The Symbiotic Curriculum: A Conceptual Framework for Integrating the SDGs Through Transformative Eco-Pedagogy

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Abstract
The urgency of global challenges necessitates a re-conceptualization of how the Sustainable Development Goals (SDGs) are addressed in education. Current models often treat the SDGs as isolated topics, failing to cultivate the interconnected, critical, and transformative competencies required for a sustainable future. This paper introduces 'The Symbiotic Curriculum', a conceptual framework designed to foster an integrated and holistic engagement with the SDGs. The framework is grounded in a synthesis of Freire's critical pedagogy, Bronfenbrenner's ecological systems theory, and Mezirow's transformative learning theory. This paper employs a conceptual analysis methodology, developed through an integrative review of literature from sustainability science and critical education studies. The framework is built on three core pillars: Inter-Goal Synthesis, which connects multiple SDGs through systems thinking; Place-Based Praxis, which links global challenges to local contexts to foster critical agency; and Futures-Oriented Dialogue, which uses speculative methods to promote perspective transformation. Key findings indicate that: critical praxis is essential for translating SDG knowledge into learner agency; systemic understanding is achieved by connecting macro-level goals to learners' micro-level contexts; and perspective transformation is a prerequisite for envisioning and enacting sustainable futures. The study recommends embedding eco-pedagogy modules in teacher training colleges and redesigning national curricula to foster interdisciplinary, place-based learning in line with SDG Target 4.7. Ultimately, the Symbiotic Curriculum provides a robust pathway for re-conceptualizing education as a central driver for a more just and sustainable future.

Keywords: Sustainable Development Goals (SDGs), Conceptual Framework, Eco-Pedagogy, Critical Pedagogy, Systems Thinking, Transformative Learning, Curriculum Theory

1.0 Introduction

Currently, humanity finds itself at a pivotal crossroads where it is faced with a confluence of interrelated challenges. These range from the rapid progression of climate change to enduring social and economic disparities. The data is unequivocal whereby the previous ten years represent the highest temperatures recorded and the disparity in wealth between the most affluent and the least affluent nations is 25 per cent greater than it would have been in the absence of climate change (Diffenbaugh & Burke, 2019; WMO, 2024). The interconnectedness of these crises is evident in the way they are intertwined through escalating inequalities that both propel and are influenced by disturbances such as climate-induced disasters and economic volatility. In light of these profound existential challenges, the global community has embraced the 2030 Agenda for Sustainable Development which is a comprehensive initiative delineated by 17 Sustainable Development

Goals (United Nations, 2015). These objectives serve as a detailed framework for attaining a future that is more prosperous, equitable, and sustainable for everyone. The SDGs show that advancements in one domain, such as education, are fundamentally interconnected with results in other areas including poverty alleviation, health, and environmental stewardship (United Nations, 2015).

Education is distinctly acknowledged as an independent objective (SDG 4: Quality Education) and serves as an essential facilitator for the attainment of all other SDGs (United Nations, 2015). Education for Sustainable Development (ESD), as delineated in SDG Target 4.7, seeks to guarantee that all learners attain the knowledge, skills, values, and attitudes that are critical to encouraging sustainable development (United Nations, n.d.). Nevertheless, in light of this directive, educational systems across the globe have encountered challenges in transcending disjointed methodologies regarding sustainability. The prevailing approach frequently regards the SDGs as isolated subjects to be incorporated into an already dense curriculum. It tackles the SDGs within subject-specific confines that overlook their fundamental interrelations. This siloed approach represents a significant shortcoming because it limits learners from cultivating the systems thinking and critical consciousness essential for comprehending and tackling the intricate interrelated nature of global challenges (Bourn & Hatley, 2022). This methodology fosters educational superficiality wherein sustainability is regarded as an add-on instead of a core redefinition of the learning experience (Huckle & Wals, 2015).

