in developing effective curricula that are able to promote climate change issues while integrating all the sustainability dimensions [8]. Purvis et al. [9] discovered that the efficacy of sustainable development is significantly contingent upon the attainment of sustainability across three interrelated dimensions: economic, environmental, and social. Therefore, it is essential for us to guarantee that we are allocating equal attention to these three dimensions in the context of green education, particularly within the framework of ESD.

Balakrishnan et al. [10] have identified a deficiency in the integration of sustainability values that comprehensively address the three dimensions of sustainability: environmental, social, and economic in Malaysian higher education institutions. While previous studies indicated that Malaysian undergraduates possess a satisfactory level of awareness regarding environmental sustainability, their understanding of the social and economic dimensions remains lacking. This specific circumstance may hinder the cultivation of graduates who

are capable of leading the initiatives of sustainable development within the framework of greening efforts aimed at safeguarding our biosphere from the challenges posed by climate change.

This study addresses two main research questions, which are as follows:

RQ1: To what extent is Climate Change Education (CCE) currently integrated into the curriculum of ESD-related subjects across selected Malaysian higher education institutions?

RQ2: What pedagogical strategies and frameworks can be developed to infuse a holistic green curriculum into the existing ESD model?

In this study, the researchers will explore the current state of the green curriculum, particularly regarding climate change education (CCE) within ESD-related subjects at Malaysian higher education institutions, and propose innovative strategies to integrate a holistic green curriculum into the existing ESD model. This integration aims to help learners understand the significance of climate issues, not only in terms of environmental effects but also in relation to the economic and social impacts of climate change.

At the same time, this study is vital due to limited research on integrated multi-dimensional sustainability curricula, in which most of the current studies focused on the isolated dimensions or disciplines. Moreover, the researchers found that the majority of the studies that were conducted in the context of a holistic green curriculum in ESD are Western-centric, and the findings of these studies may not fully generalize to the non-Western nations, especially to the HEIs in the Asian region.

Hence, this study can be the foundation for all the HEIs to infuse a holistic green curriculum in the ESD paradigm that not only takes care of the environmental aspect but also amalgamates all three pillars of sustainability collectively in the curriculum to develop undergraduates—the future leaders and professionals—who can think and act holistically to protect our planet earth.

Green Education in Malaysia

In Malaysia, the emphasis on sustainability has emerged as a prominent policy focus, as evidenced by the Malaysian Green Technology Master Plan, the National Climate Change Policy 2.0, and wider commitments to SDG 2030 in the majority of policies by the Malaysian government. Comprehensive analyses of sustainability within Malaysian higher education indicate an increase in activity; however, they characterize the overarching landscape as disjointed and constrained, marked by inconsistent incorporation of environmental, social, and economic factors among various institutions and initiatives [11]. A considerable number of higher education institutions in Malaysia have adopted green campus initiatives, encompassing waste reduction, energy efficiency, and involvement in UI Green Metric, as integral components of their overarching strategies to decarbonize and exhibit environmental stewardship. Nevertheless, these initiatives frequently prioritize physical infrastructure and operational practices, whereas curriculum reform and the enhancement of student learning experiences tend to receive relatively less methodical consideration [12]. The newly introduced Malaysian Higher Education Blueprint 2026-2035 has strong emphasis on the sustainable development elements, especially in the context of climate change education, in which it needs an overhaul of the current paradigm of ESD practiced in Malaysian HEIs.

Studies emphasize the necessity for comprehensive frameworks and assessment instruments that transcend mere symbolic inclusion of sustainability topics, aiming instead for profound curricular integration and transformative learning experiences [13, 14]. At the same time, climate change is becoming a pivotal element that will determine the future of the well-being of our planet, which needs every world citizen's determination and responsibility [4]. Research that was conducted among the Malaysian undergraduates indicated that environmental awareness tends to be high; however, the understanding of knowledge, attitudes, and values pertaining to sustainability is often inconsistent, particularly regarding the dimensions of social and economic sustainability, which are less distinctly comprehended and prioritized [10]. Such a scenario brings the need for more integrated frameworks in terms of curriculum transformation to foster a more holistic approach to sustainability education.

Malaysia has prioritized sustainability values and the Sustainable Development Goals (SDGs) at a national level; however, recent evaluations suggest that the integration of sustainability within Malaysian higher education continues to be characterized as fragmented and limited, even in light of heightened policy focus. The studies regarding sustainability in Malaysian higher education reveal that universities are engaged in initiatives related to campus greening and sustainability reporting and participating in the green metrics ranking [11]. However, the methodologies employed by different institutions exhibit significant variability and are often devoid of cohesive curricular frameworks that integrate environmental, social, and economic aspects. This disparity is of paramount importance, as both global and national policies—such as the SDG Roadmap for Malaysia and the nascent Higher Education Institutions Sustainability Policy—clearly advocate for a comprehensive incorporation of sustainability within educational practices, extending beyond mere operational considerations.

