Article

Sustainable and Responsible Design Education: Tensions in Transitions

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Abstract: Sustainable and Responsible Design (SRD) harnesses design's potential to address eco-social problems and in doing so challenge the status quo of design education by reframing the social and ecological consequences, boundaries and agencies of design. This critical and transdisciplinary approach frays the edges of traditional design disciplines with embedded and reflexive modes of learning. We describe characteristics of SRD education and present theories of learning to empower students in this complex terrain. The learning associated with SRD education is ecologically engaged, participative, critical, expansive and designerly. We recount case studies of our own experiences advancing sustainable and responsible undergraduate design education in the UK. We identify path constraints such as disciplinary fragility, appropriation, and power dynamics in the design school. The push for a revision of priorities generates tensions where there is often greenwashing rhetoric of sustainability and inclusivity. We describe strategies and tactics to address these tensions. We highlight the agency we have as educators and designers and argue that design education can only meaningfully participate in response to the challenges presented by climate change, other types of ecocide, and social problems when educators make substantive commitments to supporting sustainability literacies and design approaches that serve the interests of diverse stakeholders.

Keywords: design for sustainability; responsible design; transdisciplinary design; design education; social design; ecological literacy; transition; disciplinary fragility; defuturing; sustainability

1. Introduction

We live in a world of multiple, large-scale crises—from the degradation of the Earth's ecological systems to social and cultural inequalities of power and representation. Increasingly expansive design practices facilitate social, cultural, and economic processes that have consequences for human and nonhuman stakeholders. As designers and design educators, we can reproduce current problems—or we can learn from historic mistakes and contemporary transdisciplinary research. Designers can be valuable agents of social change—but this will not happen without significant changes in practice and theory. Design educators can play a pivotal role in this process by facilitating change in design education in line with progressive design research.

Designers need more than good intentions and basic design skills when approaching complex eco-social problems. Sustainable Design and Responsible Design (SRD) is a basis for progressive design education—and yet embedding this content in undergraduate design (UG) programmes can be profoundly challenging. Responsible design will also be sustainable design, but since we are not even close to a situation where normative design is sustainable, in this paper we include the word sustainable to emphasise the need for explicit knowledge and strategies to support sustainable transitions. Sustainable and Responsible Design Education disrupts established norms in UG design education, not least by questioning exactly what constitutes "good design". Educators often face significant challenges

in genuinely shifting institutional priorities (beyond marketing platitudes)—as well as the opinions and assumptions ("hearts and minds") of some colleagues and students.

Sustainable and Responsible Design asks learners to consider the unintended social and environmental consequences of what designers propose and do. Many of these consequences can be anticipated if students and designers take time to consider the implications of their practice. But this analysis can often only be achieved if we are familiar with the analytic tools and frameworks to inform decision-making from a wider set of perspectives. These frameworks are only accessible with expansive transdisciplinary engagement. Since design schools in the UK have a legacy of narrow technical instruction in undergraduate education, increasingly situated within managerialist frameworks, the transition to Responsible Design UG education is not easily implemented in traditional UG programmes. There is, however, both strong student demand and policy directives for the SRD agenda.

While SRD education can thrive in dedicated postgraduate contexts in supportive institutions with smaller classes with committed students [1], educators working in undergraduate contexts face more significant obstacles. Creating new standards of practice in UG design programmes is not as straight forward as it might seem. Early exposure to SRD content can help students understand the various ways that design can engage with complex problems. The capacity for the design industry to support sustainable transitions is dependent on the rigour of these shifts in UG design education. The practice of "bolting on" sustainability without engagement with theories and debates is insufficient [2]—and often worse than no sustainable content at all (due to the way it reproduces and legitimises disengaged and dismissive attitudes). A recent UK Design Council report claims: "well-meaning designers have a limited conception of the tools and approaches necessary to design for sustainability and other important emerging issues" [3] (p. 6). Some years earlier, the AHRC Social Design Futures report raised the same concern—with somewhat less urgency [4] (p. 20). Design educators need to address this knowledge and skill deficit with haste.

SRD education is a multi-faceted challenge across design disciplines in the classroom and in institutional logics at design schools, universities and wider HE levels. SRD, like Education for Sustainable Development (ESD), "fundamentally calls for a change in the way we educate (i.e., teaching methodologies), what we teach (curriculum and subject matter) and why we do it (rationales and outcomes)" [5] (p. 596). More recently, the ESD guidance issued by the UK's Advance HE highlights the need for a transformative and critical learning agenda: "ESD is an educational change agenda grounded in transformative learning and critical pedagogy. It can be understood as a lens that permits us to look critically at how the world is and to envision how it might be and equips us to deliver that vision" [6] (p. 8).

The navigation of SRD transitions in UG education is the subject of this paper. We argue that traditional design knowledge must be accompanied by sustainability literacy, critical contextual transdisciplinary knowledge along with traditional design skills and thinking. We present learning theories for SRD education, reflect on our own experiences, examine tensions and discuss transition strategies to address these tensions. Design education can expand its remit with the ideas below.

2. Sustainable Design and Design for Sustainable Transitions

As authors we have been committed to design for sustainability and have long advocated that design education must expand the scope of its analysis and engagement to produce responsible, socially aware and ecologically attuned design graduates that can exhibit good global citizenship. This goal depends on critical engagement with key debates and analytic frameworks. The focus on narrow visions of employability in Design Schools too often fails to make space for these transdisciplinary debates. This blinkered perspective is increasingly irresponsible in a context of climate change, social inequity, and other critical eco-social challenges. Design in this mode reproduces "defuturing" conditions which must be confronted, as "the amount of time that humanity has to save itself from itself is very

limited" [7] (p. 155) [8]. Design is one of many disciplines in universities that must "increase the awareness, knowledge, technologies and tools to create an environmentally sustainable future" [9] (p. 2). With guidance, design students can develop the new capacities to use design skills to respond to global environmental and social challenges. Design educators have a responsibility to "engage the complexity of design as a world-shaping force and help explain it as such" [7] (p. 3). Engaging with the complexity of design involves engaging with critical sustainability theories and practices. This is achieved approaches such as the Sustainability Education Framework for Teachers (SEFT) focus on systems, values, futures and strategy [10,11] and ecological and sustainability literacy approaches as described in Section 5.