This conceptual paper addresses this significant gap by presenting the symbiotic curriculum which is an innovative framework aimed at cultivating a comprehensive and interconnected understanding of the SDGs. Advancing past simple knowledge transfer, this framework is rooted in the tenets of transformative eco-pedagogy. It highlights the importance of critical reflection, systems thinking, and fosters pro-environmental values and agency. This paper, initially, delineates the methodological approach to conceptual analysis employed in the framework's development. The subsequent analysis tackles the theoretical foundations of the symbiotic curriculum intricately interlacing perspectives from Paulo Freire’s critical pedagogy, Urie Bronfenbrenner’s ecological systems theory, and Jack Mezirow’s transformative learning theory. Subsequently, the document will elucidate the three fundamental pillars of the framework: inter-goal synthesis, place-based praxis, and futures-orientated dialogue. Ultimately, the study

elucidates the conceptual insights gained from the synthesis and provides pragmatic recommendations for policymakers, curriculum developers, and institutions focused on teacher training. The paper introduces an innovative framework that serves as a comprehensive model for transitioning from a fragmented to a thoroughly integrated approach. It outlines a pathway for re-envisioning education as a pivotal force in the pursuit of a more equitable and sustainable future.

2.0 Methodology

The methodology entails a conceptual analysis and integrative review. Empirical studies depend on the gathering and analysis of fresh data, whereas the rigour of a conceptual paper is determined by the clarity and methodical approach of its analytical framework. Thus, a comprehensive literature review executes a methodology of conceptual analysis, which forms the foundation of the symbiotic curriculum framework. This methodology is especially effective in elucidating intricate and frequently unclear notions, such as integrated SDG education. It also amalgamates insights from various disciplines to produce a novel and cohesive framework.

Conceptual analysis serves as a research methodology that dissects a concept into its fundamental components thereby facilitating clarity and fostering a more coherent comprehension. This procedure entails discerning the fundamental attributes, precursors, and ramifications of a concept as it manifests throughout the scholarly literature. This paper analyses an educational framework designed to integrate the SDGs in a transformative manner. The analysis is aimed to discern the fundamental pedagogical, structural, and psychological elements necessary for the successful implementation of such a framework. This analysis is conducted through an integrative literature review, a methodology that transcends mere summation to critique, synthesise, and amalgamate scholarship from various disciplines, aiming to produce a novel perspective or framework. An integrative review represents the most comprehensive form of research review that facilitates the concurrent incorporation of both experimental and non-experimental studies. It also incorporates theoretical and empirical sources, to achieve a more profound understanding of a phenomenon. The corpus for this analysis comprises seminal works and modern academic contributions across various critical fields:

a) Sustainability Science and Education for Sustainable Development (ESD): to grasp the fundamental principles of sustainability, the interrelated aspects of the SDGs, and the recognised competencies for ESD (UNESCO, 2020).

b) Critical Pedagogy: mainly referencing the contributions of Paulo Freire to formulate principles of empowerment, critical awareness, and experiential learning (Freire, 1970).
c) Ecological Systems Theory: Employing Urie Bronfenbrenner's framework to elucidate the intricate interconnections between individuals and their surrounding environments (Bronfenbrenner, 1979).
d) Transformative Learning Theory: engaging with Jack Mezirow's scholarship to explore the cognitive mechanisms underlying perspective transformation in adult learners (Mezirow, 1991, 2000).

The approach entails a methodical integration of fundamental concepts from various disciplines to tackle the recognised issue of disjointed implementation of Sustainable Development Goals in the realm of education. By elucidating this cognitive process, this methodology affirms the scholarly rigour of the Symbiotic Curriculum, illustrating that it is not a random assortment of concepts but a deliberately crafted framework grounded in a solid theoretical basis.

3.0 Theoretical Foundations

The theoretical foundation provides ground for weaving a transformative pedagogy. The Symbiotic curriculum transcends a mere assemblage of instructional techniques. It represents a pedagogical framework grounded in a unified theoretical basis. This transformative potential is realized through the synthesis of three robust and complementary theories: Paulo Freire's critical pedagogy, Urie Bronfenbrenner's ecological systems theory, and Jack Mezirow's transformative learning theory. These theories collectively clarify the reasoning, context, and methodology of a comprehensive approach to sustainability education.

3.1 Paulo Freire's Critical Pedagogy

This is the engine of praxis and transformation. Central to the Symbiotic Curriculum is the influential work of Brazilian educator Paulo Freire whose philosophy presents a significant critique of conventional educational practices. Freire (1970) astutely critiqued what he termed the "banking concept of education" a paradigm wherein educators are perceived as mere depositors of knowledge while students are relegated to being passive recipients. Freire (1970) contends that this methodology is inherently dehumanizing because it stifles critical inquiry and perpetuates

oppressive societal frameworks by instructing learners to conform to their circumstances rather than challenging them.

