



A Conceptual Framework for Embedding Sustainability Competencies into Higher Education Pedagogies for Achieving the SDGs

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Abstract: This theoretical paper proposes a novel conceptual framework interrelating Sustainability Competencies (C1) and Pedagogical Strategies (C2) in Higher Educational Institutions (HEIs) to expedite achievement of the Sustainable Development Goals (SDGs). Although Education for Sustainable Development (ESD) has become standard as the impetus behind SDG implementation, the academic imbalance between high-level policy objectives and classroom pedagogical practice remains a prominent challenge of the SDG implementation process. The paper uses a methodical conceptual synthesis of available literature in ESD, key competency models, and organizational theory. The resulting framework formally defines and incorporates five central constructs (C1-C5)—namely Competencies (C1), Pedagogy (C2), Institutional Enablers (C3), Learning Mechanisms (C4), and SDG-aligned impact (C5)—and shows how these constructs are causally and moderately linked. The model presents four testable propositions that can be empirically tested which give a strong foundation upon which ESD integration can have a guideline and assessment. This paper bridges a conceptual gap by connecting two established yet often distinct discourses: competency-based ESD and pedagogical design. Its unique contribution lies in specifying actionable competency–pedagogy matches, clarifying the mechanisms through transformative and organizational learning, and integrating these five constructs into a causal, testable frame (C1–C5).

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1. INTRODUCTION

Higher Education Institutions (HEIs) are under immense pressure to meet the reality of the global environmental and social crises stipulated by the United Nations Sustainable Development Goals (SDGs). Being the hubs of knowledge, the engine of innovation, and the future leaders, universities are in the best position to support the transformational change that is needed to achieve the SDGs by 2030 (Lozano *et al.*, 2015). However, there is a lack of conceptual correspondence of the strategy of HEI and SDGs. The big question is whether it is possible to go beyond a conceptual alignment and the practical curriculum design, that is, how the philosophical goals of the Education for Sustainable Development (ESD) can be incorporated in the teaching processes in a way that enables the development of the key student competencies (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2017; Wiek *et al.*, 2011). This required shift is part of the wider acceptance of Universities in their Social Responsibility (USR) as a fundamental driver to the implementation of sustainable development (Bokhari, 2017). Although the idea of using active and experiential pedagogies is backed by numerous schemes, the gap in the system is still present: the system lacks a solution model that could explicitly relate:

Development of student competence (C1)

Teaching approaches (C2)

Strategic support of the institution (C3)

Learning theories (C4)

To generate measurable SDG-consistent impact (C5).

Although previous studies established required core competencies (Wiek *et al.*, 2011) and necessary changes in pedagogy (Lozano *et al.*, 2017), a comprehensive system that integrates these elements with organizational facilitators and learning processes has remained underexplored.

To fill this knowledge gap, this paper proposes a new conceptual framework of incorporating ESD into the curriculum of higher education institutions. The framework aims to go beyond the identification of the necessary elements

by elaborating on the causation links among them, thus creating a systematic foundation for empirical research and strategic planning. This model is constructed on the assumption that student competency acquisition will be maximized when pedagogical approaches (C2) are accompanied by strong institutional enablers (C3) and mediated by efficient learning mechanisms (C4).

The paper is divided into several sections as follows: Section 2 introduces the literature review of the five core constructs (variables). Section 3 explains the research methodology and design logic. Section 4 shows the combined conceptual framework, which establishes the cause-and-effect relationships and testable propositions (P1-P4), including the pedagogy-competency alignment matrix (Table 2). Section 5 formalizes these testable propositions. Section 6 employs three illustrative case studies to show how the framework is applicable in practical HEI environments. Lastly, Sections 7 and 8 provide a discussion on the implication of the framework on research, practice, and policy.

To address this critical gap and ground the proposed solution in established scholarship, the following section reviews the state of the art for the five core constructs that form the basis of the conceptual framework.