Some responses to design's complexity that expand the scope of design theory and practice to catalyse systems level change are Transition Design [12], Design for Sustainability (DfS) (Figure 1) [13] and Systemic Design [14,15]. These approaches all situate design within an ecological paradigm with methods that encourage engagement with complex, often political, problems. Design educators can respond to this recontextualization, from 'business as usual' constructs to embrace social practice theory and multi-scale perspectives of technology, innovation, and change. These visions of transition seek an ecological imperative and require design education that will help learners reimagine lifestyles and expectations, to recalibrate resource use and to codesign and enliven communities and the systems and structures that support them.
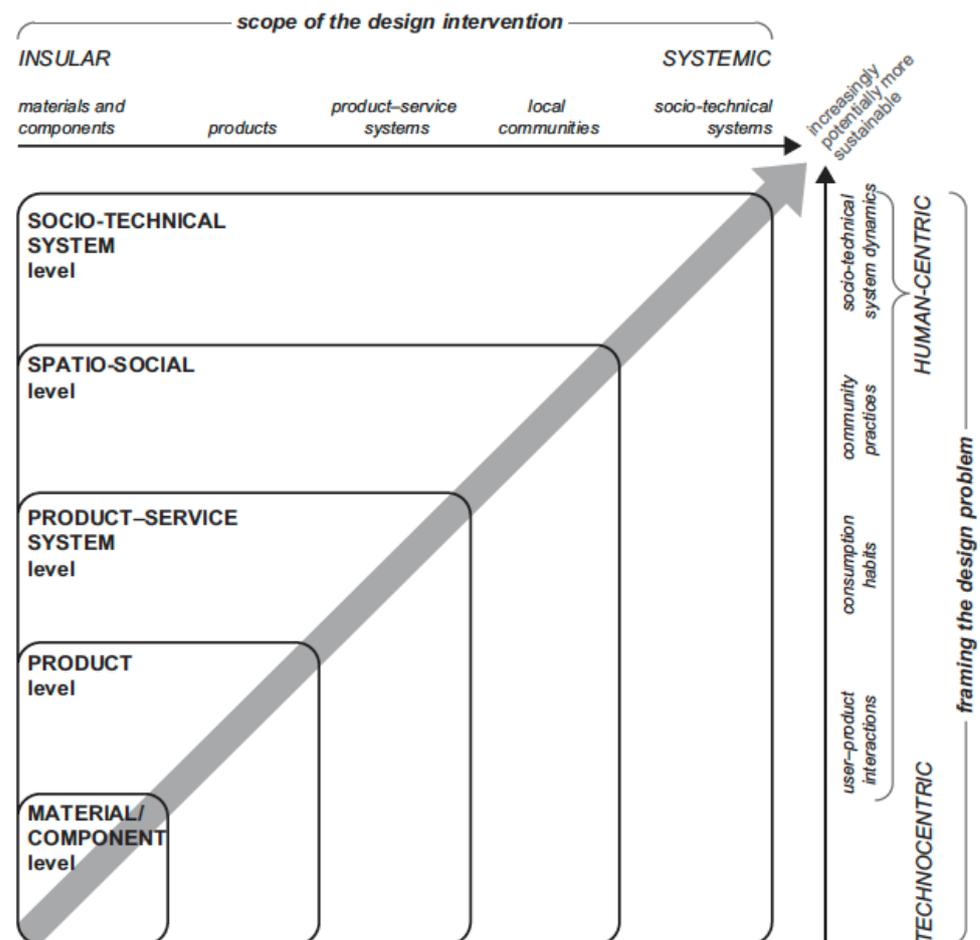

Figure 1. The DfS innovation framework (Ceschine & Gaziuluso 2019) [15] (p. 144).

Over recent decades sustainability in design research has shifted from a "product-based focus" to "design for sustainability"—with an expansive commitment to the development of new services, systems and ways of living. While design research has expanded its remit, design education has been slow to follow [1] (p. 2) [16], especially at the UG level. The proposals made by sustainability-oriented design researchers require design skills and transdisciplinary knowledge that are not traditionally evident in UG design education. Here lies one of the most significant obstacles in building capacity for SRD. In response to warnings of physical scientists, dramatic changes are necessary. We must place life at the centre stage [17] (p. 50). We can embrace a posthuman perspective [18] and foreground the ecological [19]. Design education can and must progress beyond its narrowly focused anthropocentric traditions.

Recently, there has been a step change in the design institutions in the UK engagement with sustainability. The UK Design Council's 'Design for Planet Festival' 2021 event and their *Beyond Net Zero: A Systemic Design Approach* (2021) report are significant in their advocacy of directional change in Design for Sustainability. We do not have space here for a review of the policy documents but note that Jacque Giard and Deborah Schneiderman reviewed relevant policies in the 2013 paper where they wrote: "the context has changed. The premise of most design programs, which is based on industrialisation, will have to be replaced with a premise based more on realities emanating from a post-industrial world" [20] (p. 133). Design research has generated significant new ideas and practices since this chapter was published. Yet global eco-social problems and the struggle to embed progressive ideas in design education have both intensified. In a 2021 report the Design Council notes "for the most part, designers are not yet using their skills and knowledge to deliberately support the green transition in the way that they should and could" [21] (p. 7). Design educators and institutions can respond, but these transitions require substantial commitments to enable SRD education.

3. Responsible Design

The Responsible Design movement has emerged over the last five years as an extension of Sustainable Design. The roots of both Responsible Design and Sustainable Design can be identified in writings including *Design for the Real World* (Papanek, 1972). A half a century later Responsible Design remains an emerging field without a fully defined theory or characterisation. Other associated works includes Inclusive Design, Participatory Design, Systems/Systemic Design, Design Futures and Decolonising Design [21–24] as key foundations of thought and evolutions in design practice.

> "The 'responsible' practice concept is being adopted in adjacent disciplines (Responsible Innovation, Responsible Management Education, etc.). In a design context, responsible practice includes tracing analytical and generative connections among design methods, research approaches, ethical stakes, and impacts. DRI [Design for Responsible Innovation] is concerned with objective, fair, nonpartisan and sustainable design actions, especially with regard to issues of contemporary debate such as environmental conservation, ethics, justice, equity, culture, and identity" [25] (p. 51).

Science and Technology Studies (STS) describes the notion of responsibility in this context as not only a technical one but as largely socially and politically constituted [26] (p. 1568). With this socio-political lens, a framework for Responsible Innovation includes four dimensions: anticipation, reflexivity, inclusion and responsiveness [26] (pp. 1570–1573). These dimensions could also be mapped on the Responsible Design Principles as illustrated in Section 6.1.

Responsible Design is closely related to Davey et al.'s (2005) model of Socially Responsible Design which proposes that all designed interventions should be undertaken from a position of responsibility [27]. However, rather than positioning design within, and in service to, the larger (and often compromised or distrusted) framework of Corporate Social Responsibility, Responsible Design requires designers to act independently: to design

responsibly even when briefs do not require it, and to argue for outcomes that "expand to represent other interests, outside of those of the client." [25] (p. 50). It is an approach and mindset requiring that designers accept "(a) the responsibility to avoid harm, (b) the responsibility to do good, and (c) the responsible governance of the design process" [24] (p. 1575). It is interested in addressing concerns about the environment, democracy, human values, inclusion and diversity, and social change [24]. Responsible Design engages with ideas and practices that will allow designers to address complex eco-socio-political wicked problems—including intractable global challenges such as climate change and other ecological disasters.

The Responsible Design Research Group (RDRG) at Loughborough University has established six principles which we attempt to embed in our research, teaching and practice:

1.　Responsible Designers are Ethical, both in the way they conduct and report research, and in the design interventions they propose;
2.　Responsible Designers are Pluriversal, rejecting the 'defuturing' nature of the technological status quo and accepting multiple plausible futures;
3.　Responsible Designers are Planet-centric, accepting and embracing the challenges of climate change, and factoring the needs of all stakeholders, both human and other;
4.　Responsible Designers are Decolonial, realising that a primarily Western conception and canon of 'good design' is limiting and harmful;
5.　Responsible Designers are Transdisciplinary, comfortable working with and being challenged by creatives outside of their own specialism;
6.　Responsible Designers are Optimistic, believing that designers can make the world a better place [28].