Freire (1970) advocated for an educational approach that stressed "problem-posing education" which is rooted in dialogue, the development of critical consciousness (conscientização), and the application of praxis. 'Conscientização' refers to the journey individuals undertake to transcend mere superficial awareness. Instead, they achieve a profound and critical comprehension of the social, political, and economic contradictions that permeate their existence. This process enables them to identify themselves as active agents capable of causing change in their realities (Freire, 1970). Praxis serves as the driving force behind this transformation—a perpetual, iterative process of contemplation and engagement with the world aimed at effecting change (Freire, 1970). According to Freire, genuine learning transcends the mere memorization of information. It involves participating in a continuous process of critical reflection that culminates in informed and collective efforts towards social justice (Freire, 1970).

This theoretical framework actively engages the place-based praxis component of the symbiotic curriculum. This pillar defines environmental education as an endeavor deeply rooted in Freirean principles. It transcends the mere use of the local environment as a practical teaching laboratory. Instead, it frames learners as engaged participants who rigorously examine real-world socio-ecological injustices present within their communities (Cashion, 2024). When exploring food deserts (SDG 2), inequitable access to clean water (SDG 6), and the uneven effects of pollution on marginalized communities (SDGs 10, 11, and 13), students are encouraged to engage in a profound inquiry regarding the underlying factors contributing to these issues. By employing this problem-posing methodology individuals cultivate the critical awareness necessary to comprehend the power structures that sustain these injustices. In this way, they gain the agency to participate in collective efforts for transformation ultimately realizing authentic praxis (Freire, 1970). By anchoring this pillar in Freire's scholarship, the framework redefines education from a mechanism of social reproduction to a catalyst for social and ecological justice.

3.2 Urie Bronfenbrenner's Ecological Systems Theory

This theory serves as the map of interconnectedness. Freire offers a foundational framework for transformative education while Urie Bronfenbrenner's ecological systems theory serves as a comprehensive guide for comprehending the intricate network of relationships that characterize

sustainability (Bronfenbrenner, 1979). Bronfenbrenner (1979) posited that understanding human development necessitates an examination beyond individual isolation. He pointed out the importance of dynamic interactions within a hierarchy of interconnected environmental systems. The systems in question are as follows:

a) The Microsystem: the immediate environment in which an individual engages in direct interactions, such as with family, educational institutions, and peer groups.
b) The Mesosystem: the complex interpersonal interactions that exist between various microsystems (e.g., the connection between a child's home environment and educational institution).
c) The Ecosystem: Social environments that do not directly encompass the individual yet exert an indirect influence on their experiences (e.g., a parent's workplace, local governmental decisions).
d) The Macrosystem: The comprehensive cultural framework, encompassing societal values, legal structures, and prevailing ideologies.
e) The Chronosystem: A temporal dimension that includes life transitions and socio-historical transformations.

This theory presents an exemplary framework for the Inter-Goal Synthesis component of the symbiotic curriculum. The 17 SDGs frequently reside within the abstract realm of the macrosystem functioning as global policies and cultural aspirations (Bronfenbrenner, 1979). An exclusively macro-level perspective may render the SDGs seemingly remote and disconnected from the everyday experiences of learners. The symbiotic curriculum employs Bronfenbrenner’s model to effectively connect the global with the local and vice versa. This framework assists educators in crafting learning experiences that align overarching SDG objectives (such as SDG 13: Climate Action) with the tangible circumstances of the learner's immediate environment. This includes the school's energy usage and local transportation alternatives as well as the interplay between the school and community initiatives (e.g. a garden aimed at enhancing local food security). This methodology allows learners to perceive the concrete and reciprocal impact of their local endeavors on global frameworks. This transforms the SDGs from a distant checklist into an experienced and interwoven reality.

3.3 Jack Mezirow's Transformative Learning Theory

This theory provides the process of shifting perspectives. Freire elucidates the rationale, while Bronfenbrenner delineates the context. In this framework, Jack Mezirow's theory of transformative learning articulates the internal mechanisms of sustainability education. This is the psychological journey through which learners experience profound transformations in their perspectives (Mezirow, 1991, 2000). Mezirow (2000) suggested that transformative learning involves developing a critical awareness of the origins and limitations of our assumptions which in turn constrains our worldview. This process necessitates the re-evaluation and re-formulation of these assumptions to foster a more comprehensive and justified understanding. The process frequently begins with a "disorienting dilemma"—an encounter that eludes resolution within the existing framework of understanding (Mezirow, 2000). This predicament prompts a phase of profound contemplation wherein the individual scrutinizes and evaluates their deeply ingrained, frequently unexamined, convictions and presuppositions (Mezirow, 1991). The ultimate outcome is a "perspective transformation" which represents a profound and frequently irreversible alteration in ones understanding of the world and one's position within it (Mezirow, 2000).