2. LITERATURE REVIEW: CORE CONSTRUCTS IN ESD

The proposed conceptual framework synthesizes four distinct yet interrelated constructs from the Education for Sustainable Development (ESD) literature that are crucial for successful curriculum integration in Higher Education Institutions (HEIs): Sustainability Competencies (C1), Pedagogical Approaches (C2), Learning Mechanisms (C4), and Institutional Enablers (C3). This section reviews the scholarly basis for the integrated model presented in Section 4.

Sustainability Competencies (C1)

Sustainability competencies outline the knowledge, skills and dispositions that graduates must be equipped with to enable them to deal with intricate and intertwined sustainability issues (Barth *et al.*, 2007; Rieckmann, 2012). Although the field has many models that underline it, this paper is founded on the powerful model proposed by Wiek *et al.* (2011), which defines five action-based competencies, namely Systems Thinking, Anticipatory, Normative, Strategic, and Interpersonal. This model is widely used due to its practical

focus on the skills that are directly applicable to solving complex problems in HEIs. The aim of C1 is to give a clear, measurable objective to curriculum change, which moves education toward the provision of graduates with the agency to implement SDG solutions. These competencies require a change in instructional design.

Pedagogical Approaches (C2)

Sustainability competencies necessitate a shift to active, experiential, and cross-disciplinary pedagogies, moving beyond traditional, teacher-centered instruction (Aleixo *et al.*, 2018). These methods are needed because they enable students to face complexity, uncertainty, and differing stakeholder values--real-world experiences that are essential in creating skills such as Systems Thinking and Interpersonal Collaboration (Barth *et al.*, 2007). The pivotal debate (Alguren, 2021; Kolmos, 2018) does not focus on whether new pedagogies are required, but rather on how to ensure their consistency with the intended competencies, a goal explicitly called for in the ESD roadmap (UNESCO, 2020). According to Lozano *et al.* (2017), to develop a particular set of competencies, specific methodologies are most suitable in terms of their structure, such as Problem-Based Learning, Service Learning, and Reflective Practice. It is this congruence that forms the basis for the alignment matrix presented in Section 4.3, arguing that successful **ESD** requires intentional design of instructional components, not merely generic experiential learning.

Learning Mechanisms (C4)

The process of transformation of experience into long-term competency that active pedagogy (C2) induces is the Learning Mechanisms (C4) that determines its efficacy. This element is dedicated to two fundamental processes that connect educational philosophy and ESD success: Transformative Learning and Organizational Learning.

Transformative Learning: This is a perspective in which one critically analyzes the beliefs (or meaning structures) that are strongly held by an individual against new information, which is based on the work of Mezirow (1997). It is a paradigm shift that is required in ESD because the challenge of sustainability might require that the learner questions fundamental assumptions of economic growth, consumption, and accountability. This

is an internalized transition, thus successfully developing Normative and Self-Awareness competencies.

Organizational Learning: According to Sterling (2010), this is related to how institutions learn and how institutions transform their structures, processes and culture. To achieve success, ESD itself needs to take things to the next level of integrating individual departmental initiatives into institution-wide ones. C4 thus mediates the framework, implying that success in ESD is dependent on student learning (transformative) and adaptability at the institutional level (organizational).

Institutional Enablers (C3)

Without strong Institutional Enablers (C3), the Education for Sustainable Development (ESD) cannot be continued. These aspects, such as leadership commitment, formalized policy, dedicated resources and defined quality assurance guidelines, make up the environment, which is required to have faculty members adopt new and frequently time-consuming pedagogical methods (Aleixo *et al.*, 2018). This supportive environment embodies the institutional commitment required for USR to be effective, which forms the bedrock for integrating sustainability into education (Bokhari, 2017). The latest literature on institutional change agents (Mogren *et al.*, 2024; Weiss *et al.*, 2023) demonstrates that ESD implementation is often limited by structural elements, including disorganized departmentalization. Therefore, strong policy conditions at the top, coupled with support networks among the faculty at the bottom, are needed to steer the relationship between pedagogical intention (C2) and competency output (C1) with moderators. The recommendations made by various organizations, including the QAA/Advance HE (2021), are categorical that successful curriculum alignment requires institutional leadership to be committed to policy and allocation of resources. Having established the academic basis of each core construct, the following section describes the logical procedure used to integrate these parts into one whole, integrated, and testable conceptual framework.