Ensuring such principles (Figure 2) are foundational in teaching, rather than subsidiary or optional, presents multiple challenges, the discussion of which forms the basis of this paper.
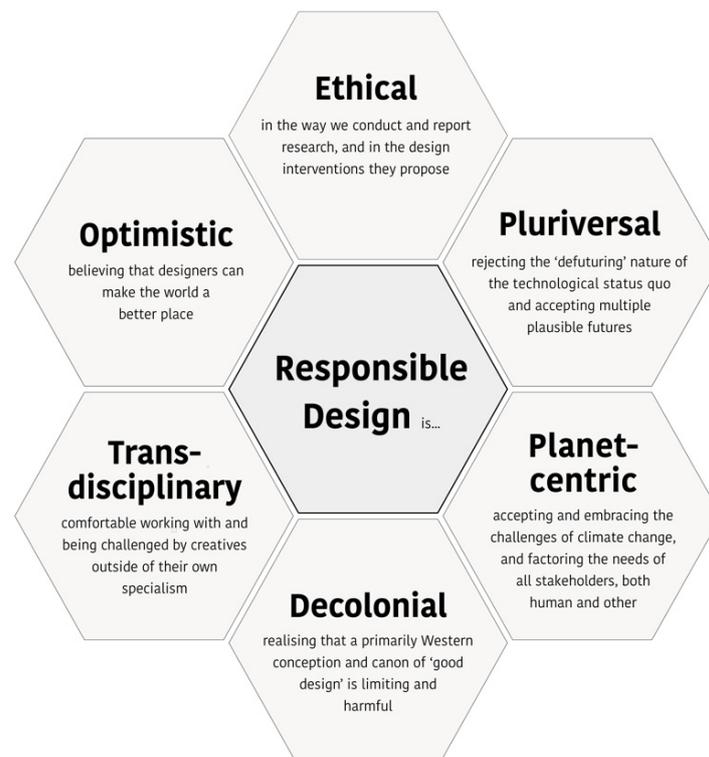
Figure 2. Six Principles of Responsible Design, Loughborough Responsible Design Research Group 2021.

4. Sustainable and Responsible Design Education

Good intentions are an inadequate basis for Sustainable and Responsible Design and this is even more true for SRD education where students are making an investment to access the skills and knowledge they will need for survival in an increasingly challenging employment and citizenship terrain. Lofthouse and Stevenson note that "the way in which responsible design goals are incorporated into the designer's thought process greatly affects the way that they will approach problem solving" [25] (p. 48). Helping design students engage with their responsibilities as design practitioners requires expanded contextual engagements and often dramatic transitions in normative design pedagogy. In our experience many students are increasingly hungry to engage in critiques of traditional framings of design (e.g., design as client-led service) and to question teaching that does not consider designers' responsibilities towards social and ecological issues. Our students often arrive at design school with a desire to build meaningful and ethical careers. It is the responsibility of the design educators to ensure they leave with the skills and knowledge necessary (advanced design practices and analytic frameworks) to not only to become capable designers, but with the ability to engage creatively and critically on collective eco-social concerns and make informed decision in their professional and personal lives.

De Vere et al. (2009) expect Responsible Design education to include "significant pedagogy in the areas of ethical behaviour, social responsibility and sustainability" [29] (p. 532). Similarly, the University of Twente identifies three strands to Responsible Design teaching: designing in a socially responsible manner, designing in such a way that the responsibility of the user is addressed through the designed artefact, and designing in such a way that the outcome encompasses social responsibility [23]. The University of the Arts London's *Responsible Design Framework* (2019) builds on these, identifying eight principles for embedding responsible approaches within a design curriculum [24]. In common these works propose a holistic design that centres sustainability and inclusive practice and makes space for social and political concerns.

5. Learning Theories for Sustainable and Responsible Design Education

Empowering students to engage effectively with complex eco-social problems requires supporting adaptive capacities to embrace new knowledge, new ways of knowing and new practices to challenge the status quo [2] (p. 2). Beyond the foundation of constructivist [30,31], student-centered learning, other teaching theories and approaches we identify to support SRD education are: (1) ecological and sustainability literacy; (2) transformative and experiential learning; (3) critical pedagogy/popular education/decolonising design; (4) transdisciplinary design and finally: (5) critical design thinking. These traditions can intersect in ways that support the development of better analytic capacities as a basis for reflective creative revisioning in SRD education.

5.1. Ecological and Sustainability Literacy

The ecological crises have revealed the need for relational approaches where complexity is understood and integrated at epistemic and ontological levels. The historic dismissal of the ecological has resulted in the gaps in knowledge and ways of knowing [32]—described by ecological theorist Gregory Bateson as a consequential epistemological error [33]. The concepts of 'environmental literacy', 'ecological literacy' and 'ecoliteracy' emerged in the last 1960s, the mid 1980s and the late 1990s respectively [34] (p. 3). Ecological and ecoliteracy both describe ways of thinking based on understanding of the interdependence between natural processes and human ways of living:

> The disordering of ecological systems and of the great biogeochemical cycles of the earth reflects a prior disorder in the thought, perception, imagination, intellectual priorities, and loyalties inherent in the industrial mind. Ultimately, then, the ecological crisis concerns how we think and the institutions that purport to shape and refine the capacity to think [35] (p. 2).

In challenging the intellectual constructs that justify the exploitation of nature, ecological literacy expands the domains of responsibility in design practice [36] (p. 47). Ecological relationships and impacts have been historically dismissed, so making space to explore the ways that design practices facilitate this dismissal is part of SRD.

Ecological literacy is a core tenant for many advocates of sustainability in design and has deep-reaching implications for design theory and practice [1,2,11,21,37]. Embedding ecologically engaged ways of knowing into design theory enables DfS:

> Creating sustainability will require both imagination and rigour. Designing for a participatory ecological worldview requires design thinking that transcends a mechanistic, interventionist and control outlook to one that reflects the values of ecological systems, emergence, complexity and uncertainty. The importance of the individual, and groups of individuals, in transformative learning is the sense of personal accountability that reconnects people (designers) to their social and ecological landscapes. This process is more effective when based on personal experience, interpretation realization. The seeing, knowing and doing that is design literacy is drawn from the potential of the individual to think critically, systemically and reflexively and for this potential to be further drawn upon in participatory, social learning that characterizes the meaning-making element of education for change [38] (p. 8).

When ecologically engaged, the ontological role of design in reproducing unsustainability becomes evident [39,40]. With this perspective, new ways practices are emergent.

Sustainability literacies are more tangible skills and competencies associated with making sustainable transitions possible. They have been substantially integrated into design research over the past three decades [41] (pp. 73–91). Energy and carbon literacy, for example, developed by learning and applying key threshold concepts (some of which can be found in Section 8.1), creates a basis for informed decisions associated with energy use. Sustainability literacies are aligned with learning for ESD competencies: systems thinking; interdisciplinary work; anticipatory thinking; justice, responsibility and ethics; critical thinking and analysis; interpersonal relations and collaboration; empathy and change of perspective; communication and use of media; strategic action; personal involvement; assessment and evaluation; and tolerance for ambiguity and uncertainty (Lozano et al. 2017, 4–5). The development of these competencies in design education relies on explicit strategies applied in the contexts of design practices. Design education relies on literature at the intersection of design and sustainability to make viable futures possible in the context of accelerating ecological disasters.

