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Connecting culture and education for sustainability through transdisciplinary learning

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ABSTRACT: As society faces increasingly critical challenges and pressures across a range of areas, third level education is under ever greater scrutiny concerning how it may provide a meaningful and significant leadership role in response. The need for education which is orientated towards navigating interrelated challenges beyond traditional disciplinary distinctions is clear, however, the ways in which this is actualised remains opaque and often restricted within embedded or possibly even disjunct cultures of learning whilst still invoking the language of "transformation". We suggest that "culture" as a fourth pillar of sustainability, may help to enable truly novel and innovative thinking and reimagining to occur. This is needed in relation to the transformation and perhaps regeneration of educational processes and institutions and how they are understood, developed, and delivered. This is especially important with regards to the complex web of sustainability challenges underpinning the polycrisis at local, regional and global scales across all sectors of society. As an opening to a larger conversation, we propose a blended pedagogy of the transdisciplinary sustainability education praxis with transcultural education to foster global cooperation and action amidst the polycrisis.

KEYWORDS: Education, Culture, Transdisciplinarity, Polycrisis, Sustainability, Transdisciplinary learning.

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Introduction

As contemporary society faces increasingly critical challenges and pressures across a range of areas, third level education is under ever greater scrutiny concerning how it may provide a meaningful and significant leadership role in response. The need for education which is orientated towards navigating interrelated challenges beyond traditional disciplinary distinctions is clear, however, the ways in which this is actualised remains opaque and often restricted within embedded or possibly even disjunct cultures of learning and teaching whilst still invoking the language of "transformation". A recent European Commission report published through the Directorate-General for Research and Innovation (Dixson-Declève et al., 2024) provides recommendations for policymaking in relation to "transformational education in polycrisis". This report, however, present a snapshot which is closer to status-quo than any true sense of transformation. Referencing "competitiveness and innovation", a "regional innovation scoreboard", and "labour shortages" amongst other bureaucratic patois, this is a potentially well-meaning call in supporting the established order and the European Union's perceived status as a leading force in education globally. Yet, this is far removed from truly novel and innovative thinking and reimagining in relation to the sectoral transformation and perhaps regeneration of educational processes and institutions and how they are imagined, understood, developed, and delivered. This is especially important with regards to the complex web of sustainability challenges underpinning the polycrisis at local, regional and global scales across all sectors of society. The polycrisis has gained prominence as a term to understand the times we live in and can be defined simply as the interaction of a multitude of crises simultaneously, creating a greater overall impact through their interplay, than any single crisis when taken alone.

Within Europe, while considering the historical circumstances which have led to the global ecological crisis faced, there lies a moral responsibility for deep institutional reflection. A systematic reflective approach as inspired by Donald Schön's reflection model and his critical challenge:

> "The practitioner allows himself to experience surprise, puzzlement, or confusion in a situation which he finds uncertain or unique. He reflects on the phenomenon before him, and on the prior understandings which have been implicit in his behaviour. He carries out an experiment which serves to generate both a new understanding of the phenomenon and a change in the situation." (Schön 1983, p. 68)

A reflective process aiming at societal transformation is one that is not content with perpetuating the status quo. For educators in the classroom, an immediate and logical point for acting could be within one's own curriculum and its delivery within the learning space. Such an approach has the potential to create bottom-up shifts in institutional culture regarding teaching and learning, especially if cooperation and coordination emerges within communities of interest.

Currently, there is increasing focus on 'transformational' learning for sustainability amongst academics, however, this concept appears to have strayed from Jack Mesirow's critical self-reflection framework, which "is far too often implemented without a critical exploration of the underlying theory" (Aboytes and Barth 2019, p. 1004). Stephen Sterling (2024) asserts, transformative learning is often times applied too lightly, and rather must consider deep learning and a shift in consciousness. Such a shift is far removed from the European Commission Research and Innovation policy recommendations, and is a process currently alien to the embedded strategic professionalism and formalisation of higher education. The institutional prioritisation, resourcing, and capacity for such a shift appears lacking, although conceptual frameworks to guide the needed transitions do exist.

Stirling (2024, pp. 153-154) advances a nested model of Bateson's learning levels for student transformation where the first order describes the basic acquisition of information without questioning assumptions or values which he describes as 'more of the same'. The second order of this model is critical thinking to evaluate assumptions and values and follows an active learning strategy which he describes as meta-learning. The third order then refers to epistemic-learning which 'involves a shift of epistemology or operative way of knowing and thinking that frames people's perception of and interaction with the world and this is the stage Stirling suggests that transformative learning occurs. This third order learning strategy perhaps should be the default aspiration in the face of the polycrisis.

The university as presently conceived is an unlikely source of remedy. It is committed not to transformation, great or otherwise, but more often than not to patching up unsightly flaws in the modern paradigm on the wager that it carries the seeds of its own repair and renewal. Nevertheless, it is difficult to envision a transformation to a more decent, inclusive, and durable world without universities and educational institutions and their committed staff at all levels stepping up to meet the largest challenges of our time.

The sustainability crisis can be regarded as "a crisis of human meaning and place in the broader framework of the world" (Evans 2015, p. 71), a reflection of the disconnection of people from nature, an uprooted culture. As such, Evans (2015) calls for "developing transdisciplinary sustainability education praxis" where educators and students embark on a shared journey. Transdisciplinarity can be understood as addressing complex and challenges through working across disciplines and with stakeholders beyond academia to develop integrated and holistic solutions. Evans (2015) views the sustainability crisis as encompassing economy, environmental, emotional and spiritual dimensions which traverse the cosmological, the epistemological and the ontological. Further, this holistic treatment of the planetary sustainability crises through transdisciplinary praxis can lead us to reflect on the very heart of culture and in particular, the hegemony of dominant cultures, the hegemony that colonizes the minds and spirits of oppressed peoples on a global scale. Evans work points to the unrealised as the oppressed in the planetary crisis, not constrained by class boundaries as the indigenous peasants once championed by Paulo Freire (1972).