The theory posited by Mezirow serves as the fundamental psychological framework for the pillar of Futures-Orientated Dialogue. The complexities of sustainability present a significant and perplexing dilemma for a global society founded on the principles of endless expansion and the perceived detachment of humanity from the natural world. This pillar deliberately engenders smaller-scale disorienting dilemmas via speculative and creative methodologies. This includes scenario construction, role-playing future crises, or employing instruments like the "Futures Wheel" to investigate the cascading ramifications of present actions (Glenn, 1971). By presenting students with credible yet demanding scenarios (such as the regional consequences of rising sea levels or the limitations of resources), it compels them to engage in a critical examination of the entrenched beliefs that underpin the current unsustainable practices. This process transcends the mere acquisition of knowledge regarding sustainable futures. It catalysis the profound, transformative journey necessary for individuals to authentically envision, aspire to, and dedicate themselves to their realizations (Balsiger et al., 2017).

In conclusion, these three theories interlace to create a unified and compelling educational argument. Bronfenbrenner presents a comprehensive framework of interrelated systems. Freire

provides the political and educational framework for traversing that landscape through critical engagement. Ultimately, Mezirow elucidates the intricate internal psychological journey of the learner detailing the essential perspective transformations required for genuine engagement. This cohesive framework transforms the symbiotic curriculum from a mere assortment of commendable concepts into a strong and justifiable paradigm for revolutionary education.

4.0 The Symbiotic Curriculum Framework

The symbiotic curriculum is built upon three fundamental, interrelated pillars that are intended to function collaboratively, promoting a profound, comprehensive, and proactive comprehension of the SDGs. The foundational elements (Inter-Goal Synthesis, Place-Based Praxis, and Futures-Orientated Dialogue) offer a robust framework for educators to craft learning experiences that are challenging in thought, resonant on an emotional level, and impactful in a social context.

4.1 Pillar 1: Inter-Goal Synthesis

The initial pillar, Inter-Goal Synthesis, addresses the issue of fragmentation prevalent in traditional SDG education. The 17 SDGs were conceived as a cohesive and interconnected framework. However, they are frequently presented merely as a series of isolated topics (United Nations, 2015). This pillar advocates for a comprehensive perspective, encouraging educators and learners to investigate the intricate and frequently obscured relationships among various objectives. The objective is to transcend narrow perspectives and foster understanding of sustainability challenges as interrelated systems.

The application of Inter-Goal Synthesis involves the meticulous design of curriculum units and projects with a distinct focus on the convergence of various SDGs. A comprehensive approach is necessary to break down the traditional barriers that divide disciplines like science, social studies, economics, and the arts. A project centered around fast fashion could act as a significant point of convergence for synthesizers:

a) The project actively engages with SDG12 (Responsible Consumption and Production) by critically analyzing supply chains and consumer behavior.
b) It establishes a connection with SDG 8 (Decent Work and Economic Growth) through an examination of labour conditions in garment factories.

c) The examination of the environmental ramifications of textile dyes and microplastic pollution encompasses the objectives of SDG 6 (Clean Water and Sanitation) and SDG 14 (Life Below Water).
d) It brings to the forefront the concerns surrounding SDG 5 (Gender Equality), given that women represent a significant portion of the workforce in the garment industry.
e) It connects to SDG 10 (Reduced Inequalities) by emphasizing the disproportionate burden of environmental and social costs associated with inexpensive clothing for communities in the Global South.

By conceptualizing learning this way, students come to understand that it is impossible to address a singular problem without acknowledging its interconnectedness with other issues. They cultivate the essential skill of "system thinking," which allows them to "recognize and understand relationships; analyze complex systems; and consider how systems are embedded within different domains and scales" (UNESCO, 2017; p. 10).