3. RESEARCH METHODOLOGY

The conceptual and descriptive methodology underlying this paper strives to organize the often-heterogeneous findings of the Education for Sustainable

Development (ESD) literature into a unified, integrated, and falsifiable model. The approach is relevant in that, although the elements of the research (competencies, pedagogies, learning theories) have been analyzed individually, the interactions between them, in their dynamism and integration, have not been formally structured for empirical testing. The design rationale is as follows:

Step 1: Identification of Variables and Synthesis

The first one involved a general conceptual literature review of organizational research and educational psychology and ESD research material (including significant publications by Wiek, Lozano and Sterling) to identify the five basic constructs or constructs that always establish the effectiveness of ESD implementation at work: (C1 - C5). The process of synthesis was based on the comparative analysis of different conceptual models to clearly explain each variable and its empirical applicability to the context of Higher Education Institutions (HEIs).

Step 2: Operationalizing ESD: The Competency Framework

The challenge in ESD is that the vision is too broad and interdisciplinary, requiring conversion into quantifiable results. Other competency frameworks applied here, namely the ones on the foundation of Wiek *et al.* (2011), are not the philosophical underpinning of ESD (which dates to decades before the competency movement). Instead, these competencies can be utilized as a practical means of operationalization of the general objectives of ESD into a contemporary higher education environment, enabling institutions to convert the ambitious objectives of Sustainable Development Goals (SDGs) into quantifiable learning outcomes. The model by Wiek *et al.* (2011) gives the priority in this paper because action-oriented competencies are considered.

Step 3: Conceptual Model Construction

The final stage involved constructing the conceptual framework itself (Section 4). Based on established theory in educational psychology (Mezirow, 1997) and organizational development (Sterling, 2010), the model explicitly outlines the hypothesized causal relationships:

Direct Relationships: Establishing the foundational $C2 \rightarrow C1 \rightarrow C5$ flow.

Mediation: Integrating Learning Mechanisms (C4) to explain the process by which pedagogy affects competency gain.

Moderation: Positioning Institutional Enablers (C3) to account for the contextual strength of the relationships.

This systematic building results in the four testable propositions (P1 through P4), which offer a systematic and rigorous basis for future empirical studies, including structural equation modeling (SEM) or big data comparative studies.

Using the systematic conceptual synthesis described above, the substantive part of the paper is the development of the novel conceptual framework, which is a synthesis of these constructs, and offers a complete guide to the implementation of ESD.

4. THE CONCEPTUAL FRAMEWORK

The substantive section of the paper develops a new conceptual framework that integrates sustainability competencies, pedagogies, institutional facilitators and learning processes to implement Education for Sustainable Development (ESD) within post-secondary schools. This model facilitates bridging the conceptual gaps in literature by integrating the purposes of learning, pedagogy, and institutional conditions into the realization of SDG-linked learning outcomes in an organic manner. This is an all-encompassing and very useful guideline that assists researchers and practitioners to plan, implement and evaluate ESD initiatives.

Core Variables

The framework is developed around five key variables as they are offered as a causal chain. Each variable is defined as empirically testable and is based on the existing literature as elaborated in Table 1.

The Conceptual Framework and Testable Propositions

The central model shows the postulated cause and effect relationships between the five constructs (C1-C5). The effectiveness of pedagogical methods is related to its correspondence to the desired sustainability competencies (C2), which are needed to respond to complex sustainability challenges (Wiek *et al.*, 2011).