At the institutional level, Malaysian universities have engaged predominantly in green campus initiatives and involvement in UI Green Metric, emphasizing infrastructure, energy consumption, waste management, and the campus environment. Research on the implementation of green campus initiatives in Malaysian public universities reveals that, although numerous UI Green Metric indicators are being satisfied, several challenges remain, such as constraints in resources, a deficiency in expertise, and the inadequate involvement of academic communities in sustainability efforts [15]. Typically, institutions view campus sustainability initiatives as a corporate social responsibility endeavor rather than an essential strategic and educational imperative. This indicates that the progress in operational greening is outpacing the necessary evolution of curriculum and pedagogy required to cultivate truly sustainability-competent graduates.

Malaysia faces challenges in Education for Sustainable Development (ESD) similar to those encountered in other countries. Analyses of sustainable development education underscore ongoing obstacles, such as insufficient educator expertise, inadequate resources, and sub-par learning experiences that impede meaningful engagement with sustainability principles [16]. Research conducted with Malaysian university students indicates a positive trend in environmental awareness; however, sustainability education continues to face challenges in advancing beyond mere awareness-raising to cultivate more complex competencies and values, particularly in the realms of social and economic sustainability [10]. A systematic review conducted in 2025 by [11], regarding the integration of sustainability within Malaysian higher education, highlights deficiencies in educator training, institutional backing, and cohesive curriculum development. It advocates for thorough, collaborative strategies that incorporate sustainability throughout programs, rather than relegating it to isolated modules or co-curricular activities.

In this context, the concept of a green curriculum is still in its nascent stages, lacking a comprehensive, research-based framework for implementation in higher education. Internationally, educators conceptualize curricula focused on sustainability as cohesive frameworks that integrate sustainability objectives, content, and evaluation across various programs. However, analyses conducted in Malaysia reveal that efforts at the curriculum level often appear sporadic, confined to specific disciplines, and only partially aligned with the agendas of SDG 2030. The current metrics and rankings, such as UI Green Metric, predominantly evaluate the tangible and operational facets of sustainability, offering minimal understanding of the extent to which environmental, social, and economic dimensions are integrated into curriculum. Referring to the latest announcement of the UI Green Metric world university ranking, the majority of Malaysian HEIs obtained good positions, which reflect the commitments that are carried out by the HEIs towards sustainability.

In light of this pivotal issue, Malaysian higher education encounters a two-fold challenge. On one hand, there exists a robust national and sectoral impetus, exemplified by the formulation of a Higher Education Institutions Sustainability Policy that underscores teaching and learning as a fundamental pillar in conjunction with research, operations, and community engagement [17]. Conversely, the existing practices surrounding green curricula are inadequately incorporated with environmental, social, and economic sustainability aspects within the framework of education aimed at addressing climate change and promoting sustainable development. This establishes an essential requirement for a comprehensive green curriculum framework specifically designed for Malaysian HEIs, in accordance with national policies and international ESD guidelines, to facilitate systematic curriculum design, implementation, and evaluation aimed at sustainability.

Integrating Holistic Green Curriculum

Higher education institutions throughout the globe are increasingly integrating green curricula in ESD and offering climate change education (CCE) as part of the course in several programs [18,19]. The commitments to a green curriculum in the educational model are multifaceted and involve several components, such as content, pedagogy, and assessment. Al-Hamad [20] found that while the initiatives of green thinking have been fostered via green economy exposure among the undergraduates, the component of social sustainability is still lacking. On the other hand, [21] cited that green education is exposed widely via campus greening initiatives; however, the infusion of green education in the ESD curriculum remains limited, and at the same time, they also found that the educators still do not possess sufficient knowledge and skills to educate undergraduates on the related issues of green education, such as climate change.

Green education is often conceptualized as a distinct subset of ESD. This framework shifts from a narrow focus on environmental education, which typically emphasized nature conservation, to a more comprehensive model that intertwines society, economy, and ecology. In theory, the holistic green curriculum and CCE that are preached among the learners must navigate the complexities inherent in balancing economic growth, social equity, and environmental constraints to cultivate informed individuals who are capable of adeptly maneuvering through the complexities of achieving SD agendas.

HEIs are playing a critical role in promoting green education, specifically in terms of planetary health and the climate crisis that has become a major concern today. The adaptation of a holistic green curriculum in an ESD model is increasingly recognized as critical to promoting sustainability awareness and practices among the undergraduates [22]. The green education that is imparted to the undergraduates must be able to transform the perspective of the learners towards climate change, whereby they need to critically reflect on their attitude, behavior, and intention towards climate change.