4.2 Pillar 2: Place-Based Praxis

The second pillar, Place-Based Praxis, anchors the theoretical global framework of the SDGs in the concrete experiential context of the learner's own community. Place-based education (PBE) represents a pedagogical approach that leverages the local community and environment as foundational elements for interdisciplinary teaching, thereby cultivating a profound connection to one's surroundings and enhancing individual and civic responsibility (Ardoin, 2006; Gruenewald, 2003). The Symbiotic Curriculum elaborates on this notion by integrating the Freirean principle of praxis, which encompasses the iterative process of reflection and action (Freire, 1970).

This principle extends the realm of education beyond the confines of the classroom, integrating it with the community and empowering students to become proactive investigators and catalysts for transformation. The endeavor commences with an exploration of local expressions of worldwide issues. For example, rather than merely examining global hunger statistics (SDG 2), students could undertake a community food audit to assess the accessibility of fresh affordable food in their own neighborhoods pinpointing regions that may be deemed ‘food deserts.’ This inquiry represents the ‘reflection’ phase of praxis.

The procedure extends beyond mere analysis. Informed by their discoveries, students subsequently transition to the ‘action’ phase. This may encompass various community-orientated initiatives, including the establishment of educational institutions or communal gardens, the initiation of a public awareness campaign focused on nutritional practices, or collaboration with local food banks. The iterative process of contemplation and implementation is critical to promoting learner autonomy. It converts students from mere consumers of information regarding global issues into empowered individuals who possess the confidence and skills necessary to engage in local solutions (Athman & Monroe, 2004). This methodology imbues the learning process with significance and illustrates that even modest, localized initiatives play an essential role in a broader, global endeavor towards sustainability.

4.3 Pillar 3: Futures-Oriented Dialogue

The concluding pillar, Futures-Orientated Dialogue, pertains to the temporal aspect of sustainability. Realizing the SDGs goes beyond the mere resolution of contemporary issues, it encompasses the imperative of fostering a fair and habitable planet for those who come after us. This aspect necessitates the ability to conceptualize diverse potential futures and engage in critical and imaginative thinking regarding routes to achieving them. This pillar employs imaginative and innovative approaches to foster what is frequently referred to as "futures literacy" or "anticipatory thinking" (UNESCO, 2017).

This framework intentionally incorporates transformative learning by creating deliberate "disorienting dilemmas" (Mezirow, 2000). This pillar advocates for a diverse and creative examination of potential futures, rather than offering a singular, fixed conception of sustainability. A highly effective educational instrument for this purpose is the Futures Wheel. This is a systematic brainstorming technique that enables individuals to investigate the intricate, multi-dimensional repercussions of a specific trend or event (Glenn, 1971). A class might position a trend such as ‘widespread adoption of electric vehicles in our city’ at the core of a Futures Wheel:

a) The initial ramifications may encompass diminished air pollution, heightened demand on the electrical grid, and potential job losses within the auto repair sector.
b) The exploration of secondary effects may then be undertaken: diminished instances of childhood asthma (resulting from decreased pollution), the necessity for new power

generation facilities (due to grid demand), and the requirement for worker retraining initiatives (stemming from job displacements).

c) The ramifications of third-order consequences may encompass reduced public healthcare expenditures, contentious political discussions surrounding new energy infrastructure, and transformations in vocational education.

This process enables students to recognize the intricate nature of change and understand that each action has unexpected and extensive ramifications. It encourages a more sophisticated and analytical discussion regarding the elements that define a 'desirable' future. Consequently, it transcends simplistic answers to acknowledge the complexities and moral implications that accompany any societal change. Through participation in this form of speculative dialogue, students are not merely acquiring knowledge about the future but are actively honing their abilities to envision and collaboratively design it.

5.0 Discussion

This section explores conceptual findings and implications**.** The integration of critical pedagogy, ecological systems theory, and transformative learning theory within the symbiotic curriculum framework produces several significant conceptual insights. These do not constitute empirical findings but reflect the foundational propositions and insights derived from the theoretical analysis. They highlight the framework's innovative contribution to the domain of Education for Sustainable Development (ESD).