5.2. Participatory, Experiential and Transformative Learning

Transformative learning is one of many progressive pedagogic practices that aim to transcend transmissive learning. The concept was introduced in a 1978 paper titled 'Perspective Transformation' based on extensive research in a 1975 American nationwide study of consciousness-raising in women education. Here Jack Mezirow identified specific learning processes embedded in women's education [42] (p. 19) [43]. In retrospect, we might see this work as supporting the dramatic changes in women's rights over the past half century. Intersectional feminist theory [44] is a key analytic lens and orientation for inclusive SRD. For example, feminist standpoint epistemology [45,46] argues that marginalized individuals have insight into mechanisms of power not normally accessible those whose epistemic position aligns with the dominant group [47] (p. 6). This lens has significant implications for codesign, inclusive design, and design justice [48] and builds a stronger case for centering the voices of those who are directly impacted by design.

Participatory and experiential learning [49] increases an individual learner's capacity for change by embracing "trans-disciplinary, participative, creative, constructive and responsive methods that allow for (and respect) new perspectives and understanding and the continual reflection necessary for problem reframing and capacity building" [2] (p. 3). Teaching practices for identifying personal values in design education help this process [50].

Design education is typical highly participatory, but in the SRD context, educators bring new contextual, sociological and sustainable ideas to inform these processes. A good example is an intervention to shape students SRD projects enabling students "collaboratively analyse their projects across three defined areas (overview/approach/stakeholders), by mapping, connecting and challenging the systems associated with their projects" [51] (p. 1). Participatory processes can engage faculty with the SRD agenda as demonstrated in the co-design of "an anti-oppressive action framework" as a means to build a shared approach to curriculum [52]. Participatory methods provoke both deeper learning and greater potential for creative revisioning for learners at all levels.

Sustainable education scholar Stephen Sterling describes levels of learning on a trajectory into deeper types of transformative learning that increase agency and capacities for creative re-visioning. The Levels of Learning [53] (p. 78) model describes transformational learning that we aspire to as educators (Table 1):

Table 1. Levels of Learning, based on Stephen Sterling's model (2001).

Type	Level	Characteristics
No change	no learning	ignorance, denial, tokenism
Accommodation	1st order learning	adaptation and maintenance
Reformation	2nd order learning	critically reflective adaptation
Transformation	3rd order learning	creative re-visioning

Deep learning is theorised as multidimensional and occurring on multiple levels from psychological (changes in understanding of the self), convictional (revision of belief systems) and behavioral (changes in lifestyle) [54]. Design education has always aimed to provoke creativity, but in SRD education we aim for creative revisioning based re-orientation of priorities towards sustainable and responsible ends. This goal requires exposure to, and engagement with, key SRD concepts and practices (see Threshold Concepts in Section 8.2). Sterling's Levels of Learning framework identifies weak and token sustainability and can be used to categorise and potentially assess learning.

5.3. Popular Education, Critical Pedagogies, and Decolonisation

Critical pedagogy emerged from Paulo Freire's work in Latin America and has been mobilised to powerful effect in recent decolonising movements. Along with popular education, critical pedagogy supports learning to deconstruct the ways in which dehumanising effects are reproduced socially. Critical pedagogy helps learners distinguish cultural assumptions embedded within designed artifacts and media, cultural practices and social structures as aligned, or misaligned with the values they explicitly support. Cultural literacies enhance "people's capacity to engage in the production of social discourse, cultural artefacts and political actions" [55] (p. 78). Socio-political critique is coupled with commitments to social change. These practices engage with values and norms [56] creating conditions for realignments necessary to address issues-oriented design problems [57] (p. 16). Eco-pedagogy links critical pedagogies to environmental education with critical literacies, social theory and political action, linking educators with social movements to enact social change.

These traditions have been newly emphasised in design with the "decolonising turn" that has brought new approaches and "issues of power, institutionality, subject formation, globalisation, and systemic change" to design [58] (p. 136). These critical design discourses focus on the interrogation of whose interests and perspectives are met by design—and whose interests have been excluded. In receptive institutions and venues, design education has dramatically expanded its scope and its potential for effective and inclusive social change. But decolonialisation is not simply a set theories, but rather an approach that presents a radical challenge to traditional design education. Following Tuck and Yang [59], Ahmed Ansari writes that decolonisation cannot be grafted easily to other discourses and frameworks as it is nothing less than "rethinking of what design fundamentally is so

that we can imagine designing ontologies that care, redirect, and world otherwise" [60] (p. 138). This work is facilitated with multiple liberatory frameworks for design pedagogies as described, for example, by Sasha Costanza-Chock in *Design Justice* [50] (pp. 171–209). In our experience, many students find this work profoundly inspirational—as the work aspires to end the reproduction of historic injustices.

5.4. Transdisciplinary/Interdisciplinary Design

Design theory and practices on their own are insufficiently equipped to tackle complex eco-social challenges. Expansive design practice on complex "challenges require inter- and transdisciplinary approaches in which various disciplines and ways of knowing are integrated" [60] (p. 103) [61,62]. As design expands its remit.

> This emerging field is considered to be transdisciplinary; it learns from and contributes to multiple and expanding areas of theoretical and practice-relevant literature. These include but are not limited to: collaborative and participatory design, policy design and design for government, systemic design, more-than-human design, decolonial and pluriversal design, indigenous and non-Western ontologies and epistemologies, solution-oriented sustainability, science, sustainability transitions, complex systems theories, futures studies, transformative sustainability innovation in business, practice theory, alternative economies, critical urban research and feminist theory [63] (p. 20).

This expansive vision for design relies on interdisciplinary concepts and approaches to enable contextual analysis and transformative practice.

Where environmental problems are framed with overly simplistic and outdated models of nature and society, capacities for transformative are diminished [64] (p. 6). The social sciences provide denaturalising frames that help us understand human agency in change making [65] (p. 6). The critical social sciences describe the social and the environmental as profoundly intertwined, that environmental problems are inescapably social problems. Building on this simple point . . . power relations play a very significant role in how broadly or narrowly "socio-environmental problems" are defined, how the histories of socio-environmental relations are narrated, how they are experienced, who they impact and how solutions are approached [66] (p. 213).

With this understanding, more boldly reconstructive political work and "critical hybrid imaginaries" become possible [67] (p. 214)—as an evolution in the sociological imagination [66]. With this social theory, we see the ways in which "socio-environmental problems" are defined influences "who they impact and how we approach solutions" [67] (p. xviii). SRD like sustainable development, depends on analysis and reflective approaches, with frameworks that support contextualisation to understand the scope of specific issues [2] (pp. 2–3)—and, ideally, an integrated social theory that considers the entanglements between the environment, social relations, and human subjectivity [21,67] (pp. 2–3). UG education is the ideal place embed this learning to foundational modes of analysis.