**Table 1: Core Constructs of the ESD Integration Framework (C1–C5):
Definitions and Scholarly Basis**

Construct	Definition	Literature Support
C1. Sustainability Competencies	The knowledge, skills, and dispositions that enable graduates to address complex sustainability challenges.	Barth <i>et al.</i> , 2007; Wiek <i>et al.</i> , 2011; Rieckmann, 2012
C2. Pedagogical Approaches	Active, experiential, and participatory teaching methods essential for facilitating the development of sustainability competencies (C1).	Barth <i>et al.</i> , 2007; Lozano <i>et al.</i> , 2017
C3. Institutional Enablers	Organizational structures, policies, and resources that facilitate the integration of ESD.	QAA/Advance HE, 2021; Mogren <i>et al.</i> (2024)
C4. Learning Mechanisms	Processes through which pedagogical approaches lead to competency acquisition, including transformative and organizational learning.	Mezirow, 1997; Sterling, 2010
C5. SDG-Aligned Learning Impact	Tangible outcomes reflect competency acquisition, learner agency, and the integration of SDGs into coursework, projects, and research activities.	Ferrer-Estévez & Chalmeta, 2021; Abo-Khalil, 2024

More importantly, this model outlines the contextual factors and mechanisms involved. Transformative learning and organizational learning are these mediation processes (C4) that transform pedagogical input to the competency acquisition (Mezirow, 1997; Sterling, 2010). Moreover, the process is moderated by institutional enablers (C3: leadership and policy support) that provide the required supportive environment in the implementation process (QAA/Advance HE, 2021).

Lastly, a combination of these variables contributes to SDG-oriented learning impact (C5) which deals with the level in which the students are learning, and their sense of agency, which puts Sustainable Development Goals (SDGs) into the context of learning and projects (Ferrer-Estevez and Chalmeta, 2021). The final framework is presented in Figure 1.

Pedagogy–Competency Alignment

One of the key aspects in realizing the benefits of the relationship between teaching approaches and learning objectives is the deliberate attempt to align

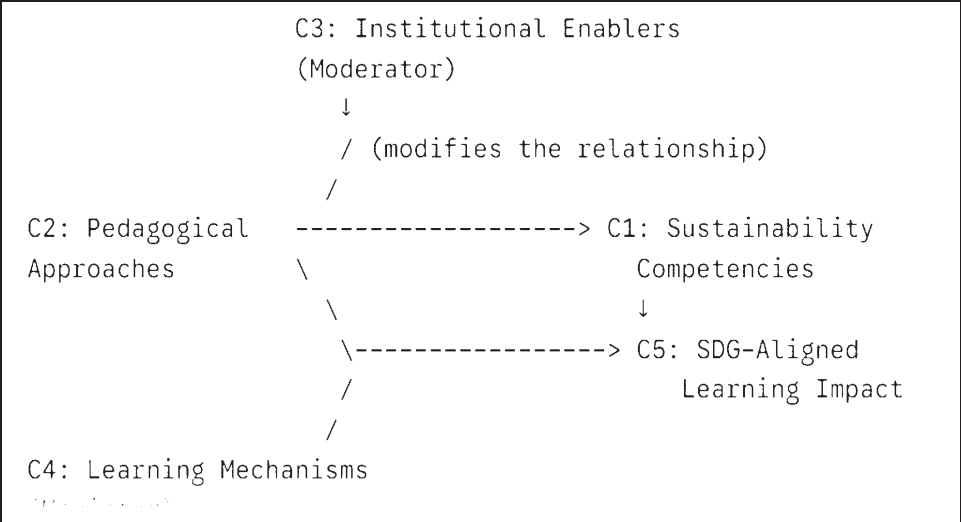


Figure 1: Conceptual Framework for ESD Integration (Causal Model)

Source: Developed by author

the methods of instruction with individual learning objectives. To implement the framework, we must identify how pedagogical methods correlate with the competencies they best develop.

Justification for Alignment

The rationale behind the chosen matrix is that the active pedagogies are structurally necessitated to form action-oriented competencies (Lozano *et al.*, 2017; Frisk & Larson (2011). As an example, Problem-Based Learning offers structural support to Systems Thinking because it involves students tracing the intricate interdependencies, whereas Reflective Practice is pertinent to the development of Self-Awareness and Normative Competencies since it compels an individual to explicitly reflect on their own values and moral judgment. Although numerous methods are associated with developing broad skills (e.g., it is true that Service Learning involves Interpersonal competence), the alignment presented revolves around the most structurally appropriate pedagogical approach that will help to substantially support the competence, according to the reviewed literature.