5.1 Conceptual Finding 1: The Primacy of Critical Praxis

The framework demonstrates that a significant integration of the SDGs cannot be accomplished merely through content delivery. It necessitates a profound pedagogical transformation from passive knowledge transmission to active critical engagement. Conventional approaches to environmental education frequently emphasize identifying issues which may result in discomfort and helplessness among students. The symbiotic curriculum (via its Place-Based Praxis pillar) recognizes that Freire's problem-posing approach is vital for cultivating the critical consciousness and sense of agency. This is necessary for individuals to actively engage with the SDGs as transformative agents in their world rather than merely as subjects of academic inquiry (Freire, 1970). When individuals are encouraged to explore, analyze, and respond to the socioecological

injustices present in their communities, the SDGs evolve from a mere theoretical framework to a concrete demand for justice. This discovery suggests that effective education for sustainable development is fundamentally political and must provide learners with the necessary tools to confront and transform the systems that sustain unsustainability.

5.2 Conceptual Finding 2: The Systemic Connection between Local and Global

The framework illustrates that a comprehensive grasp of sustainability (a fundamental skill of ESD) becomes attainable when abstract global objectives are clearly and methodically aligned with the lived experiences of learners. The fragmented methodology in SDG education is inadequate, as it portrays global challenges as unrelated to the everyday experiences of students. The Inter-Goal Synthesis pillar, underpinned by Bronfenbrenner's Ecological Systems Theory, reveals that linking macro-level SDG targets to the micro- and meso-systems of students' lives constitutes a vital pedagogical strategy (Bronfenbrenner, 1979). This approach renders intricate global issues such as climate change and inequality tangible, relatable, and capable of prompting action. This discovery indicates that the design of curricula aimed at sustainability should be purposefully multi-scalar, consistently directing learners to recognize the interconnections between their individual decisions, the frameworks of their communities, and broader global systems.

5.3 Conceptual Finding 3: Perspective Transformation as a Prerequisite for Sustainable Futures

Ultimately, the framework asserts that a true commitment to sustainable futures demands more than mere imagination. It calls for a profound transformation in the learner's foundational beliefs and perspective on the world. The prevailing cultural narrative of advancement, founded on perpetual economic expansion and human supremacy over the natural world, presents a substantial obstacle to sustainability. The Futures-Orientated Dialogue pillar (rooted in Mezirow's theory) demonstrates that involving students in disorienting dilemmas concerning future scenarios serves as an effective means of illuminating and subjecting to scrutiny the deeply ingrained, unsustainable assumptions (Mezirow, 2000). This process begins the profound transformative journey necessary for individuals to authentically conceptualize and dedicate themselves to the development of alternatives. This approach suggests that ESD should transcend mere instrumentalism (the acquisition of problem-solving skills). It must also embody a communicative and emancipatory

dimension fostering environments where learners can engage in critical reflection and reimagine the meanings they ascribe to the world (Mezirow, 1991, 2000).

6.0 Recommendations for Policy and Practice

The theoretical insights derived from the symbiotic curriculum framework yield practical suggestions for essential stakeholders involved in the development of education. These suggestions aim to connect theoretical frameworks with practical applications, offering a route for transformative change in the manner in which education interacts with the SDGs.

6.1 Policymakers

The formulation of educational policy establishes a conducive atmosphere for the advancement of pedagogical innovation. To facilitate the transition towards a more cohesive and transformative approach to Education for Sustainable Development, it is imperative that policymakers take the following actions:

i. Embed transformative eco-pedagogy within national curriculum frameworks: instead of listing sustainability as a subject, national policies ought to clearly advocate for and facilitate interdisciplinary, project-based, and community-engaged learning methodologies. Such activity is essential for achieving the objectives of SDG Target 4.7 which stresses the necessity for all learners to obtain the knowledge and skills required to advance sustainable development (UNESCO, 2020).
ii. Re-evaluate assessment and accountability metrics: high-stakes, standardized testing that emphasizes rote memorization within isolated subjects fundamentally undermines the tenets of the symbiotic curriculum. It is essential to formulate policies that endorse more comprehensive assessment methodologies including portfolio-based and project-based evaluations. These are capable of reflecting the evolution of intricate competencies such as systems thinking, collaborative problem-solving, and civic engagement (UNESCO, 2017).
iii. Provide financial resources and endorse school-community collaborations: the Place-Based Praxis component necessitates robust connections between educational institutions and local entities, including organizations, businesses, and governmental bodies. Policymakers have the capacity to enhance this process by establishing grant programmes and support networks that foster and maintain essential collaborations.