Our contribution to this collection is humbly offered as academics with experience of working on sustainability in the context of higher education. Collectively, we have sought at times to affect system change and to deploy new methods for working with students- across disciplines and into the world of embodies knowledge beyond the academy. This paper is framed across four core questions which help us to at once reflect upon our own experiences, whilst moving forward to explore the relationship between sustainability, education, transdisciplinarity, and culture. How can new transdisciplinary approaches to education support action to respond to the polycrisis? How can culture and transdisciplinary be related in questions of education for sustainability? What novel approaches can we envision? And finally, what is the relationship between culture and nature in questions of education for sustainability? For such a wide-ranging topic of concern, our modest offering aims to open up a conversation on the role of culture as the fourth pillar of sustainability and its relevance to transforming education.

1. University and its Challenges for Sustainability

Climate change is a component of the larger polycrisis, as outlined in the work of Edgar Morin and popularized more recently by historian Adam Tooze. The polycrisis consists of complex and interrelated risks—economic, societal, environmental,

geopolitical, and technical. As such, no single issue can be treated in isolation; rather, they must be viewed as relational and functioning as part of a larger system originally described as a "complex intersolidarity of problems, antagonisms, crises, uncontrollable processes, and the general crisis of the planet" (Morin and Kern, 1999, p.74). As more recently described from a societal perspective by Popenici (2022):

> We have a humanitarian crisis, where millions deal with extreme poverty, famine, racism, and injustice, all disputing our commitments to stated ideals and questioning the very idea of humanity. We have a migration crisis with impacts across the world. We have a political crisis, with new fascist regimes and wars arising in the last few years. We have an energy crisis and massive imbalances with impact across the world. We also have a worldwide crisis of liberal democracy, a social crisis, a crisis of inequality, and a public health crisis. Most importantly, we have a crisis of ideas. (p.1)

Higher education is seen to also be in crisis (Mintz, 2021). Despite this, explorative learning and transformative action are suggested as important means through which higher education institutes can play a role in responding to the range of crises currently faced within 21st Century society (Lorenzen & Vöpel, 2025). This call comes considering long standing debate around the role of universities in society, and highlights new tension which the university faces in balancing old expectations and new solution orientated approaches. These tensions are articulated through individual versus collective expectations, disciplinary outcomes versus inter- or transdisciplinary outcomes, and learning objectives versus research objectives (Fam et al., 2020).

Throughout the 20th Century as the 'modern' University continued to be shaped by globalization leading on from industrialization, the core function of the academy changed. In his Science as Vocation (1946) lecture, Weber reflects upon the increasingly rationalized and bureaucratized status of universities. Processes of formalization and regulation have been both deepened and diffused in the century since Weber's discussion, yet the lecture still serves as an important entry point to consider the current crisis of the university (Lam, 2021; Lee and Walsh, 2022). Under neoliberal pressures, universities are often-times acting as exporters of stock for the professional workplace. The 'edu-factory' (borrowing from Fleming, 2021) is not only at odds with the moral, ethical and liberal ideals of the university from its origins, but has become an accepted reality that inverts those ideals harkening back to a halcyon past from which it seems impossible to

return. However, emergent counter currents exist driven by realizations that universities need value-led and purpose- driven leadership in the face of an increasingly volatile, uncertain, complex, and ambiguous (VUCA) world driven by globalization (Waller et al. 2019).

Several key historical shifts have been suggested (Rudolph et al., 2024) which have led to the current status of higher education. In the 19th Century, the idea of transforming students into global citizens was built upon Wilhelm von Humboldt's thoughts on academic freedom across both research and teaching. Becoming a driving force of 20th Century liberal universities, this was an important development in higher education, whilst still retaining elitist tendencies. As a second shift, following the Second World War and coming after Science as Vocation, a solutionist logic informed by international bodies such as the Organisation for Economic Co-operation and Development (OECD) and the World Bank considered higher education as a core remedy to the ills of society. The academic revolution of the 1960s represented a third shift, with a greatly increased in-take of students as a more technologically dependent world needed a more highly education workforce, effectively democratising access to higher education in developed countries.

Metrification and top-down managerialism with a strong focus on cost cutting measures and efficiency, mirroring the wider societal trend towards neoliberalism in the 1980s, acting as a fourth shift. And finally, the fifth shift, to the 'edu-factory' was accelerated by the COVID-19 pandemic (Rudolph et al., 2024), with an increasing emphasis on virtual or distance learning. Taking these shifts, and the current higher education landscape related both to research funding and the plethora of challenges this presents to academic freedom under the constraints of market efficiency, and the economic necessity for increased fee-paying student enrollments and the implications of this on standards, the function of the university within society must be considered in light of the polycrisis or the more recently coined *permacrisis* characterised by prolonged instability and insecurity without resolution.

The structural and institutional challenges faced in contemporary higher education are coupled with challenges for the student body with an uncertain future. Going beyond a wider societal trend, university students have been shown to have a higher prevalence of anxiety when compared to the general population, with factors such as family responsibilities, managing time and finances, establishing friendships and relationships

and managing expectations all long since established within the literature. Now, however, at a time of polycrisis, there are further factors at play with eco-anxiety commonly impacting upon younger generations (Brophy et al., 2023; Tavolacci and Ladner, 2024). Considering the polycrisis, it has been suggested that there is a responsibility on the University to enable students to use critical thinking skills whilst simultaneously developing a moral and ethical responsibility through sensitively engaging with topics of crisis. Such an approach, merging rational distancing with affective closeness, may "promote a deeper understanding as well as a greater compassion with a subject/a Lévinasian "other" at hand" (Redling, 2024, p.101).