Transdisciplinary design education at undergraduate level can demonstrate how different disciplinary traditions intersect with design. Designers' SRD problem-solving abilities depend on their understanding of design's engagement with the sociomaterial, and associated social practices, and thereby requires comprehensive social research to enable sociotechnical innovation [68] (pp. 3–4). Politics, sociology, anthropology, psychology, geography, economics, history, etc. create more integrated knowledge on eco-social problem contexts. Environmental sciences, sustainability sciences, energy, etc. create a basis for informed decisions on complex environmental challenges. Interdisciplinary engagements give students conceptual tools understand problem contexts. Transdisciplinary design intersects with systemic design (combining systems thinking to design theories and practices) in tackling complex challenges [69]. Systems thinking can be a valuable approach for this work. The UK Design Council's *Beyond Net Zero: A Systemic Design Framework* report advances this agenda [23] (pp. 43–53) with their recent advocacy of systemic design.

5.5. Critical Design Thinking and Designerly Ways of Knowing and Doing

The ideas above address knowledge gaps in design education and support the expanding scope of SRD practice. Design education already nurtures synthesis and creative revisioning with its orientation towards analysing problems from a systemic perspective. Integrating more diverse types of contextual knowledge, analytic lenses, methods and teaching practices support the aspirations of eco-social design movements and as well those of earlier proponents of design thinking. This expansive engagement supports Richard Buchanan's call for design to be recognised as liberal art of technological culture (1992) [70] and more current formulations of critical design thinking [71–73]. The liberal arts model for design education provides basis for rich contextual understanding. Critical and expansive orientations build on the notion of design as having distinct ways of knowing and doing [74,75] (p. 3). Buchanan's four orders of design (signs, things, actions, ways of thinking) can be most effectively enacted for wide ranging stakeholders by mobilising the theories marginalised groups have created to address their own interest (feminist theory, decolonising theory, etc.) and the theories environmental scholars have developed to address the needs of the planet and ecosystems on all scales (ecological literacy, sustainability literacies). Design knowledge can be integrated with ideas above for effective SRD.

5.6. SRD Learning and the Future of Work

The potential for design to act as a change making practice is clearly recognised in the World Economic Forum's Future of Jobs report (2020). Their list of the top skills required includes: analytical thinking and innovation; critical thinking; creativity, originality and initiative; problem solving and ideation; emotional intelligence; and user experience [76] (p. 36). Similarly in the OECD's Skills for 2030 report, design is used more than any other verb to describe its examples of new and emerging jobs [77] (p. 9). This focus on skills cultivated in design education could be good news if design education is also able to adapt. Design risks becoming a practice that is developed outside of the traditions of design education in the UK if design institutions are slow to respond to eco-social imperatives and engage with SRD as described in this paper. Despite the potential for SRD learning, the modern university's framing of education as a service industry where technical skills are prioritised—to the exclusion of other types of knowledge, can diminish the agency and transformative potential of design education. We describe below our own experiences delivering and building capacity for SRD education over the past 25 years in UK universities.

6. Transition Experiences with Sustainable and Responsible Design Education

6.1. Early Attempts: DEMI—Design for Environment Multimedia Implementation

DEMI was a three-year TLTP-funded consortium project (1998–2001). Its membership comprised five UK higher education institutions, led by Goldsmiths College, University of London, and the UK Design Council, Forum for the Future and the Royal Society for the Arts. The project aim was, at the time, novel: to explore and develop a new way of engaging higher education design curricula with sustainability ideas and resources through the design of online, web-based resources. The project aimed to integrate non-compulsory learning resources into established programmes of UK design education through online modes of learning. As well as exploring new modes of learning DEMI also presented a philosophical challenge to the rationale for design education. It was recognised that effectively responding to the UK government's Agenda 21 principles of sustainable education in design education [78] would require a considerable shift in thinking both from within disciplines of design and within Higher Education (HE).

Figure 3 illustrates the fundamental challenge of sustainability education. It is based on an image constructed by the demi researchers to show different contexts of teaching sustainability [40]. The left of the figure shows information *about* sustainability as an 'add-on' to design where discipline expectations remain unchanged and outcomes of learning reflect, at best, a more normative response to sustainability, reflecting a 1st order level

of learning; "accommodating" new information but not changing the way in which we learn or the outcomes of such learning [55]. This approach has been described as '*reducing unsustainability*' [79]—in other words, improving the environmental performance of existing things (eco-efficiency), rather than a more radical (and effective) approach of questioning what should exist. Education *about* sustainability doesn't connect to deeper learning and associated levels of action required to meet sustainable goals.
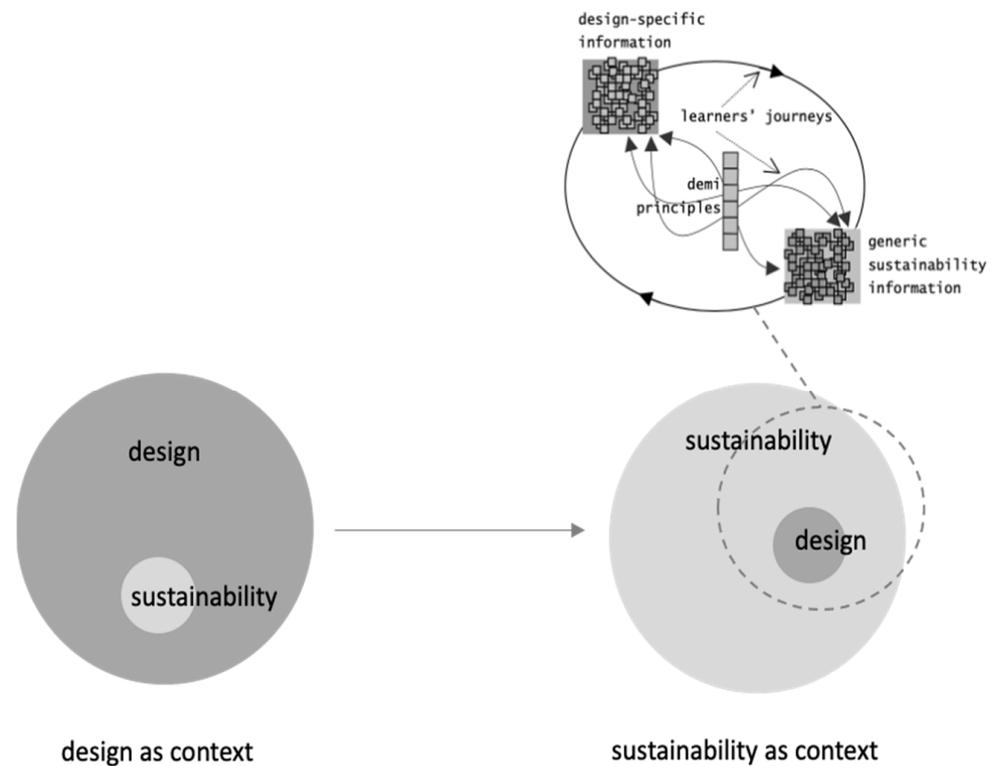

Figure 3. DEMI: Sustainability as context for design teaching.

On the right-hand-side of the figure is a picture of what the DEMI project was attempting: to situate design within a context of sustainability and to draw out new interdisciplinary relationships to help make sense of sustainability goals for design learners (and educators). In this context design is small in relation to the broad and interdisciplinary knowledge of sustainability and the attempt was to show how the discipline of design could 'grow and learn' and benefit from this new perspective. To that end the DEMI team devised six sustainable learning principles for design:

- efficiency,
- sufficiency,
- equity,
- scale,
- systems and
- appropriateness.