6.2 Curriculum Developers

Curriculum developers serve as the architects of the educational experience. Implementing the Symbiotic Curriculum effectively requires the following steps:

i. Develop interdisciplinary learning modules: transition from traditional subject-specific units to thematic, problem-based modules that are intentionally crafted around the convergence of various SDGs as exemplified by the Inter-Goal Synthesis pillar (Commonwealth Secretariat, 2021). This necessitates the development of resources that facilitate effective collaboration among educators across various disciplines.

ii. Develop resources for local adaptation: design curriculum materials that are not excessively rigid but rather offer adaptable templates and case studies that educators can modify to suit their specific local environments. This aligns with the Place-Based Praxis pillar by enabling educators to link global challenges to the distinct social and ecological contexts of their students' communities (Gruenewald, 2003).

iii. Integrate tools and activities that encourage speculative thinking and future-orientated perspectives (such as the Futures Wheel and scenario-building exercises) to enhance the pillar of Futures-Orientated Dialogue. These resources ought to be crafted to assist educators in guiding intricate discussions regarding the future ensuring that the process is both stimulating and empowering for students.

6.3 Teacher Training Institutions

Educators serve as pivotal catalysts for educational transformation. They can only successfully adopt innovative methodologies with sufficient training and continuous assistance. A notable obstacle to the successful implementation of ESD is the prevalent sentiment among educators regarding their lack of preparedness to engage with intricate, value-driven, and interdisciplinary subjects. A worldwide survey reveals that approximately 25% of teachers express uncertainty about their readiness to address themes associated with sustainable development and global citizenship. Consequently, teacher-training institutions hold a pivotal responsibility:

i. Integrate fundamental competencies into pre-service education: transformative eco-pedagogy ought to be a foundational component rather than an optional course or isolated workshop. It is essential for pre-service teacher education programmes to incorporate

mandatory modules focused on critical pedagogy, systems thinking, place-based education, and transformational learning theory throughout their curricula.

ii. Exemplify transformative pedagogy: teacher educators ought to embody the pedagogical methods they advocate. Rather than merely delivering lectures on problem-posing education, it would be more beneficial to immerse teacher candidates in experiential learning opportunities centered around problem-posing. This encompasses offering avenues for pre-service educators to participate in community-orientated action research initiatives as a component of their professional development.

iii. Facilitate continuous professional development (CPD): in-service educators require sustained assistance to enhance and hone their pedagogical skills. Teacher training institutions (in collaboration with school districts) ought to provide ongoing cooperative professional development programmes centered on the implementation of integrated sustainability education. This initiative should foster communities of practice, enabling educators to exchange resources and engage in mutual learning (Cashion, 2024).

7.0 Conclusion

The pressing nature of current global issues requires our educational systems to go beyond simply conveying information. The current method of tackling the SDGs within isolated, discipline-specific frameworks is fundamentally insufficient for equipping learners to adeptly manage the intricacies of the 21st century. It does not foster the necessary frameworks for holistic understanding, critical awareness, and personal empowerment essential for both comprehending and actively influencing the creation of a more sustainable and equitable world.

This paper presents the symbiotic curriculum as a conceptually robust and practically applicable framework designed to tackle this shortcoming. By integrating the transformative potential of Paulo Freire's critical pedagogy, the systemic perspective of Urie Bronfenbrenner's ecological systems theory, and the psychological depth of Jack Mezirow's transformative learning theory, the framework presents a cohesive model for a novel approach to education. The three foundational elements—Inter-Goal Synthesis, Place-Based Praxis, and Futures-Orientated Dialogue—offer a coherent framework for crafting learning experiences that are interconnected, contextually relevant, and geared towards actionable outcomes.

This paper presents the argument that effective education for sustainable development should be grounded in critical praxis, systematically link local contexts to global frameworks, and deliberately cultivate the transformative perspectives necessary for imagining and implementing sustainable futures. The results of this study necessitate unequivocal recommendations for comprehensive reform, urging policymakers, curriculum designers, and teacher educators to collaborate in fostering an educational landscape conducive to transformative learning.

The paper asserts that the symbiotic curriculum presents a compelling avenue for evolving education from a mere recipient of SDGs directives into a dynamic and influential force for fostering the potential of a more just, equitable, and sustainable future. It is imperative to transcend mere instructions on sustainability and embark on the essential endeavor of fostering education, which embodies it.

References

Ardoin, N. M. (2006). Toward an interdisciplinary understanding of place: Lessons for environmental education. *Canadian Journal of Environmental Education, 11*(1), 112-126.