2. Transdisciplinary Pedagogy (Culture of TD)

Disciplinary demarcations provide the foundations to third level education. There is increasing acknowledgment that approaches to grand challenges requires more holistic approaches to knowledge, with this growing in support within research. Despite this, however, with regards to education more work is needed. Established modes of education, in a Foucauldian sense, are situated within an educational system which operates as a mechanism of power used to exert control through the shaping of individuals and embed them with a dominant historical and social power structure. In this context, what is considered true or relevant is defined by pre-established norms and power structures (Foucault, 1975). In classical antiquity, education was seen as a process to cultivate virtue and intellect in attainment of human flourishing. Aristotle saw learning as an active process through which the individual could not only achieve intellect but also build character and moral foundations. From this, different types of knowledge emerge: phronesis (practical knowledge), Sophia (theoretical knowledge), and techne (productive knowledge). In a neo-colonial context, Paulo Freire (1968) outlines the emancipatory potential of learning and knowledge through conscientisation which can be viewed as a foundational element of transformative learning. The distinctions can be made here between education and power dynamics, learning and its potential for virtue, and liberation through knowledge which is created through dialogical participatory approaches. Transdisciplinary learning provides a pedagogy through which the standard, embedded power dynamics of education can be challenged. This is a process which is already seen as underway as articulated by Philipp and Schmohl (2023):

> Science is no longer a hierarchical, dichotomous, or tree-like order to distribute and stabilize privileges, power, and status. It is rather a cooperative-egalitarian network-based process in which a variety of knowledge resources, educational biographies, and knowledge potentials gain their form. (p.14)

While arcane organisational structures and practices persist in higher education, there is an increased understanding amongst policymakers, academics, funding bodies, and other stakeholders of the need for co-produced knowledge which can respond to the complex and interrelated polycrisis within which sustainability is situated (Irwin et al., 2018). Transdisciplinary approaches to research have been shown to usefully assist in responding to challenges emerging through the ecological crisis (Brown et al., 2010; Pohl et al., 2017; Köhler et al., 2019). As scholarly inquiry becomes more aligned with cross-disciplinary collaboration which moves beyond the academy to engage with wider partners, it is important to reflect upon mechanism for transdisciplinary learning for students (Wall and Shankar et al., 2008; Boyle and McGookin, *forthcoming*). Our interest within this paper is focused within the European context but other models exist such as general education requirements across North American Universities.

The links between transdisciplinarity and higher education more broadly have been outlined by the work of Vilsmaier et al., (2024). Calls for reform of the education system in the 1960s and 70s were informed by the wider social landscape and upheavals of that time. This represented a turning point in higher education from which the transdisciplinary discourse of cooperation, mutual learning, case studies, and transformation has been invoked to understand learning as taking place in both formal and informal spaces. Transdisciplinary learning is not solely then a matter of intellect but also the emotions and the body. Values, norms, beliefs, and conceptual skills are all engaged with through the transdisciplinary learning environment (Stokols, 2014). The central question around implementing transdisciplinary learning in higher education concerns when it should take place. On one side, a solid and highly focused disciplinary foundation is seen as necessary, whilst on the other, the earliest possible intervention is seen as preferable to avoid disciplinary narrowing (Vilsmaier et al., 2024). Whilst the former attitude plays out through doctoral and early career researcher experiences (as shown above through Wall and Shankar (2008); Boyle and McGookin, (forthcoming)), the latter perspective is usefully situated in relation to learning and education more broadly.

As generally constituted and normalised in a European context (although not universal), the primary (elementary) and secondary (high/ senior school) cycle, and continuing into third level (higher education), is a process of constriction towards narrower forms of specialisation. As most commonly found, this process culminates in a returning to more open and broadened approaches to knowledge and learning at the end stages through post-graduate, doctoral, and professionalised stages in the learning process. The early learning experience of the young child setting out in pre-primary school is opened up to learning of both the mind and body, or numbers and letters, while the final year Bachelors level student homes in on a very narrow investigation within a sub-discipline of a defined discipline within an established school. Not to suggest a deconstructionist move to undisciplined approaches to education, but more joined-up thinking in relation to climate change. It has been noted that "we must be specialists in our fields while recognizing the interconnections among disciplines but never failing to keep in mind the totality of society" (Strmic-Pawl, 2016, p.106).

Hans Dieleman considers transdisciplinarity, not as some kind of super-discipline – but as a cultural endeavor that contextualizes science *via* cultural ideas, the subjective experiences of researchers in the research process, and of imagination and the artful creation of new possibilities (Dieleman, 2017, p.170). But no overall methodology can capture all of reality. Knowing in between, across and beyond the scientific disciplines means knowing using multiple ways of connecting and understanding reality. Modern science needs to be complemented with culture, philosophy, art, subjective experiences, spirituality, and wisdom (Dieleman, 2017). Yet, "transdisciplinarity does not reject disciplinary knowledge, methods and agendas…it argues instead for the importance also of bringing together knowledge that is often dispersed in highly specialized fields and their disciplines" (Montuori & Donnelly 2016, pp.752-3). The hybridization of knowledge is central to transdisciplinary learning whereby knowledge is created through interactions across diverse and distinct knowledge areas. This can be provided by different stakeholders, sectors, disciplines, ways of knowing, and perspectives (McGregor 2013, pp.108-181). More inclusive and transdisciplinary discourse has been called for to move beyond narrowly defined mechanical formulations of transitions and science and technology understandings of sustainability. Education, in this way, can act as a subsystem (along with gender, religion etc.) of the global cultural system (Hughes et al., 2024).

The formal, informal and hidden dimensions of the curricula (within our host institution) are expressed in Fig. 1 and the institutional culture enabling student activism in the forms of practice, engagement and creativity. The core curriculum consists of academic programmes of study such as engineering or environmental sciences. The informal or co-curriculum would be exemplified by community-based learning while pedagogy-based events such as a Bio-Blitz or Hackathon could be categorized as the hidden curriculum.