Prieto-Jiménez et al. [23] found that when all three dimensions of sustainability—environment, social, and economy—were successfully integrated, the systematic thinking skills and practical self-sufficiency values were well developed among the learners. This shows the importance of integrating all the dimensions in educating undergraduates on sustainable development and instilling sustainability values.

However, the implementation of a holistic green curriculum in ESD is still rare in most HEIs, which contributes to the shortcomings in developing future professionals and leaders who can think and act effectively as agents of biosphere protection.

Theoretical Framework

This study is grounded in a dual-layered theoretical framework that bridges global sustainability mandates with localized educational paradigms. At the global level, the study is anchored in the UNESCO Framework for the Implementation of Education for Sustainable Development (ESD) and the United Nations' Sustainable Development Goals (SDG 2030) [3,5]. At the same time, the Brundtland Commission defines sustainable development as meeting present needs without compromising future generations, establishing the critical tripartite pillars of economic, environmental, and social sustainability [2]. Moreover, the Paris Agreement highlights the urgent necessity of integrating Climate Change Education (CCE) to mobilize action against the climate crisis [4].

To suit to the context of this study, in order to contextualize these global models against local realities, this study is further viewed through the lens of the Malaysian Higher Education Plan 2026-2035 and the National Green Technology Policy. While Malaysian Higher Education Institutions (HEIs) have successfully adopted operational green campus initiatives such as the UI Green Metric, there remains a fragmented approach to curricular reform. By combining the holistic, multi-dimensional UNESCO ESD framework with Malaysia's specific higher education policies, this research establishes the theoretical necessity to develop Holistic Green Curriculum framework for ESD subjects in Malaysian higher education institutions. The developed envisaged to explicitly

transiting Malaysian HEIs from surface operational greening initiatives to transformative pedagogy encompassing cognitive, affective, and psychomotor domains.

While global and national mandates establish the structural necessity of a holistic green curriculum, the operationalization of this framework is grounded in three established educational theories. The Systems Thinking Theory provides the cognitive foundation for integrating the Brundtland Commission's tripartite pillars which are economic, environmental, and social [32]. It posits teaching learners to perceive climate change not as an isolated environmental issue, but as a complex web of interrelated global systems [32]. The second theory that relevant to this study is Transformative Learning Theory which suggests the shift from passive awareness to active responsibility, it is because the climate change education requires profound shifts in attitudes and behaviors that requires a transformative approach to disrupt students' pre-existing assumptions and foster deep affective engagement with planetary health [33]. Another theory that relates to this study is Experiential Learning Theory. The theory bridges the gap between theoretical knowledge and practical action which dictating the sustainability competencies are best acquired through active, reflective engagement with real-world problems [34]. Together, these theories form the pedagogical engine of the proposed Holistic Green Curriculum framework that proposed in this study.

METHODOLOGY

This study has divided into two parts; in the first part, we have conducted several steps in the selection of the universities and respective undergraduate programme that we want to analyse in terms of (i) subject(s) related to ESD and (ii) the learning outcomes of the ESD subject(s).

To evaluate the current state of Education for Sustainable Development (ESD) and the integration of Climate Change Education (CCE), the first phase of this study involved a systematic document analysis of undergraduate curriculum frameworks. A total of 20 undergraduate programmes were analyzed, with two programmes selected from each of the 10 participating Malaysian universities – University A to University K.

These 10 universities were chosen utilizing cluster sampling strategy designed to ensure broad representativeness of the Malaysian higher education landscape. The clusters were defined by two primary variables: geographical location—encompassing the Northern, Central, Southern, Eastern, and Borneo regions—and institution type, ensuring a balanced inclusion of both public and private universities.

While for the critical criterion for programme selection was the deliberate exclusion of environmental science or sustainability-specific degrees because those programmes must educate the learners on the climate change and environmental issues in their ESD related subjects. Thus, to avoid biasness in the curriculum analysis, we have excluded those programmes in this study.

The mainstream undergraduate programmes across diverse disciplines such as Engineering, Accountancy, Mass Communication, and Education were chosen to obtain the reality of ESD paradigm in Malaysian HEIs. This approach was intentionally taken to assess the extent to which ESD and CCE are integrated into general tertiary education, reflecting the necessity for all future professionals, regardless of their specific field that may facilitate to develop multi-dimensional sustainability competencies among undergraduates.

Evidence for this phase was collected through the direct examination of official university curriculum documents. The researchers analyzed (i) course pro forma outlines, (ii) syllabi, (iii) course synopses, and (iv) documented learning outcomes.