Learning resources were mapped using these principles. The focus here was how we as designers connect to the planet; how we understand ourselves as human beings (in multiple cultures and contexts); and how we understand what is the right thing to do (the consequences and unintended consequences of designing).

DEMI reflected an optimism in how design education could transform, en masse, to reflect a broader landscape of care and to shift the conversations around the value of design from one focused on industry and market dominance, to one addressing justice, protection, precaution and long termism. Reflecting back on DEMI twenty years later, there

are perhaps key reasons why its successful integration across HE design curricula wasn't forthcoming at that time:

1. Online learning resources were still relatively conceptual and their effective interaction with traditional and studio ways of design teaching was not understood.
2. The content of DEMI challenged existing ways of knowing and doing in design education. Through exploring wider disciplinary knowledge to inform the creation of DEMI principles, set up challenges for which design education wasn't prepared.
3. Finally, how teaching is supported and nurtured in universities is paramount in leading change. Introducing greater levels of interdisciplinarity and critical thinking requires leadership to leverage new structures and expectations—from the student level through to senior academics, many of whom have established ways of working and traditional views of outcomes. The importance of an institutional vision for change should not be underestimated.

Despite the failure to roll out DEMI on a scale that would have catalysed the sustainability agenda in the UK HE design sector, there were more modest achievements. In parallel to the development of the DEMI online resource, a new undergraduate programme, BA Ecodesign, was established at Goldsmiths in the 1990s. The DEMI principles pragmatically fed into the face-to-face lectures and studio teaching of this new programme. In our experience reasons the last two reasons are still obstacles to SRD education twenty years later as we describe in Sections 7 and 8.

6.2. Optional Sustainability: Loughborough Design School 2000's

The Design Department at Loughborough University in the 2000s included a group of academics addressing how sustainable design could be integrated into design curricula. In 2000 an education for sustainability programme was developed [79]. A yearlong optional module in sustainable design delivered in the second year of the UG programme was established. We taught different themes of sustainability, making links to wider systems, theories and applications to situate learning from a design perspective, often through small set tasks carried. However, in the time available it was likely that many students viewed the themes of sustainability as 'add-on' and 'desirable option'—but not essential—to an already established design curriculum which was well regarded by external employers. Here sustainable information was "bolted on" to a mainstream design training narrative. During its duration, sustainable content was optional, but it was still more than many institutions were doing at the time. From 2000–2019, 24 PhDs in issues related to sustainable design were awarded by Loughborough Design School (Loughborough University Research Repository, 2022). A Master's degree in Sustainable Product Design was launched in 2007 and then discontinued in 2011. A Design and Innovation for Sustainability MSc Programme ran for two years in 2012 and in 2014. Despite the marginality, a concentration of sustainable design practitioners in Loughborough Design School was a foundation for SRD spanning the last two decades and the basis of the work described below in Section 6.3.

6.3. Integrating SRD Education in the Design Programme: Loughborough School of Design and Creative Arts, 2018-Ongoing

A 2018 review of undergraduate teaching in the Loughborough Design School (now known as the School of Design and the Creative Arts, SDCA) proposed replacing the current Industrial Design programme with a new programme which would allow students to choose from three specialisms in their second year: Industrial Design, Experience Design, and Environments Design. This proposal was accepted by the University's senior management team at the School's Quadrennial Review in November 2019. Its implementation involved entirely restructuring the delivery of teaching, such that modules would be taught serially in blocks rather than the previous model of multiple, parallel modules. Visits to the Design Schools at Delft and Aalto Universities allowed their management of changes to programmes to inform and justify proposals. In February 2020, the new programme

received approval and its first cohort began this year (2021). The programme's review was initiated for a number of reasons:

- A recognition that the nature of design is changing: becoming transdisciplinary as the boundary between tangible and digital has blurred, and increasingly requiring engagement with experiential and systems-level thinking
- A demand from students, expressed in the National Students Survey and internal feedback, for greater freedom in creating their own learning programme
- A realisation that the programme as previously manifested was unable to address contemporary and future societal and global issues such as zero-carbon growth, machine intelligence, design ethics, etc.

In particular, it was felt that the existing programme's framing of design as a problem-solving activity encouraged an approach that limited possible solutions, rewarding the tight definition of problems and design concepts. A new approach would allow students to consider underlying issues, such that concepts would be based on the most appropriate design intervention, rather than one that was determined by the constraints of its domain discipline. Simultaneously, while maintaining the School's expertise and reputation in teaching user research, emphasis on users as sole arbiters of whether a proposition was successful would evolve and become more nuanced, introducing students to the impacts experienced by other stakeholders, both human and other:

First Year　Design should be user centric (you're not designing for yourself or people like you);

Second Year　Design should be human centric (what you're designing isn't the only thing in the world, it has to fit into people's everyday lived experiences);

Third Year　Design should be planet centric (what you're designing will affect humans and other life forms, just because they're not your customers doesn't mean they're not your stakeholders).

Making changes of this nature, in particular designating 'industrial design' as one specialism among three rather than the core focus of teaching, inevitably raised issues in a programme that is internationally recognised as highly successful. At the beginning of the process, reservations about the wisdom of incorporating an unproven approach were expressed by many staff. Acceptance of changes to both the curriculum and modes of delivery have been difficult for some staff, bringing with them an implicit criticism of the way they have taught previously. In addition, a number of alumni and graduate employers consulted about the programme have questioned whether a new focus comes at the expense of less concentration on traditional strengths.

Taking these issues into account, the redevelopment was managed within a consultative and co-creative process, involving fortnightly meetings of a Programme Working Group, presentations and feedback sessions to academic, technical, marketing and admin staff; consultations with student reps and 'open' sessions for all students; and one-on-one meetings with staff that would have key roles in delivery of the new programme. To ensure the intended relevance to industry was embedded in the programme from the beginning, consultations with representatives of more than 40 industry and third sector organisations were held. But at the same time the global events of the last three years have made many objections appear redundant, and the decision to make SRD the subject of the very first lecture to new students was enthusiastically accepted. Other specific tactics are described in Section 8.2.

6.4. SRD Education in Graphic Design: Loughborough SDCA 2020–2022

Undergraduate Graphic Design at Loughborough School of Design and the Creative Arts is also currently in the process of being replaced with a new programme. The previous titled Graphic Communication and Illustration programme has traditionally been delivered as 2/3 studio modules and 1/3 Art History and Visual Culture (AHVC) theoretical modules. The AHVC modules provided high quality critical skills and contextual knowledge. The

process of embedding critical and contextual content into the design studio units started with a revision of a practice-based module that already contained a sustainability brief and a global challenges brief based on the UN SDGs. This large compulsory 2nd year module was transformed to include a lecture series with transdisciplinary content, required critical readings, a new seminar series, and a new design studies essay. The briefs were re-written. The lectures introduced ideas from the environmental and social sciences in ways that demonstrated how different disciplinary traditions intersect and inform communication design. The seminars on required readings provided space for students to engage with key ideas and frameworks on design and sustainability, consumption, representation, politics, decolonisation, and social change. The practical work included topics such as system mapping, speculative design, critical discussions on sustainability options, and participatory design. We created space for critical engagement with all change-making proposals, based on the lectures, required readings and the seminar discussions on the literature introducing key eco-social debates. The module was designed to teach SRD practices and concepts.