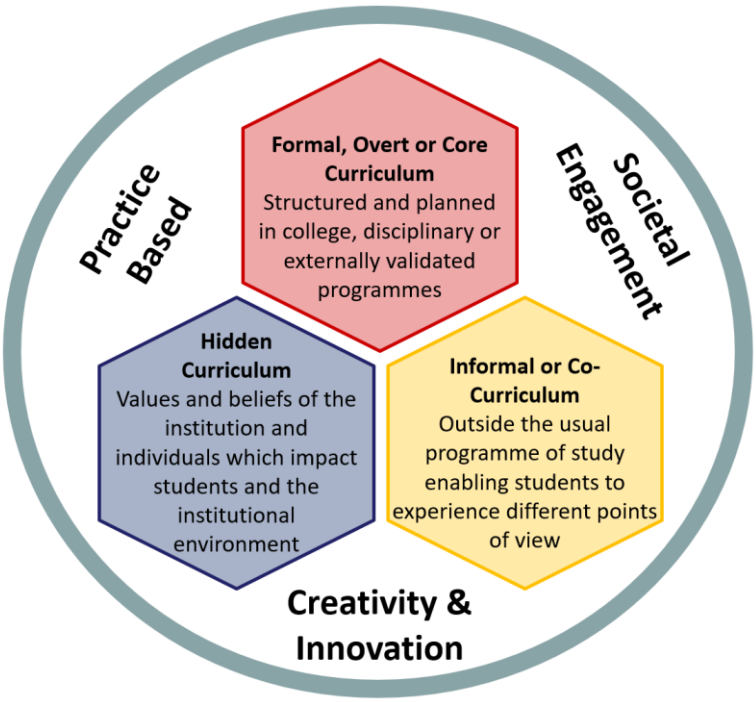

Fig 1. The formal (core), informal (co-curricular), and hidden (subliminal) and attributes of the learning culture as articulated at University College Cork, Ireland (adapted after Barimo et al., 2025).

Transdisciplinary learning is presented as a deep systemic change which includes with it some core reorientations of the teacher-student didactic. The teacher must be willing to hand over some control to facilitate the flowering of creative processes. With this, it concerns the dismantling of hierarchy in order to open learning to a plurality of knowledge paths. An embrace of failures, setbacks and detours becomes important components of the learning process. Reflective practice, often missing from more traditional approaches to education in third level, is helpful in ensuring learning opportunities are opened to different eventualities which can play out. This is also coupled with feedback literacy as required to support the building of institutional capacity in this space (Philipp & Schmohl, 2023). Transdisciplinary education can "equip students with the framework required to differentiate between diverse knowledge-based resources,

evaluate their application to specific challenges, and devise strategies for integrating these diverse sources into their academic pursuits and research" (Philipp & Schmohl, 2023, p.15). The ethical dimensions of such must be noted (Wittmayer et al., 2024) and means through which to navigate these understood. Similarly, regarding failure (Fam & O'Rourke, 2020), an awareness of the potential and impact of institutional, praxis, and individual failures should be central to the educational experience, opening students up to new considerations beyond the standard immediacy of their own performance, in isolation form external pressures and factors.

3. An Institutional Approach to Integrated Sustainability Education

The 2030 Agenda aims to promote the knowledge, skills, and values necessary for achieving sustainable development especially in relation to education for sustainable development (ESD) and global citizenship, i.e., SDG Target 4.7 (Leal Filho 2022; UNESCO 2018). Target 4.7 also calls for promoting an 'appreciation of cultural diversity and of culture's contribution to sustainable development' (United Nations, 2015, p. 15) . While there are many examples of disciplinary interventions to SDG challenges (Leal Filho 2022), implementation of SDGs across curricula does not appear holistically integrated with transdisciplinarity and multi-stakeholder engagement (Lozano et al. 2013; Tejedor et al. 2018).

The transformative potential of the 2030 Agenda which clearly articulates that the SDGs and SDG Targets are indivisible, integrated, interlinked, and/or universal, on no fewer than seven occasions, while also calling on all sectors of society, including academics and researchers, to implement this ambitious agenda (United Nations, 2015). The challenge stemming from the 2030 Agenda can be viewed as encouraging a shift from Newtonian or Cartesian Reductionism to a more holistic or ecological epistemology which is considered a critical basis of teaching and learning for sustainability (Sterling 2024, Orr 2012). For example, this more systemic point of view can be realised when considering SDG 8, Decent Work and Economic Growth, where cause and effect relationships amongst targets would reveal negative impacts on the environment or society from continued reliance of fossil fuels, non-sustainable resource extraction and/or non-circular dimensions of supply chains.

Here, we offer an integrated approach to embedding sustainability across a university curriculum in the context of a wider vision for sustainability education. The sustainability journey of University College Cork, Ireland was globally recognised in 2010 when it was the world's first university to be awarded a Green Flag by the Foundation for Environmental Education (Reidy et al, 2015). Sustainability became part of the university culture by engaging the whole campus community with a top-down, bottom-up and middle-out approach across all operational units including curriculum, research, engagement, buildings and estates, procurement, energy use, waste, etc. (Kirrane et al, 2018). With regard to the curricula, sustainability was codified in UCC's Academic Strategy with an emphasis on fostering "a quality enhancement approach and a culture of transparency and accountability' but also recognising a diversity of disciplinary cultures" (UCC, 2018, p.7).

The first pillar of the academic strategy calls for developing a 'Connected Curriculum' to create a more holistic, interconnected and seamless student experience underpinned by six existing strengths, specifically, of employability, sustainability, inter-transdisciplinary, global reach and civic and community engagement. There are many interrelations amongst these 6 strands, e.g. sustainability challenges as expressed by the 2030 Agenda that often require inter- or transdisciplinary teams working within global frameworks and with an understanding of planetary processes. However, when sustainability solutions are sought at the local level, civic and community engagement becomes a critical dimension of the process.

This strategy called for actions on a systemic or institutional level but still needed to respect academic freedom and maintain the top-down, bottom-up and middle-out principles fundamental to UCC's sustainability journey and overarching institutional culture.

The SDG Toolkit for Teaching and Learning: To address the needs of UCC's academic strategy, a suite of resources was co-developed with staff, students and a representative from the local municipal authority, and through broader consultations with other Irish universities and the local business community while building on institutional exemplars such as the University Wide Module of Sustainability or degree programmes such as the Bachelors of Process and Chemical Engineering (see UCC 2018). The general consensus of stakeholders was to create and curate pandisciplinary resources for teaching staff of any skill level to catalyse curriculum (re)design by integrating sustainability

concepts into ones teaching and learning practice. The rationale for and details on the creation of a web-based open-source SDG Toolkit and subsequent continuous professional development (CPD) trainings can be found in Barimo et al (In Press) and Guiry et al (In Press). Meanwhile, this section will examine the SDG Toolkit in the context of a whole of institution approach and its apparent influence on shifting institutional teaching and learning culture at UCC and elsewhere.