To ensure the highest level of data validity and authenticity, we make sure that the collection of these curriculum documents was strictly conducted adhering to the formal verbal agreements and permissions obtained from the respective Deans or Heads of Departments at each chosen university. These verified documents were then systematically reviewed to identify the presence and depth of ESD and CCE components.

The courses were categorized into two distinct groups based on explicit textual evidence:

Group 1 - ESD with explicit CCE components: A course was classified into Group 1 if the curriculum documents contained clear, explicit phrasing indicating the teaching of climate change or specific green education topics. During the coding process, the researchers scanned for specific keywords and terminologies within the synopsis, learning outcomes, or weekly content. Wording that qualified a course for Group 1 included explicitly mention "climate change," "climate crisis," "global warming mitigation," "carbon footprint," "greenhouse gas emissions," or "green technology applications". If a course dedicated specific learning outcomes or weekly modules to these exact topics, it was coded as Group 1.

Group 2 -ESD without explicit CCE components: A course was classified into Group 2 if it covered general sustainability, ethics, or community development but lacked any targeted focus on climate change. For instance, university core subjects such as Appreciation of Ethics & Civilization or general Community Service often touch upon general societal sustainability or environmental cleanliness. However, if the course synopsis and weekly content relied only on broad, generic terms such as civic responsibility, environmental awareness, or general ethics without any explicit reference to the climate crisis or actionable climate education terminology, it was coded as Group 2.

To design innovative strategies for the Holistic Green Curriculum, the second phase of this study employed a participatory research methodology. Two domain experts were purposefully selected based on strict criteria regarding their professional tenure and subject matter expertise, whereby Expert A is a climate change advocate with over 10 years of direct engagement in environmental non-governmental organizations, while Expert B is a senior academic with over 15 years of experience instructing ESD subjects within Malaysian higher education.

To ensure the framework was data-driven rather than purely conceptual, the collaborative process was conducted through a series of semi-structured focus sessions and rigorous, iterative feedback loops. This process was structured into three validation rounds:

Round 1 - Drafting & Elicitation: The researchers presented the baseline empirical findings from Phase 1—specifically identifying the critical lack of explicit CCE in current ESD subjects—to the experts. The experts were guided by targeted prompts, such as: "Based on the current curriculum gaps, what pedagogical approaches and learning environments are necessary for undergraduates to bring in the holistic green curriculum in ESD?"

Round 2 - Feedback & Refinement: The discussions were transcribed, and an initial framework was drafted based on the experts' insights. This preliminary model was presented back to the experts in a subsequent session for critical review, allowing them to correct misinterpretations, refine the pedagogical strategies, and ensure the strategies addressed the empirically identified gaps from Phase 1.

Round 3 - Finalizing & Consensus: The revised Holistic Green Curriculum model was evaluated against both local HEI constraints and international ESD mandates. Final adjustments were made, and intersubjective validation was achieved when both experts and the research team reached a full consensus on the final structural components of the framework.

To systematically interpret the expert feedback, all focus group discussions were audio-recorded, transcribed verbatim, and subjected to a reflexive thematic analysis. The coding procedure was conducted utilizing manual coding approach. First, the researchers familiarized themselves with the data, generating initial, granular codes related to pedagogical needs, assessment strategies, and environmental awareness.

To establish coding reliability and mitigate researcher bias, an independent double-coding approach was utilized. Two researchers independently coded the transcripts, and any discrepancies were resolved through consensus meetings. These initial codes were subsequently aggregated and mapped into broader, meaning-based themes. This analytical coding procedure directly informed the three core pillars of the proposed framework: (i) Learning Outcomes, (ii) Learning Approaches, and (iii) Learning Environment.

For thematic saturation, the study relied on the principle of information power and theoretical sufficiency [35]. Given the highly specialized, long year of expertise of the selected individuals, the data yielded exceptionally

dense and contextually relevant insights. Furthermore, the iterative validation loops continued until no new structural components or sub-themes for the framework emerged from the expert discussions, indicating operational saturation for the development of this exploratory model.

FINDINGS AND DISCUSSION

Table 1 shows consolidated summary of investigated undergraduate programmes by Region, Discipline, and CCE Classification.

Table 1: Summary of investigated undergraduate programmes by Region, Discipline, and CCE Classification for University A to University K.