The alignment, i.e. what pedagogical strategies best fit the structural requirements of developing sustainability competencies is formalized in Table 2.

Table 2: Mapping Active Pedagogies to Key Sustainability Competencies (C2 C1 Alignment)

<i>Pedagogical Approach</i>	<i>Systems Thinking</i>	<i>Anticipatory</i>	<i>Normative</i>	<i>Strategic</i>	<i>Interpersonal</i>	<i>Collaboration</i>	<i>Critical Thinking</i>	<i>Self-Awareness</i>
Problem-Based Learning	✓	✓		✓	✓	✓	✓	
Project-Based Learning	✓	✓	✓	✓	✓	✓	✓	✓
Service Learning	✓	✓	✓		✓	✓	✓	✓
Transdisciplinary Projects	✓	✓	✓	✓	✓	✓	✓	✓
Challenge-Based Studios	✓	✓	✓	✓		✓	✓	
Participatory/Digital Pedagogy		✓	✓		✓	✓	✓	
Reflective Practice			✓					✓

5. TESTABLE PROPOSITIONS FOR EMPIRICAL VALIDATION

Building on the conceptual framework laid out in Section 4, this section formalizes the testable propositions (P1–P4) that guide future empirical inquiry. The framework provides a structured basis for testing the conditions under which Education for Sustainable Development (ESD) interventions are most effective.

The framework’s integrated causal logic, including the mediating and moderating effects of C3 and C4, is consolidated into the following four testable propositions, which are summarized below in Table 3:

Table 3: Summary of Testable Propositions and Hypothesized Causal Relationships (P1 - P4)

<i>Hypothesis/Proposition</i>	<i>Variables Involved</i>	<i>Rationale</i>
P1: Experiential, participatory, and transdisciplinary pedagogies positively influence sustainability competencies.	C2 -> C1	Pedagogies aligned with real-world challenges foster the application of knowledge, collaboration, and reflective skills.
P2: Transformative and organizational learning mediate the relationship between pedagogy and competency development.	C4 mediates C2 -> C1	These learning mechanisms explain the process of competency development at both the individual (transformative) and systemic (organizational) levels.

<i>Hypothesis/Proposition</i>	<i>Variables Involved</i>	<i>Rationale</i>
P3: The development of sustainability competencies positively predicts SDG-aligned learning impacts.	C1 -> C5	Students with higher competencies exhibit greater agency and integrate SDG principles into their actions and projects.
P4: The presence of institutional enablers positively moderates the effect of pedagogy on competencies.	C3 moderates C2 -> C1	Supportive structures and leadership are necessary to effectively translate pedagogical intent into lasting competency development and mitigate implementation barriers (Mogren <i>et al.</i> (2024).

To demonstrate the framework’s utility and its potential as a tool for comparative research, the following section applies the model to three illustrative case studies, showing how theoretical constructs and causal relationships are operationalized in diverse Higher Education Institutions.

6. ILLUSTRATIVE CASE STUDIES FOR FRAMEWORK COMPARABILITY

To illustrate the usefulness and possible use of the conceptual framework, this section provides a multi-institutional analysis with three case studies in illustration. These illustrations demonstrate how the factors of the framework can be implemented in practice and represented as a springboard to the future comparative studies that may be devoted to effectiveness evaluation.

6.1. The University of Bath: A Top-Down and Bottom-Up Approach

An example of how institutional enablers (C3) and Pedagogical Approaches (C2) can be combined using a systemic program is provided in the University of Bath. The work was strongly supported by the good base of institutional commitment—as in the introduction of citizenship and sustainability as a principle of core curriculum. Top-down mandate (C3) gave credibility and resources to bottom-up faculty programs. This top-down requirement was not a substitute, but it stimulated the bottom-up efforts; the policy (C3) was converted to a pedagogical strategy (C2) by enabling the faculty to adopt project-based learning that would guarantee ownership and institutional legitimacy. It supports transformation as well as organizational learning (C4), which leads to sustainability competencies targeting (C1) and increased alignment with SDGs (C5) (University of Bath, 2025).