The new SRD content and modes of delivery challenged previous ways of design knowing and working. The Graphic Design programme area did not have the benefit of the time devoted to deliberation in the Design programme as described above, and there was insufficient time to build collective understanding and design vision for the proposed SRD curricula (this problem was aggravated by the pandemic). Integrating social-ecological criticality requires opportunities to help colleagues see and make links with past ways of working—to create greater collective understanding and design vision for the proposed SRD curricula. Since the SRD vision is still embryonic in design education, time needs to be allocated for deliberative processes. Constrained by the structures and the priorities of the programme, embedding new content within just one module was difficult. Despite advocacy for Sustainable and Responsible Design within the Design Programme (located in a different building) and university wide EDI policy, within the Graphic Design programme tensions arose where ideas, priorities, and practices challenged existing norms. The refrain of trying to do too much too soon was persistent. Colleagues questioned the relevance of sustainability content. A decision-maker rejected the Responsible Design approach for the module. Beyond the intellectual work creating new content, the emotional and cognitive labour associated with this attempt to embed SRD content in just one module was severe (an experience supported by research in other fields, this work and these dynamics are described in Section 7). The module only lasted for two years as one committed to SRD as described in this paper.

Contested SRD in Communication Design

In comparison to other design disciplines, communication design education has been slow to embrace sustainability and socially engaged design practice. While drawing on abundant critical literature describing its role in promoting unsustainable consumption and obscuring ecological and social harms, it is arguably less proficient in supporting SRD alternatives. The First Things First Manifesto called for a "reversal of priorities" back in 1964, but enacting the processes by which these transitions would happen in communication design education have made slow progress over the past 50 years. The low standards for eco-social engagements have been noted by multiple educators. Already back in 1997 Kathrine McCoy argued for more rigorous graphic design education and suggested a liberal arts education model to provide holistic education beyond basic technical skills [80]. Even where there is solid engagement with critical ideas in visual culture and design studies, there are often gaps in bridging critique to generative practices. SRD requires not only deep reaching critiques of the role design plays in society, but practice developed from critically informed social imaginaries.

Communication design is perhaps the most politicised of all design disciplines as it is so often involved in erasing the complexity of eco-social relationships in the logic of marketing and advertising. This obscuring can mask grave social and ecological harms

that are always not evident without critical sociological, historical and contextual lenses and frameworks. While the impact of unsustainable practice has been evident in design disciplines such as architecture and industrial design for decades (as ecological impacts are easier to quantify) and these disciplines have, in places, more mature engagement with sustainability, it has taken much longer for the DfS research community to demonstrate how communication design can meaningfully respond to eco-social challenges—despite a strong tradition in literature describing the various negative eco-social harms associated with advertising and marketing. Communication designers can respond in substantive ways, but not with the same ideas and practices that are responsible for getting us to where we are now. The teaching practices described in Section 5 respond can help.

Systemic design is one of several approaches for transformative practice for communication design education. "Sustainable systems thinking approaches require that a given design challenge is informed by a consideration of the variable factors, users/audiences, non-variable conditions and socio-cultural issues that contextualize, or "frame", that particular challenge" [18] (p. 148). Visual methods have been used in systems thinking long before designers became involved because even visualisations created by those without training in visual methods can work exceptionally well in the process of revealing complex contextual and relational information. We note that graphic design's power to obscure can also be used to reveal, to facilitate, to enable and to help transform.

7. Findings: Path Constraints

In our experience, transitions to SRD education are far from straight forward even when there is an institutional will to respond in progressive ways. Active and critical engagement with transformative transition pathways is foundational for SRD education. Higher education institutions most easily default to disinterestedly reproducing current practices and associated problems. Enabling SRD education requires commitments to avoid path constraints we describe below as: disciplinary fragility; structural conditions including inertia within the institution; and the appropriation and neutralisation of key concepts. These dynamics limit the scope of possible pathways to deliver complex and transdisciplinary content. Identifying these tensions can help navigate this complex terrain. Below we discuss some of the key obstacles we have identified.

7.1. Disciplinary Fragility

In the UK and other countries oriented toward neoliberal modes of governance, educators work within institutional structures that are risk averse, working on a model with students as consumers, with full timetables, heavy workloads and multiple other pressures that regulate activities. In this narrow and heavily regimented context, efforts to advance critical and socially engaged agenda can provoke defensive manoeuvres in response to what is seen as not only disruptive content—but content that could be unwelcome by those who prefer not to question issue of equity and equality on social or environmental issues. We borrow the concept of disciplinary fragility—a term coined by geographers James Esson and Angela Last [80,81] to describe the difficulties progressive educators face in anti-racist education. The concept is supported by empirical work documenting the consequences including the intense cognitive and emotional labour required in advancing Responsible Management Education in Business Schools [82]. Disciplinary fragility takes form in backlash and pressures from both above and below in undergraduate education. Beyond the personal consequences for individual educators, it has implications for teaching quality and content. Eco-social issues can continue to be taught with outdated disciplinary norms and priorities (associated with creating the problems in the first place)— or we do the work to enable SRD. All too often weak sustainability or even unsustainable and irresponsible design education persists despite increasing evidence of the need to counter an 'education as usual' approach to external evidence of social and ecological crises and challenges.

No educator one wants to do be seen to be doing "unsustainable" or "irresponsible" design and thus the configuration of ideas in this domain are highly contested. No one wants to own the state of irresponsible design—but where Design Schools dismiss SRD requirements for sustainability literacies, domain expertise in eco-social design and design engagement with transdisciplinary debates, values and ethics, they teach students to make design outcomes with low regard for the ecological and social consequences of their practice. Undergraduate design education built on the ignoring and dismissal of the social and ecological "unintended consequences" of design is irresponsible by default. Here design schools create agency make things worse. Clearly these dynamics, i.e., the ongoing dismissal of SRD concerns, must either be camouflaged or transformed. Failing to create transition pathways from old (defuturing) conventions enables the reproduction of unsustainable and irresponsible design education and design practices.

As we have witnessed, integrating SRD content into compulsory large UG cohorts will often provoke tensions. Some students may not like to be asked to engage with ideas that asks them to reflect on assumptions about consumption, colonialism, race, gender, etc. Across disciplines, this type of education is often "deeply unsettling" [83] (p. 206) for some students and colleagues. Since there is gender, race and ethnicity bias in student feedback and teaching evaluations [84,85]—and this bias is potentially amplified when gender, race and ethnicity issues are part of the course content, student complaints can be used to attack progressive educators. Esson and Last use Robin DiAngelo's theory of "white fragility" (2011) [86] to describe how anti-racist geography educators are often subject to abuse. It is easier, they write, to "blame the person, group, or event that triggered the discomfort, and instigate a range of counter- moves such as refusal to engage, silence, retaliation, and ostracization" [87] (p. 672). Sociologists Boaventura de Sousa Santos [88], Jana Bacevic and other scholars, especially those advocating decolonising work, write of epistemic injustice, epistemic erasure and epistemic violence—where knowledge claims are impacted by structural conditions that privilege the ideas and interests of the dominant group [49]. Creating space for SRD education can trigger defensive moves that can take the form of complaints which are mobilised in ways that maintain the status quo—disenabling SRD. As design educators working on an SRD agenda, we have all experienced of the backlash in multiple angles: from students, colleagues and management—for advancing agendas that implicitly involve a criticism of 'Business as Usual'. Where SRD intersects with issues of gender, race, ethnicity and justice, we have found disciplinary fragility a useful analytic lens.