Geographical Region	University	Institution Type	Programme	ESD Classification
Northern Cluster	University A	Public	Bachelor of Accountancy	Group 2
Northern Cluster	University A	Public	Bachelor of Science (Information Technology)	Group 2
Northern Cluster	University B	Private	Bachelor of Engineering	Group 2
Northern Cluster	University B	Private	Bachelor in Early Childhood Education	Group 2
Central Cluster	University C	Public	Bachelor of Engineering	Group 1
Central Cluster	University C	Public	Bachelor of Counselling	Group 2
Central Cluster	University D	Private	Bachelor of Mass Communication	Group 1
Central Cluster	University D	Private	Bachelor of Accountancy & Finance	Group 1
Southern Cluster	University E	Public	Bachelor of Technology (Digital Construction Mgt.)	Group 2
Southern Cluster	University E	Public	Bachelor of Biotechnology	Group 2
Southern Cluster	University F	Private	Bachelor of Engineering (Bio-Medical)	Group 1
Southern Cluster	University F	Private	Bachelor of Science (Human Resource Development)	Group 1
Eastern Cluster	University G	Public	Bachelor of Entrepreneurship	Group 2
Eastern Cluster	University G	Public	Bachelor of Information Technology	Group 2
Eastern Cluster	University H	Private	Bachelor of Manufacturing Engineering Technology	Group 2
Eastern Cluster	University H	Private	Bachelor of English with Communication	Group 2
Borneo Cluster	University J	Public	Bachelor of Communications	Group 2

As summarized in Table 1, a total of 20 undergraduate programs were analyzed across 10 HEIs. The consolidated findings reveal that only 25% (5 out of 20) of the investigated programs explicitly integrate CCE components into their ESD-related subjects, qualifying them for Group 1. On the other hand, the vast majority—75% (15 out of 20)—fall into Group 2, relying solely on general university core subjects such as Appreciation of Ethics and Civilization that educate the learners upon sustainability superficially without any explicit or dedicated climate change education.

When contrasting public and private higher education institutions (HEIs), a clear disparity in curricular agility emerges. Out of the 5 programs that successfully integrated explicit CCE components (Group 1), 4 were housed within private universities (University D and University F), while only 1 belonged to a public university (University C). Conversely, public universities dominated the Group 2 classification. This pattern suggests that private HEIs in Malaysia embed climate change components into their ESD. Public universities, conversely, appear constrained by highly rigid institutional approval ecosystems and a heavy over-reliance on standardized, national general core modules mandated for regulatory compliance.

From the location perspective, Central and Southern Clusters contain 100% of the Group 1 programs identified in this study. Specifically, 75% of evaluated programs in the Central Cluster (University C and D) and 50% of programs in the Southern Cluster (University F) feature explicit CCE integration. The Northern, Eastern, and Borneo Clusters exhibit a profound educational deficit for explicit CCE across all analyzed programs. In these

regions, sustainability education remains entirely confined to surface-level university core subjects.

The comparative analysis also found that the engineering programs at University C and University F achieved Group 1 status due to vast, explicit CCE exposure in ESD. The engineering program at University B in Group 2, the ESD related subject(s) relying on ethical concepts rather than focused climate change related elements. Similarly, while accountancy and finance at University D actively operationalized explicit sustainability thinking, accountancy program at University A offered non explicit climate change modules. This indicates that Malaysian HEIs are not yet systematically enforcing explicit and uniform climate literacy mandates across disciplines. It is vital in which an undergraduate receives appropriate climate change education depends entirely on the curriculum structure. At the same time, the disciplinary integration remains entirely fragmented that may leave future professionals unprepared to manage the global climate crisis that mentioned in the Malaysian National Green Technology Plan under the education initiatives.

The empirical findings of this study reveal a critical structural disconnect between global sustainability mandates, localized Malaysian higher education realities, and the pedagogical theories necessary to drive for efficient CCE in HEIs in Malaysia referring to the Thrust 9 of Malaysian Higher Education Plan 2026-2035 which emphasized on Sustainability and Planetary Health. Out of the 20 analyzed undergraduate programs, an overwhelming 75% (15 programs) fall into the Group 2 classification, meaning they lack explicit Climate Change Education (CCE) and rely purely on general university core subjects.

Analyzing this deficit through the lens of Systems Thinking Theory exposes a fundamental pedagogical shortcoming in the current Malaysian higher education landscape. Systems Thinking posits that learners must perceive climate change not as an isolated issue, but as a complex web of interrelated environmental, social, and economic pillars. Recent studies similarly [36,37,38] show that traditional teaching methods often fail to engage students meaningfully in sustainability learning, requiring skill-based and inquiry-driven approaches to align with the principles of Education for Sustainable Development (ESD). However, the document analysis shows that sustainability concepts are heavily condensed within compulsory modules required by the Malaysian Qualifications Agency (MQA). While these courses satisfy local regulatory compliance, they treat environmental protection as an abstract ethical sub-topic rather than a systemic crisis. Moreover, current literature on climate change education highlights that an overemphasis on cognitive knowledge usually neglects socio-emotional and behavioral learning aspects [39,40].