The SDG Toolkit also aimed to expose the interlinked nature of the 6 strands of the connected curriculum listed above with inter- and transdisciplinarity being the most evident; however, research-based teaching and community-engaged learning were also realised as staff priorities and key enablers during consultations. This approach acknowledges universities alone cannot solve the root causes of the polycrisis while recognising complementary knowledge also comes from outside the walls of the university (Byrne et al. 2017).

The overarching challenge of this SDG Toolkit was to create a useful resource for all disciplines and skill levels with regard Education for Sustainable Development (ESD) and recognise the 2030 Agenda as a call for the long-term sustainability of civilisation itself. The inclusiveness of disciplines in the initial consultative stage and within the Advisory Committee helped ensure the pandisciplinary project's primary aim while also accommodating a wide array of skill levels from 'novice to advanced' in the design of the toolkit and its intertwined CPD trainings. For example, the SDG toolkit's website (University College Cork, 2025) assumed no prior ESD knowledge or experience and provided initial 'on-ramps' to leave no educator behind. This is evident in the mapping tools which have incremental scores and subsequent reflection exercises to encourage initial visualisation of disciplinary or curriculum connections to SDG Targets and expanding one's ESD practice. Further, the library of resources includes introductory material such as basic information, literature references and videos and includes more advanced resources to promote enquiry-based learning for sustainability.

The SDG toolkit was also sensitive to the fear and worry of students which can manifest as eco- or climate anxiety and it can be transformed through action and hope (Panu, 2020, Wu et al 2020, Hayes et al 2018). Thus, it is thought that when our students develop a deep understanding of disciplinary knowledge and values aligned with sustainable development, they can be motivated and empowered to act with a sense of agency. The SDG toolkit also promotes action-oriented pedagogies where students might

create short videos or other artifacts which could be communicated and shared beyond the direct learning environment so that students can practice social responsibility and effective global citizenship. Raising educator awareness to eco- or climate anxiety is also viewed as an important element to consider when working within the Transformative Sustainability Learning framework (Sipos et al, 2008) which underpins the SDG Toolkit and associated CPD trainings.

4. Culture as the Fourth Pillar for Sustainability

Education for Sustainable Development (ESD) has generally been underpinned by three pillars - society, environment and economy. However, the concept of culture as the fourth pillar of sustainable development appears to be gaining acceptance. Sabatini (2019) argues for the inclusion of cultural sustainability alongside the traditional three pillars, highlighting the interconnections between economic, societal, and artistic dimensions. This perspective challenges the instrumental view of culture as a tool or device, and thus proposing a more integrated and holistic approach to sustainability that encompasses cultural heritage, identity, and values.

Komatsu et al. (2022) raises concern that technological, cognitive and behaviourist approaches have failed to achieve environmental sustainability after 50 years of effort and makes a case for a cultural approach to prevent environmental catastrophe. The technological approach is the only one not requiring behavioural change on the part of individuals as it assumes new technological solutions will remedy existing global challenges. The cognitive approach is based on rational uptake of new knowledges by individuals, yet environmental awareness does not necessarily translate into lifestyle changes or active engagement by the individual. Komatsu et al. (2022) then elegantly frames the behaviourist approach in the context of the cultural approach:

> The behaviourist approach thus assumes a direct relationship between human behaviour and human tendency for self-preservation. The cultural approach argues that although human behaviour can be rooted in human tendency for self-preservation, culture mediates these two. The cultural approach thus assumes that different groups of people with different cultures behave differently, even under the same conditions. (p.112)

The cultural approach highlights the significance of bridging diverse cultures while also assuming that "the root cause of our unsustainability is mainstream modern culture, particularly the dominant concept of selfhood" (Komatsu et al., 2022, p. 109). They also allude to a false dichotomy of humanity and nature in Western societies as "a particular attitude towards nature, one derived out of early Judaism and further elaborated through Christianity" (Komatsu et al., 2022, p. 112). However, it is arguably through the transformative potential of education, especially from a transdisciplinary perspective, that the interdependence of humans with their surrounding natural ecosystems can be realised and begin to help shift the dominant societal culture towards sustainability. The work of Komatsu and colleagues underscores the cultural significance of Laudato Si'—On Care for Our Common Home, the 2015 encyclical letter of Pope Francis (2015) which makes a strong moral argument for environmental stewardship with direct reference to "our Sister, Mother Earth, who sustains and governs us" (p.3).

Transdisciplinary sustainability education as a holistic framework considers the need for developing a common frame of reference or group culture by which Evans (2015) articulates a foundational element:

> Through an effective process of forming a shared reality, transdisciplinary sustainability educators foster amongst themselves a collective validation of each member's contribution and perspectives, a process that builds trust and encourages continued collaboration. The success of developing common ground in a shared reality is very much influenced by the process of individual group members developing transdisciplinary identities and competence. (p.86)

Burns (2015) further emphasized the importance of integrating cultural perspectives into sustainability education. By incorporating Indigenous teachings, particularly those from the Okanagan worldview, the model promotes a deeper understanding of the interconnectedness of all beings and the environment. This cultural integration ensures that sustainability education is not only intellectually engaging but also culturally resonant and respectful. Transdisciplinary learning in ESD involves the collaboration of various stakeholders, including academia, communities, and policymakers, to address complex sustainability challenges (Vaniev & Malt-Cullen, 2024). Integrating culture into this framework enriches the learning process by incorporating diverse perspectives and knowledge generating systems. Vaniev and Malt-Cullen (2024) continue to assert that in higher education, curricula that include diverse knowledge and contexts, such as

indigenous and local knowledge systems, create adequate space for students to engage with sustainability in multifaceted ways. This aligns with practices of decolonizing the curriculum, challenging traditional Eurocentric perspectives, and fostering a more inclusive and comprehensive understanding of global sustainability challenges.