Athman, J., & Monroe, M. (2004). The effects of environment-based education on students' critical thinking skills and disposition toward critical thinking. *Environmental Education Research, 10*(4), 507-522.

Balsiger, J., Förster, R., Mader, C., Nagel, U., Sironi, H., Wilhelm, S., & Zimmermann, A. B. (2017). Transformative learning and education for sustainable development. *GAIA-Ecological Perspectives for Science and Society, 26*(4), 357-359. https://doi.org/10.14512/gaia.26.4.15

Bourn, D., & Hatley, E. (2022). *Learners as global citizens: A review of the evidence*. Development Education Research Centre, UCL Institute of Education.

Bronfenbrenner, U. (1979). *The ecology of human development: Experiments by nature and design*. Harvard University Press.

Cashion, M. (2024). *Critical Sustainability: Critical Professional Development for Sustainability Education* (Doctoral dissertation, Arizona State University).

Commonwealth Secretariat. (2021). *Curriculum framework for the sustainable development goals*. https://www.thecommonwealth-ilibrary.org/commonwealth-education-hub/doc/10.14217/9781848599638-en

Diffenbaugh, N. S., & Burke, M. (2019). Global warming has increased global economic inequality. *Proceedings of the National Academy of Sciences, 116*(20), 9808-9813. https://doi.org/10.1073/pnas.1816020116

Freire, P. (1970). *Pedagogy of the oppressed*. Herder and Herder.

Glenn, J. C. (1971). *The futures wheel*. Antioch Graduate School of Education.

Gruenewald, D. A. (2003). The best of both worlds: A critical pedagogy of place. *Educational Researcher, 32*(4), 3-12.

Huckle, J., & Wals, A. E. (2015). The UN Decade of Education for Sustainable Development: Business as usual in the end. *Environmental Education Research, 21*(3), 491-505.

Mezirow, J. (1991). *Transformative dimensions of adult learning*. Jossey-Bass.

Mezirow, J. (2000). *Learning as transformation: Critical perspectives on a theory in progress*. Jossey-Bass.

Mind the Graph. (n.d.). *A guide to conceptual analysis research*. Retrieved August 27, 2025, from https://mindthegraph.com/blog/conceptual-analysis-research/

Takona, J. P. (2025). Transformative education: Paulo Freire's pedagogy of the oppressed and its contemporary resonance. *Journal of Global Education and Research, 9*(1), 87-107. https://www.doi.org/10.5038/2577-509X.9.1.1351

UNESCO. (2017). *Education for Sustainable Development Goals: Learning Objectives*. https://unesdoc.unesco.org/ark:/48223/pf0000247444

UNESCO. (2020). *Education for sustainable development: A roadmap*. https://unesdoc.unesco.org/ark:/48223/pf0000374802

UNESCO & Education International. (2021). *Teachers have their say: Motivation, skills and opportunities to teach education for sustainable development and global citizenship*. https://unesdoc.unesco.org/ark:/48223/pf0000379914

United Nations. (n.d.). *Goal 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all*. Retrieved August 27, 2025, from https://www.un.org/sustainabledevelopment/education/

United Nations. (2015). *Transforming our world: The 2030 Agenda for Sustainable Development*. https://sdgs.un.org/2030agenda

United Nations Development Programme. (2023, January 30). *Interconnected crises of climate change, biodiversity loss and pollution demand urgent action to ensure a healthy future for all*. https://www.undp.org/asia-pacific/news/interconnected-crises-climate-change-biodiversity-loss-and-pollution-demand-urgent-action-ensure-healthy-future-all

United Nations Research Institute for Social Development. (2022). *Crises of inequality: Shifting power for a new eco-social contract*. https://cdn.unrisd.org/assets/library/reports/2022/full-report-crises-of-inequality-2022.pdf

University of Sussex. (n.d.). *Education for sustainable development*. Retrieved August 27, 2025, from https://staff.sussex.ac.uk/teaching/enhancement/support/curriculum/sustainable-development

Whittemore, R., & Knafl, K. (2005). The integrative review: updated methodology. *Journal of Advanced Nursing, 52*(5), 546-553.

WMO. (2024). *State of the Global Climate 2023*. World Meteorological Organization. https://wmo.int/publication-series/state-of-global-climate-2023