The empirical data exposes a clear paradox when evaluated against Malaysia's national sustainability achievements, a phenomenon that can be described as curricular decoupling. Majority of the investigated HEIs maintain strong positions in global environmental benchmarks, yet majority of the investigated institutions of their mainstream curricula fail to explicitly articulate climate change issues to students.

To rectify this decoupling, institutions must look toward Transformative Learning Theory, which dictates that education must disrupt pre-existing assumptions to foster profound shifts in attitudes, behaviors, and intentions, such as addressing the root causes of climate change and varying vulnerabilities [41]. The current reliance on Group 2 macro-level ethics courses limits learning to passive, cognitive memorization for exams. Without explicitly incorporating affective and psychomotor domains into CCE, universities were not able to facilitate the necessary to cultivate deeply committed, climate-ready graduates who are sensitive to planetary health [42]. This aligns with recent advocacy for a systemic reorientation of educational policies toward transformative action in learning settings, recognizing that education must move beyond mere knowledge transmission.

The profound educational deficits mapped in this study underscore the necessity of a Holistic Green Curriculum framework. The framework that proposed in this study may serves as an actionable and theory-driven intervention. This approach shifts the focus away from curriculum design meant solely for the attainment of abstract competencies, toward meaningful experiences where competencies are developed through direct action and critical self-reflection by learners.

The framework actively corrects the passive delivery mapped in the Group 2 of the study. Experiential learning theory that highlights hands-on involvement and collaborative problem-solving experiences, which move beyond rote learning to empower students to think and act sustainably. In addition, whole-institution approaches that

emphasize coherence across curriculum and campus operations have been shown to yield stronger sustainability learning outcomes. By anchoring the tripartite model in these pedagogical theories, the framework operationalizes global climate mandates within the strict structural boundaries of Malaysian higher education.

Strategies for Holistic Green Curriculum in ESD

In building a holistic green curriculum for education for sustainable development in Malaysian higher education institutions, it is pivotal to identify the aspects and the strategies that may be implemented in order to instill the appropriate knowledge, skills, and values that can build a climate-ready undergraduate.

These aspects that are proposed are believed to not only foster a more holistic understanding of climate change but also craft the path for more critical steps to develop green skills and values among the learners.

Education should engage and, at the same time, mold the learners' mindset and characteristics in relation to sustainability and climate change. Mocan et al. [26] cited that educational methodologies have vast impacts on students' perceptions of pro-sustainability initiatives and cultivating sensitivity towards the environment. This underscores the significance of understanding what, how, and where the learning process should happen for green and sustainable development education.

It is essential for learners to grasp the nuances of climate-related changes; this understanding ought to act as a stimulus for constructive shifts in attitudes, behaviors and intentions towards planetary health. Educational settings must encourage responsibility and optimism among students.

Three aspects were identified from the participatory research method that was carried out by the researchers with the group of experts for an effective learning process of green education; they are as follows:

1. Learning Outcomes

Learning outcomes are the key elements in the learning process that have shared responsibilities between both the educators and undergraduates [27]. When it comes to a holistic green curriculum in Malaysian higher education, it is important to have a vivid picture of the outcomes that need to be achieved via the teaching and learning process. The outcomes must be aligned with both national and international policy for climate change and sustainable development. Theoretically, these outcomes must be driven by Systems Thinking Theory and Transformative Learning Theory. By applying Systems Thinking, the learning outcomes ensure that students grasp the complex interplay across all three dimensions—environmental, social, and economic—of sustainability holistically. Simultaneously, drawing on Transformative Learning Theory, the outcomes must target deep perspective shifts by encompassing all three learning domains—cognitive, psychomotor, and affective. The cognitive domain provides the essential knowledge of climate science and economic policy. The affective domain fosters the ethics and empathy required for social equity and environmental stewardship, creating the transformative shift in mindset. Finally, the psychomotor domain develops the practical skills needed to implement tangible solutions. To ensure learning outcomes explicitly address climate change, HEIs should mandate a university-wide revision of ESD-related subjects whereby, rather than utilizing generic objectives, institutions must require at least one measurable CCE learning outcome.