6.2. The University of Leeds: Systemic Curriculum Integration

Unlike the Bath model, The University of Leeds can be characterized by an institution-wide approach. The strength of strong Institutional Enablers (C3), such as a formal framework (the Leeds Skills Matrix) and the Leeds University Network for Sustainability in HE (LUNSHE) are highlighted in this case. The LUNSHE network is an effective Learning Mechanism (C4), that generates a community of practice. The program promotes the adoption of various Pedagogical Approaches (C2), which will make the curriculum more suitable in providing students with a variety of Sustainability Competencies (C1), which will have a positive effect (C5).

6.3. Lorain County Community College: A Thematic Approach

The third and quite different approach is at the community college level. LCCC declared the principles of foundational sustainability (e.g., “Community,” “Equity”) that will be used to design the curriculum. The common interdisciplinary vocabulary serves as an important Institutional Enabler (C3) that provides problem-based Pedagogical Approaches (C2) and Organizational Learning (C4) throughout the institution. The outcome is a curriculum that promotes a broad set of Sustainability Competencies (C1) and the holistic understanding of the interconnectedness of issues eventually resulting in a broader SDG-related impact (C5).

Key Takeaways and Model Validation

These three cases, when combined, prove that there is no universal solution to successful implementation of ESD. Nevertheless, they have a similarity, namely, they are consistent with the major relationships within the conceptual framework. They demonstrate that when pedagogical practices are intentionally connected with sustainability competencies, and when the latter are reinforced with institutional facilitating, and effective learning mechanisms, meaningful, SDG-relevant outcomes are given consideration of the former. These examples are visually mapped onto the causal framework in Figure 2, and this illustrates that the model can help in **organizing and justifying complex and real-life ESD initiatives**.

After illustrating the applicability of the framework through comparative analysis, the next section provides insights into the major implications of the

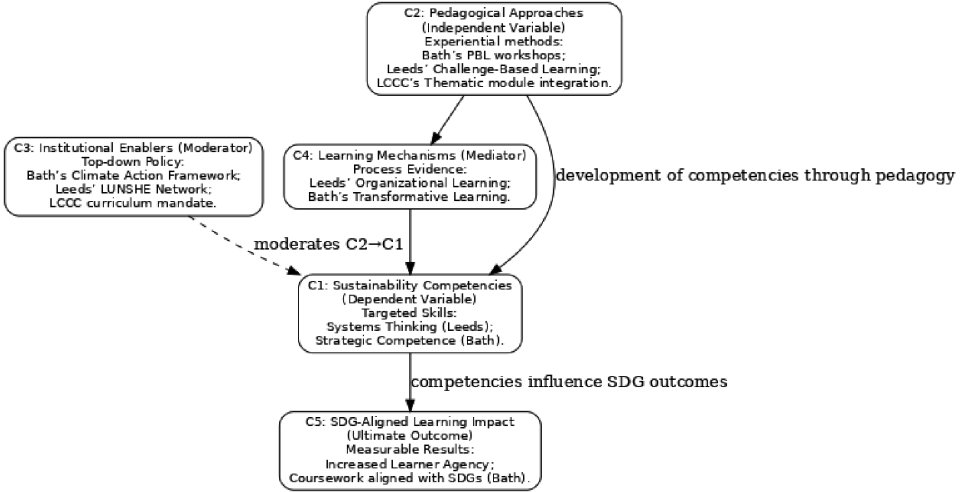


Figure 2: Conceptual Framework Applied to Case Studies

Source: Author's own conceptualization based on the literature review

integrated model, the limitations of the study, and critical pathways of future empirical research.