Despite the recognized importance of culture in ESD, several challenges impede its integration into teaching and learning practice. Sabatini (2019) asserts that traditional educational structures and curricula often prioritize scientific and economic perspectives, marginalizing cultural considerations. Moreover, there is a lack of consensus on how to assess cultural sustainability and its impact on broader development goals. By adopting a transdisciplinary approach that values cultural diversity and local knowledge, educational institutions can develop more holistic, ecological and context-sensitive sustainability programs to empower communities and promote cultural resilience and in turn advance SDG progress.

Integrating culture as a key pillar in transdisciplinary ESD is essential for addressing the complex and interconnected challenges of sustainability enveloped in a seemingly ominous polycrisis. By embracing cultural diversity and fostering inclusive learning environments, educational institutions can and must enhance the relevance and effectiveness of sustainability education. This approach not only enriches the learning experience but also contributes to the development of sustainable societies that honour cultural heritage and promote equity and social cohesion. Evans (2015) also notes that humility and generosity are key ingredients to transdisciplinary endeavours so that those engaged are sensitive to existing power structures amongst disciplines and are open and receptive to diverse academic cultures with divergent underlying epistemologies.

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makes a case for a cultural approach to prevent environmental catastrophe. The technological approach is the only one not requiring behavioural change on the part of individuals as it assumes new technological solutions will remedy existing global challenges. The cognitive approach is based on rational uptake of new knowledges by individuals, yet environmental awareness does not necessarily translate into lifestyle changes or active engagement by the individual. Komatsu et al. (2022) then elegantly frames the behaviourist approach in the context of the cultural approach:

> The behaviourist approach thus assumes a direct relationship between human behaviour and human tendency for self-preservation. The cultural approach argues that although human behaviour can be rooted in human tendency for self-preservation, culture mediates these two. The cultural approach thus assumes that different groups of people with different cultures behave differently, even under the same conditions. (p.112)

The cultural approach highlights the significance of bridging diverse cultures while also assuming that "the root cause of our unsustainability is mainstream modern culture, particularly the dominant concept of selfhood" (Komatsu et al., 2022, p. 109). They also allude to a false dichotomy of humanity and nature in Western societies as "a particular attitude towards nature, one derived out of early Judaism and further elaborated through Christianity" (Komatsu et al., 2022, p. 112). However, it is through the transformative potential of education, especially from a transdisciplinary perspective, that the interdependence of humans with their surrounding natural ecosystems can be realised and begin to help shift the dominant societal culture towards sustainability. The work of Komatsu and colleagues underscores the cultural significance of Laudato Si'—On Care for Our Common Home, the 2015 encyclical letter of Pope Francis (2015) which makes a strong moral argument for environmental stewardship with direct reference to "our Sister, Mother Earth, who sustains and governs us" (p.3).

Transdisciplinary sustainability education as a holistic framework considers the need for developing a common frame of reference or group culture by which Evans (2015) articulates a foundational element:

> Through an effective process of forming a shared reality, transdisciplinary sustainability educators foster amongst themselves a collective validation of each member's contribution and perspectives, a process that builds trust and encourages continued collaboration. The success of developing common

> ground in a shared reality is very much influenced by the process of individual group members developing transdisciplinary identities and competence. (p.86)

Burns (2015) further emphasized the importance of integrating cultural perspectives into sustainability education. By incorporating Indigenous teachings, particularly those from the Okanagan worldview, the model promotes a deeper understanding of the interconnectedness of all beings and the environment. This cultural integration ensures that sustainability education is not only intellectually engaging but also culturally resonant and respectful.

Transdisciplinary learning in ESD involves the collaboration of various stakeholders, including academia, communities, and policymakers, to address complex sustainability challenges (Vaniev & Malt-Cullen, 2024). Integrating culture into this framework enriches the learning process by incorporating diverse perspectives and knowledge generating systems. Vaniev and Malt-Cullen (2024) continue to assert that in higher education, curricula that include diverse knowledge and contexts, such as indigenous and local knowledge systems, create adequate space for students to engage with sustainability in multifaceted ways. This aligns with practices of decolonizing the curriculum, challenging traditional Eurocentric perspectives, and fostering a more inclusive and comprehensive understanding of global sustainability challenges.

Despite the recognized importance of culture in ESD, several challenges impede its integration into teaching and learning practice. Sabatini (2019) asserts that traditional educational structures and curricula often prioritize scientific and economic perspectives, marginalizing cultural considerations. Moreover, there is a lack of consensus on how to assess cultural sustainability and its impact on broader development goals. By adopting a transdisciplinary approach that values cultural diversity and local knowledge, educational institutions can develop more holistic, ecological and context-sensitive sustainability programs to empower communities and promote cultural resilience and in turn advance SDG implementation.

Integrating culture as a key pillar in transdisciplinary ESD is essential for addressing the complex and interconnected challenges of sustainability enveloped in a seemingly ominous polycrisis. By embracing cultural diversity and fostering inclusive learning environments, educational institutions can and must enhance the relevance and effectiveness of sustainability education. This approach not only enriches the learning

experience but also contributes to the development of sustainable societies that honour cultural heritage and promote equity and social cohesion. Evans (2015) also notes that humility and generosity are key ingredients to transdisciplinary endeavors so that those engaged are sensitive to existing power structures amongst disciplines and are open and receptive to diverse academic cultures with divergent underlying epistemologies.

5. Inspirations for transdisciplinary learning from Ireland and Portugal

Our collaboration through the SHiFT Cost Action has brought together an interdisciplinary team of academics to consider and discuss transdisciplinary learning and the culture of sustainability through which it can be developed and considered. As contributors, we reflect upon the context of transdisciplinary learning for sustainability in both Portugal and Ireland.

5.1 Portugal

Portugal provides a valuable context for exploring how transdisciplinary education can be mobilized to address the interconnected global polycrisisthrough culturally grounded, nature-integrated, and community-based learning. Recent educational initiatives demonstrate how culture and nature can be harnessed together in innovative ways to foster sustainability competencies and transform educational systems.