2. Learning Approaches

From the learning approach perspective, as cited by [28], the student-centered approach is the core pedagogical strategy that needs to be implemented in the teaching and learning process of green education. This strategy is fundamentally supported by Experiential Learning Theory, which posits that students learn most effectively through active experimentation and reflection. To instill the appropriate knowledge and values that can bring forward the paradigm shift among the learners on sustainability and climate change, the learning approaches must be focused on self-directed and participatory learning. This enables learners to understand the significance of the climate crisis more responsibly and advocate for sustainability both individually and within their communities. The students need to be equipped with the right skills to address climate and sustainability issues via experiential and participatory approaches. Another point that is worth focusing on is the indigenous knowledge infusion in the content of the subject, especially in exposing the learners to managing the climate crisis utilizing the

knowledge and skills of the indigenous community, which is deemed to be an effective approach in environmental protection [29]. Such an approach will equip the students with both modern and traditional ways to manage climate change issues. To actualize student-centered and experiential learning, universities should implement interdisciplinary Problem-Based Learning (PBL) geared towards local climate challenges in ESD-related subjects [30]. For example, capstone projects could ask teams from different departments to come up with and put into action ways to cut down on waste in the communities around them. At the same time, in integrating indigenous knowledge, HEIs should move beyond textbook examples by formally partnering with local indigenous communities, which involves inviting indigenous practitioners as guest lecturers and conducting practical workshops on traditional ecological knowledge, such as sustainable agricultural practices and local biodiversity conservation.

3. Learning Environment

The classroom is the most pivotal point for learning sustainability in higher education institutions, but it cannot be the only one. Rooted in the principles of Experiential Learning Theory, higher education institutions and educators need to provide dynamic platforms that move beyond traditional classroom walls to develop the knowledge, skills, and values of the learners. Mandating structured field excursions, such as site visits to climate change-affected areas, can trigger deep affective learning and empathy, fundamentally changing the way learners perceive the climate crisis [30]. Involvement in climate change campaigns, exhibitions, and awareness projects develops their attitude, behavior, and intention toward sustainability [31]. To fully embrace experiential learning, universities must transform their campuses into living labs, allowing learners to actively monitor, test, and manage campus green technologies—such as solar micro-grids or composting sites—as direct components of their coursework. Moreover, artificial intelligence (AI) must be effectively utilized to show students how technology can be used efficiently for sustainable decision-making, reinforcing the systems thinking approach to climate management.

Figure 1 illustrates the proposed strategies for a holistic green curriculum for ESD. By merging these three important components, it aligns with global goals by empowering students to understand, care for, and actively build a balanced future. This synergy ensures that sustainability is not just a concept studied but a practice lived.