7. DISCUSSION AND FUTURE RESEARCH DIRECTIONS

7.1. Discussion

In the paper, a conceptual framework has been formulated to give an answer to the linkage between the capability of a Higher Education Institution (HEI) to incorporate sustainability competencies in pedagogy and the attainment of SDG-relevant outcomes. The model has five dimensions (C1-C5) which offer a broad perspective on the multilayered processes that facilitate Education for Sustainable Development (ESD).

Notably, our findings point to a significant complication to ESD implementation other than instructional design. The processes at the individual and organizational levels foster this effect. The translation of pedagogy and institutional support into meaningful outcomes occurs via Learning Mechanisms (C4) at the micro-level (transformative learning) and the meso-level (organizational learning). Transformative learning promotes critical thinking, change of perspective, and agency of learners (Mezirow, 1997), whereas organizational learning provides continuity in integrating ESD concepts across departments and courses (Sterling, 2010).

7.2. Limitations and Future Research Directions

While the framework provides a comprehensive theoretical model, it is purely conceptual, making all the relationships hypothetical. Its multi-layered character may also be difficult to implement fully in HEIs with limited resources.

Consequently, the main benefit of the framework is a systematic map of academic research:

- **Empirical Testing:** Measuring the relationships among constructs, that is, based on structural equation modelling (SEM), which is ideally suited to test the hypothesized mediating and moderating relationships (P2 and P4).
- **Cross-Cultural Comparisons:** The investigation of how the proposed pedagogical strategies work under different institutional contexts and cultural norms, especially extending research into non-Western contexts.
- **Digital and Hybrid Learning:** Exploring how online learning platforms can effectively support the acquisition of sustainability competencies, particularly through transformative learning processes.

The paper assumes a multi-level perspective in outlining the major players of higher education as agenda-setting towards sustainable development. It emphasizes the interrelationship among drivers, enablers, and mechanisms in transformative, SDG-related learning outcomes and this in a manner of ultimately enabling HEIs to graduate competent graduates.

In conclusion, the final section summarizes the paper's contribution and formalizes the substantive implications of the conceptual framework for research, educational practice, and public policy.

8. CONCLUSION AND IMPLICATIONS

Conclusion

The proposed conceptual framework provides a systematic strategy of integrating sustainability competencies into teaching pedagogies in higher education to empower SDG-oriented outputs. The framework summarizes the existing bodies of knowledge about what is meant by Education for Sustainable Development (ESD), pedagogical innovations, institutional enablers, and transformative learning processes. The framework highlights the fact that the implementation of learning outcomes that align to the SDGs is not a choice

that can be boiled down to the application of active pedagogies. It entails thorough alignment of pedagogy with some sustainability skills and business enabled by institutional facilitators, such as leadership and quality assurance (C3). The development of competency and SDG-based effects are aligned to learning processes on both the micro- (transformative learning) and meso-level (organizational learning). The final model (Figure 2) gives the required visual synthesis and confirmation to the real-life cases, which enhanced the contribution of the entire paper as a means of comparative research.

This framework presents a roadmap with substantive practical, research, and social implications.

Practical and Policy Implications: The model offers a useful tool to the HEIs to design the curriculum in a systematic manner, allowing them to map desired competencies (C1) to active pedagogies (C2). University leaders can use it if they want to include ESD in their strategic plans and formal quality assurance cycles (C3).

Research Implications: The framework provides a good foundation to conduct more empirical research. The propositions that are expounded in Section 5 can be used as a guideline for quantitative research with complex models (e.g., SEM).

Social and Educational Implications: HEIs can facilitate resilience and general betterment in society by developing student agency and transformational skills, which could impact local policy making by employing graduates in sustainable industries and making direct contributions to the realization of the UN SDGs (UNESCO, n.d.).

In conclusion, by institutionalizing the alignment between pedagogical design and sustainability competencies, this framework provides HEIs with the necessary roadmap to graduate globally competent, agency-driven professionals who can accelerate the achievement of the UN Sustainable Development Goals.

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