Transdisciplinary approaches in Portugal are increasingly shaped by the understanding that education for sustainability must extend beyond academic boundaries, engaging with communities, ecosystems, and diverse knowledge systems. This approach responds directly to the complexity and urgency of the polycrisis by fostering adaptive, participatory, and contextually relevant educational strategies (Vasconcelos et al., 2022). It also reflects a broader European movement toward integrating the SDGs into higher education through experiential, case-based, and collaborative learning. As Vasconcelos et al. (2022) emphasize in their cross-country case-based study, engaging university students with real-world sustainability challenges through case-based learning strengthens their capacity to navigate complexity and ambiguity—essential skills for future change agents. As Činčera et al. (2019) point out, such collaborative frameworks are crucial to managing diversity in sustainability education and ensuring inclusive, inter-university and inter-institutional cooperation. Another example is the work of the Centro de Monitorização e Interpretação Ambiental de Vila do Conde (CMIA), coordinated by CIIMAR-

Interdisciplinary Centre for Marine and Environmental Research, which offers integrated programs that link marine ecology, climate change, and cultural heritage. The center organizes beach clean-ups, storytelling events, biodiversity surveys, and school-based exhibitions, among others. These initiatives engage both cognitive and emotional dimensions of learning and reflect the value of connecting scientific knowledge with place-based identity and participatory action. These initiatives respond to the call by Činčera et al. (2019) for cooperative educational frameworks that respect cultural and ecological diversity while building institutional bridges.

The integration of nature-based solutions (NbS) into environmental education has also gained traction in Portugal. Constructed wetlands for wastewater treatment, green roofs and walls, and ecological sanitation systems serve as both infrastructure and pedagogical platforms. Rodrigues et al. (2022) describe how NbS implemented in schools and rural communities simultaneously provide ecological services and function as powerful tools for experiential learning. These projects promote not only environmental literacy but also behavioral change through direct interaction with ecological systems. Recent research underscores the relevance of these approaches in shaping everyday sustainability practices. A study across five European countries, including Portugal, during the COVID-19 pandemic found that private-sphere pro-environmental behaviors were significantly influenced by values, emotional engagement with nature, and trust in science and governance (Iwińska et al., 2023). Educational initiatives that foster such trust and engagement—especially through experiential and culturally resonant methods—thus play a crucial role in supporting broader societal transitions.

Higher education institutions in Portugal are also actively participating in this transformation. Educational programs grounded in the principles of Geoethics provide interdisciplinary and ethical lenses for exploring Earth systems and the responsibilities of humans within them. As outlined by Azanza et al. (2020), geoethics resources developed for university educators integrate scientific knowledge with philosophical, cultural, and civic dimensions, making them well suited to transdisciplinary sustainability education. These resources encourage reflection on the ethical implications of human-environment interactions and invite learners to consider their role in shaping sustainable futures. Interdisciplinary education in Portugal has expanded in part through collaborative efforts at the European level. Works such as Widening Interdisciplinary Sustainability Education (Iwińska, Jones, & Kraszewska, 2018) highlight initiatives to develop cross-sectoral

curricula that integrate environmental sciences, social sciences, the humanities, and the arts. These integrative approaches are especially valuable in enabling students to relate their personal experiences and cultural backgrounds to broader sustainability challenges and objectives.

The Portuguese experience thus illustrates how culture and nature can be integrated through education to foster relational and transformative learning. Artistic interventions—including murals, participatory theatre, and poetry—are increasingly present in environmental education activities, allowing learners to process ecological emotions such as grief and hope. These emotional and symbolic dimensions of learning are essential for cultivating agency and sustaining long-term engagement with sustainability challenges. Portugal offers rich and diverse examples of transdisciplinary learning in action. From NbS and agroecology to citizen science and geoethics, these approaches engage with the complexity of the polycrisis by connecting local realities, cultural identities, and ecological systems. Through community engagement, NbS, and culturally grounded practices, educational initiatives across the country are modeling how education for sustainability can integrate knowledge systems, foster action, and catalyze transformation.

5.2 Ireland

In the Irish context, we here reflect upon some examples of transdisciplinary education in the context of University College Cork. We do this through outlining some initiatives which seek to resituate the classroom in new ways. Opening up new spaces to learning can bring forward new learners, who though their participation new learnings can emerge.

One such new space, the “walking classroom” can be viewed as a radical pedagogy in re-imagining interconnections and an opportunity for reimagining sustainability education in its place while also having scope to localise sustainability challenges and thereby motivate the mobilisation of learnings into action (Mullally and Barimo, in press). Walking pedagogies have the potential to inspire transformative thinking and transdisciplinary discourse by creating relational learning spaces to develop classroom-campus-community connectivity and foster bonding between human and non-human. The curricular exploration of the Anthropocene by Mullally and Barimo (In Press) bridges the sociological and ecological perspectives. It also attempts to transcend Cartesian/Newtonian reductionism while expanding participants’ time horizons to

embrace geological epochs, periods, and eras. Their interventions also highlight the inherent need for justice and equity when attempting to envision a sustainable world, and in doing so, rekindle socio-ecological imaginaries not in conflict with the greater biosphere.

Walking in the context of transformative learning can foster critical pedagogy by involving an embodied, spatial, relational and mobile politics (Mullally et al., 2023) and thus evoke the holistic frames of reference needed to confront complex interactions amongst a multiplicity of crises. While walking "should be valued as an important mode of knowledge production that simultaneously widens sustainability knowledge, integrates diverse knowledge systems, and supports transdisciplinary sustainability education" (Pearsall et al. 2024, p.907), walking is also a participatory, convivial and 'non-procedural' method to reflect upon the development of transdisciplinary pedagogy (Mullally et al 2023).