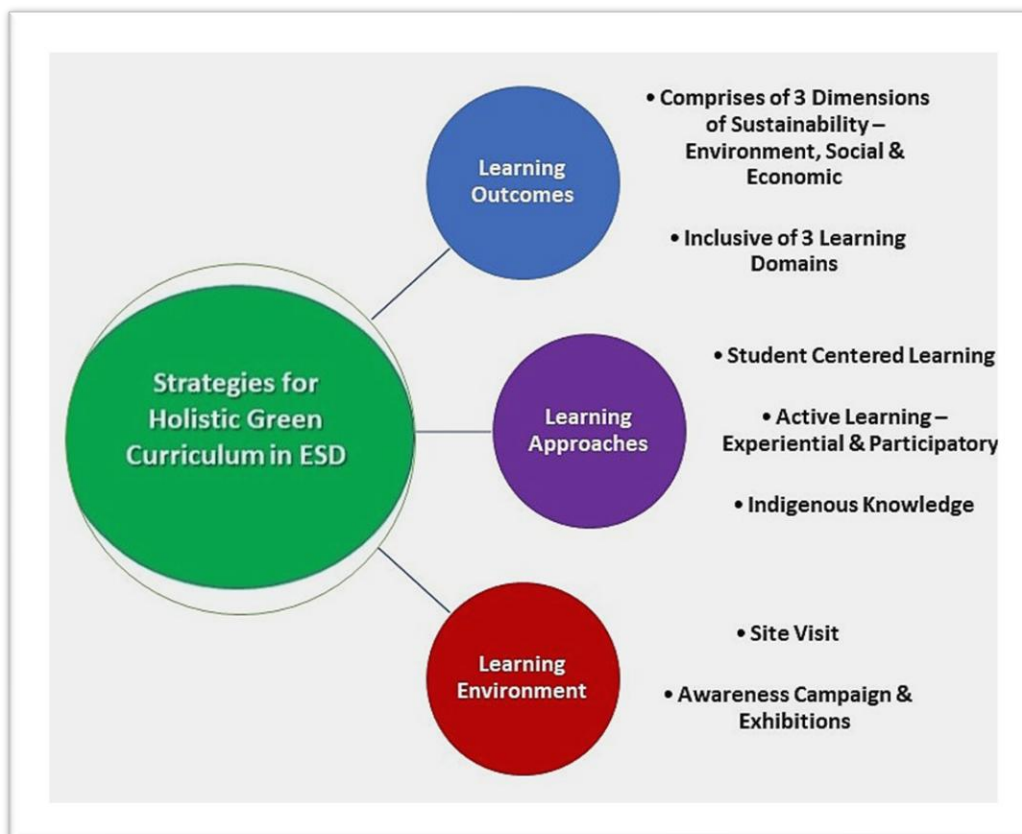


Figure 1: Framework for Holistic Green Curriculum for ESD

LIMITATIONS OF STUDY

While this study provides critical insights into the current state of Education for Sustainable Development (ESD) and the integration of Climate Change Education (CCE) in Malaysian Higher Education Institutions (HEIs), it is subject to several limitations.

First, the research features a limited sample size, analyzing 20 undergraduate programmes across 10 universities. To minimize the impact of this limitation and ensure the findings remain representative, the researchers employed a rigorous cluster sampling approach. This strategy ensured that the selected HEIs captured a diverse cross-section of the Malaysian higher education landscape, encompassing both public and private institutions across five distinct geographical regions.

Second, the identities of the investigated universities were anonymized. While anonymization prevents the reader from linking specific curriculum gaps to named institutions, this measure was intentionally taken to maintain confidentiality and encourage institutional cooperation. To offset this limitation, detailed metadata regarding the region, institution type, and programme disciplines were preserved and analyzed, allowing clear macro-level patterns to emerge without compromising ethical boundaries.

Third, the methodology in the first phase relied heavily on available curriculum information, specifically document analysis of course syllabi and learning outcomes. Document analysis alone may not fully capture the unrecorded, implicit pedagogical practices of individual educators who might informally introduce CCE in their classrooms. To minimize this gap, the researchers ensured the highest data validity by securing official, verified curriculum documents following direct verbal agreements from the respective Deans or Heads of Departments, ensuring the study accurately measured the curriculum mandated by the institutions.

Finally, the participatory research phase involved a small panel of only two experts for the framework development. To mitigate the limitation of a small sample size in this qualitative phase, the researchers prioritized profound domain expertise over quantity. The selected individuals possessed highly specialized and extensive decadal experience: one as a climate change advocate with over 10 years of NGO engagement, and the other as an ESD educator with over 15 years of instructional experience in HEIs. This ensured that the proposed Holistic Green Curriculum framework was grounded in rich and deeply contextualized professional insights.

CONCLUSIONS

This study suggests a significant disparity in Malaysian Higher Education Institutions between operational greening and curricular depth. While national policy frameworks exist, the analysis of 10 universities reveals that most institutions still relegate Education for Sustainable Development to a superficial level within general core subjects whereby the data suggests it is time to address the missing link in which a robust, integrated curriculum is necessary in ESD.

To bridge this gap, the study proposes a Holistic Green Curriculum model that shifts from narrow environmentalism to a tripartite integration of sustainability dimensions with the three strategic pillars included in the model; (i) learning outcomes that aligning with international policies to cover cognitive, psychomotor, and affective domain, (ii) learning approaches which adopt student-centered, experiential, and indigenous-knowledge-based pedagogy to foster a sense of individual responsibility and (iii) learning environment that expanding education beyond the classroom via site visits, sustainability campaigns, and the strategic use of AI for decision-making.

Ultimately, this shift is vital to cultivate climate-ready graduates who possess the values and holistic thinking necessary to protect the biosphere and navigate the global climate crisis effectively.

Building upon the findings and the proposed Holistic Green Curriculum framework, future direction of the study can be focused on the empirical validation and implementation of the proposed framework. While this study established the theoretical and structural necessity of the model, future research should pilot the actionable initiatives that proposed in the framework. While, future studies should actively engage academic staff in ESD

related subjects through surveys, interviews, or classroom observations. Understanding the specific barriers educators face—whether due to a lack of climate literacy, structural constraints, or insufficient pedagogical training—will be crucial for ensuring that the integration of Climate Change Education is effectively delivered in practice.

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DECLARATIONS

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Ethical Approval

This research has obtained verbal consent from the studies Higher Education Institutions for the document analysis and verbal agreement to record and analyse experts' view during the framework design.

Dual publication

The results/data/figures in our submission have NOT been previously published, and NOT under consideration for publication elsewhere.

Authorship

The authors understood the journal policies and we are submitting our manuscript in accordance with those policies.

Permission to use third-party material

Not necessary

Data availability

The materials described in the manuscript, including all relevant raw data, will be freely available to anyone wishing to use them for non-commercial purposes, without breaching participant confidentiality, from the corresponding author.

Consent to Publish

Not applicable

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