Dingle Peninsula 2030 (2018-2022), or Corca Dhuibhne 2030 in Irish, is an example of a collaborative transdisciplinary research project which aimed to support the transition of a region in the South West of Ireland to a low-carbon, sustainable society by 2030 (See: Boyle et al., 2021 for further details). Acting as a research project, it provided a model for how collaborative efforts can enhance local capacity to meet decarbonization targets and promote sustainable development through the 'diffusion of sustainability', as conceptually developed previously (Boyle et al., 2022). Alongside this, it also created a mechanism through which it could be linked to transdisciplinary learning. Local residents on the Dingle Peninsula (150 kilometres west of Cork City in an isolated rural community) were connected digitally to UCC and took part in a module on sustainability alongside students within the University. Creating such spaces for diverse voices to contribute to educational settings, as active learners, can provide fertile ground in relation to seeding potentially transformative learning in the context of localised action. The local partners on the Dingle Peninsula 2030 project, as transdisciplinary research collaborators, also supported UCC in organising the Walking Conversations symposium held in 2020 on the peninsula (Mullally et al., 2023). This again opened up new spaces for learning which was only possible through embedding principles of transdisciplinarity in our practice as academics.

Conclusion

Across the context of this special issue, the threads which bind culture and sustainability have been explored in relation to policies, communities, the arts, biocultural heritage, cultural studies, and education. When discussing education for sustainability, our contribution highlights the importance of transdisciplinary learning as core to the challenge of the polycrisis. Transdisciplinary learning is presented as a mode through which higher education may move towards embedding the challenge of sustainability more centrally within teaching. While transdisciplinary research is increasingly recognized, transdisciplinary learning remains relatively niche. Yet, through focusing on emotions and embodiment, in accordance with intellect, new educational potentials are established. In considering the socio-ecological potential of transformative radical pedagogies for reimagining the interconnectedness and rootedness of learners to their sense of place as discussed in Mullally and Barimo (in press), sustainability can be situated and enacted while creating opportunities to discuss 'just transitions'. Our understanding of sustainability concerns both living within our present environmental means whilst also considering the implications of current activities on future generations. As Hughes et al. propose (2024), "ways of seeing" are central to addressing sustainability challenges which cannot be achieved relying solely on a technological-economic-political axis. The core tenant of the polycrisis, a crisis of ideas, is responded to through opening up new ways of seeing the world, previously ignored or unexplored.

With this in mind, the primary focus of this work, building on from the work of Burns (2015) on the integration of cultural perspectives into sustainability education, has aimed to highlight the scope of third level education and the University more broadly as a potentially fertile ground for building educational approaches that are culturally informed and oriented towards sustainability. A transdisciplinary pedagogy provides the framework through which diverse knowledge-based resources can be integrated towards academic inquiry and research (Philipp & Schmohl, 2023). Transdisciplinary pedagogies also shift curriculum design away from reductionist ontologies to promote more holistic systems thinking, essential for addressing global sustainability challenges underpinning the polycrisis. We suggest that culture, as a fourth pillar for sustainability, is a key element of a transdisciplinary pedagogy. A self-reflexive approach or praxis which is culturally informed can build approaches for both the educator and learner which are attuned to values, norms and beliefs in which one is situated and from which one comes. This

illuminates biases, contradictions, blind spots, and offers alternative ways of being, knowing, and learning.

This paper's main function has been to set the scene for further developments of transdisciplinary learning which is undertaken in dialogue with cultural considerations. We have also, however, sought to highlight some practices which are developing in both Portugal and Ireland. For example, CMIA, in Porto, showcases approaches to education which combine place-based identity, participatory action, and scientific knowledge. This example combines both cognitive and emotional approaches to learning. In Cork, the Walking Classroom develops classroom-campus-community connectivity through a relational learning space. Both examples, alongside the others from Portugal and Ireland contained within this paper, highlight emergent approaches to sustainability education which follow principles of transdisciplinary learning. Further consideration should also be given to more flexible teaching and accreditation frameworks to increase the potential of curriculum offerings (Guiry et al, in press) yet HEIs must be cognizant of formalizing the informal and the potential dangers this may impose regarding quality assurance or loss of a valuable mode of curriculum delivery.

We have also explored cultures within universities which can potentially support or hinder institutional sustainability journeys as well as culture more broadly in curriculum with regard to inclusivity and dominant cultures and world views. Within HEIs, we often recognize discrete disciplinary cultures often with differing values, power dynamics, and even epistemologies and ontologies such as absolutism and relativism. To work effectively in inter- or transdisciplinary spaces, sensitivity to these cultural differences should be underpinned by disciplinary humility and tolerance. At UCC, the top-down, bottom-up and middle-out framework is a cultural hallmark driving institutional sustainability efforts. However, the higher education as a sector needs to accelerate implementation of SDGs and net-zero agendas, and in many if not most cases, radical transformation of institutional operations is desperately needed with regards to carbon budgets, building retrofits, procurement, green laboratories, and information technology infrastructure including the growing energy demands of data storage and artificial intelligence.

With regards to reimagining effective curriculum in the context of the polycrisis, the need was realised for transdisciplinary sustainability education that is accessible, inclusive and empowering for a plurality of cultures. Transcultural education has

potential to bridge the gulf amongst a heterogeneous array of cultures with regards to global challenges by creating spaces for seeing oneself in the other and creating common frames of reference. Wulf (2010) advocated for reimagining education that transcends national boundaries and embraces cultural diversity to promote peace and social justice. He emphasized that culture is not a self-contained, uniquely definable ensemble of practices, values, and imaginations and asserts that borders between cultures are dynamic and change according to context. More recently Grünfelder et al. (2024) responded to UNESCO's new social contract for education recognizing that no single discipline or cultural perspective can solve existing or future global challenges and called for pedagogies to build student capacities to work collectively and transform the world. This work further argued for transcultural education framed by relational context-specific processes of developing new shared meaning and action beyond existing practices through shared experiences and mutual learning in a world shaped by cultural complexity. We would propose a blended pedagogy of the transdisciplinary sustainability education praxis underpinned by transcultural education to foster global cooperation and action amidst the polycrisis. We also assert this approach will help to challenging dominant Eurocentric perspectives, and foster a more inclusive and comprehensive understanding of global sustainability challenges.

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