Sustainability advocates have often been subject to overt attacks. Since these are aimed at ideas on environmental politics and sustainable decision making—rather that one's own race, ethnicity, or gender—they are less integral and severe—but still hurtful. Furthermore, they have the capacity to derail sustainability agendas by marginalising, isolating and defaming the advocate. A prominent example of such backlash in design is the character assassination Terry Irwin faced for her early ecological work in design in Randy Nakamura's hit piece in *Émigré* (2004) and then republished in *Looking Closer Five* (2006) edited by Michael Bierut, William Drenttel, and Steven Heller. Papanek faced ostracization from the professional design communities in the US for suggesting a more responsible approach to design [88] (p. 270). Prominent and everyday environmentalists are still subject to dismissals and even attacks. Young people can also be subject to these attacks. SRD educators need to help build a culture that shifts from resistance mode to one that supports and protects students and colleagues in dealing with eco-anxieties and complex social issues in reflective and reflexive learning contexts.

7.2. Institutional Inertia

Institutional and discipline structures can reflect legacy values that are resistant to adaption to the wider sets of interests associated with SRD. An example of institutional inertia is embodied in the lack of diversity of the senior faculty, and this has been described as an obstacle in the capacity building in SRD education. The transformation of the Design

programme as described above (see Section 6.3) was facilitated by the engagement of educators who had longstanding commitments to sustainable and responsible design practice, with numerous senior women. Relatively greater diversity in decision-making roles has supported stronger SRD commitments and expectations for design to serve diverse stakeholders. Benson and Jennings argue that in US communication design education "the spectrum of cultural experiences, learning, knowledge construction, and understanding on offer within them is too limited when compared to how this spectrum operates across our increasingly diverse society" [18] (p. 132)—and this lack of diversity is an impediment to progressive education.

Design has a diversity problem in the UK. The UK Design Council reports that the design workforce is 78% men. These men are also more likely than women to be in senior roles. The design economy does, however, employ a slightly higher proportion of people from Black, Asian and Minority Ethnic (BAME) groups than are employed in the wider UK economy [89]. Where present, low levels of diversity seem to be a factor in the uptake and capacity building in SRD education, and research on how diversity informs decision making [90] and how diversity impacts educational priorities at universities supports this analysis [91,92]. Where senior staff are homogenous and decision making is hierarchical, the introduction of disruptive ideas that allow design education to address wider sets of interests can provoke defensive reactions. Sociologists have long argued that academic selection processes often reproduce the cultural interests and standards of those who are in decision-making positions [49] (p. 3) [93]. These social dynamics are evident in SRD where the subject matter is contentious. The SRD agenda calls for shifting priorities as more diverse interests are considered. It is perhaps difficult for some to understand what is at stake—and progress is unacceptably slow. We note that the presence of senior white women does not make a diverse grou—but even this low level of diversity is not always evident in design programmes. Furthermore, no type of person is necessary an advocate for the interests of their group, which is one of the many reasons why work academic supporting the interests of marginalised groups is so important. Feminist and decolonising work provides important lenses for inclusive design practice.

The inertia of the SRD education agenda can also be associated with workload. In large traditional universities, design educators face unique challenges in comparison to our colleagues in other disciplines. In the UK, design education is one of few disciplines where educators can be expected to spend more than 18 h a week in the classroom according to the University and College Union [94]. This structural condition is a legacy from when design was taught in time consuming but relatively relaxed ways in studios. Our personal experience is one where design educators at universities regularly have significantly more contact teaching time than our counterparts in other disciplines. This condition impacts capacities to manage transitions to SRD and deliver more complex content. We see an important part of our role as educators is building institutional capacity to enable SRD engaged education. Embedding SRD content seem unlikely without concerted effort of multiple individuals with at least some institutional decision-making power organising transition strategies, some of which we describe in Section 8.

7.3. Appropriation and the Role of Marginal SRD as a Counterpoint

Progressive ideas and strategies in design education are subject to academic appropriation in ways that undermine or even destroy their transformative potential. Design for Sustainability is subject to extensive co-optation, now escalated due to the newly recognised importance of these agendas—for example their incorporation into research council funding criteria/priorities [95]. There are now more good opportunities to advance the sustainability research agenda, but these can be lost where those with institutional power, rather than experience and scholarship, determine the SRD teaching agenda, with a result of weak sustainability or even no substantive DfS content. This problem is aggravated in the way those who have not engaged with ideas and debates assume there is little know—we address this specific problem with threshold concepts in Section 8.2.

The problem of academic appropriation is closely associated with greenwashing [96], i.e., the watering down of new ideas to make them more palatable to those whose support is casual or conditional and remain fundamentally uncommitted to the transition agenda—or committed only in ways that avoids any type of serious scrutiny or enquiry. SRD is necessarily firmly committed to not only the systemic understanding that engagement with climate change and other ecological problems necessitate—but the activation of the transition and transformative change project. Institutional treaties that are not accompanied by plans for implementation fall in this category. Madina Tlostanova writes that all potentially transformative and critical ideas are "commodified, trivialised, and caricatured losing their critical edge" [97] (p. 165). Without rigorous SRD education, it remains all too easy for students to develop the false (and dangerous) sensibility that eco-social problems can be addressed with superficial engagements.

The appropriation, instrumentalization, and depoliticisation of transformative knowledge is well theorised by decolonising movements. Ansari argues that "Decolonising design(s) should be directly and fundamentally opposed to all forms of design and designing that co-opt or appropriate its language in order to uphold colonial paradigms of development and equity" [59] (p. 138). Decolonising scholars warn how superficial engagements with their work can do more harm than good [98] (p. 384). We suggest that SRD educators must be equally vigilant and protective of the transformative theory we have managed to make. We also note that while SRD education should be integrated in all education, even marginal sustainability and responsibility can offer a counterpoint where it is impossible to integrate SRD more fully. Even when only in marginal spaces, high quality SRD can prevent the wholesale appropriation of the "sustainable" and the "responsible" by the normative disengaged, unsustainable, unresponsible and defuturing position. We have described how sustainable content in the margins can build future capacity for more integrated delivery, such as where content from an optional module is integrated into the entire programme (see the case study in Section 6.2). The following section includes specific strategies used to move from marginal to integrated.

8. Discussion: SRD Transition Strategies

SRD must be integrated in UG level design programmes if design is to be effective in addressing ecological and social problems. Undergraduate design education offers three years with opportunities for sustained engagement with complex ideas that can be to be integrated into design theory and practice. Here we have the time to open possibilities for critical ideas and transdisciplinary engagements in taught class and practice-based work. Along with traditional skills and knowledge, design graduates require basic sustainability literacy, and engagement with sociological and ethical engagements to make informed decisions. SRD content at UG level embeds necessary analytic frameworks to inform design practice at a foundational level. SRD education requires not only appropriate learning principles and approaches, but capacities to navigate obstacles (see Figure 4)—and implementation transition strategies we describe below.
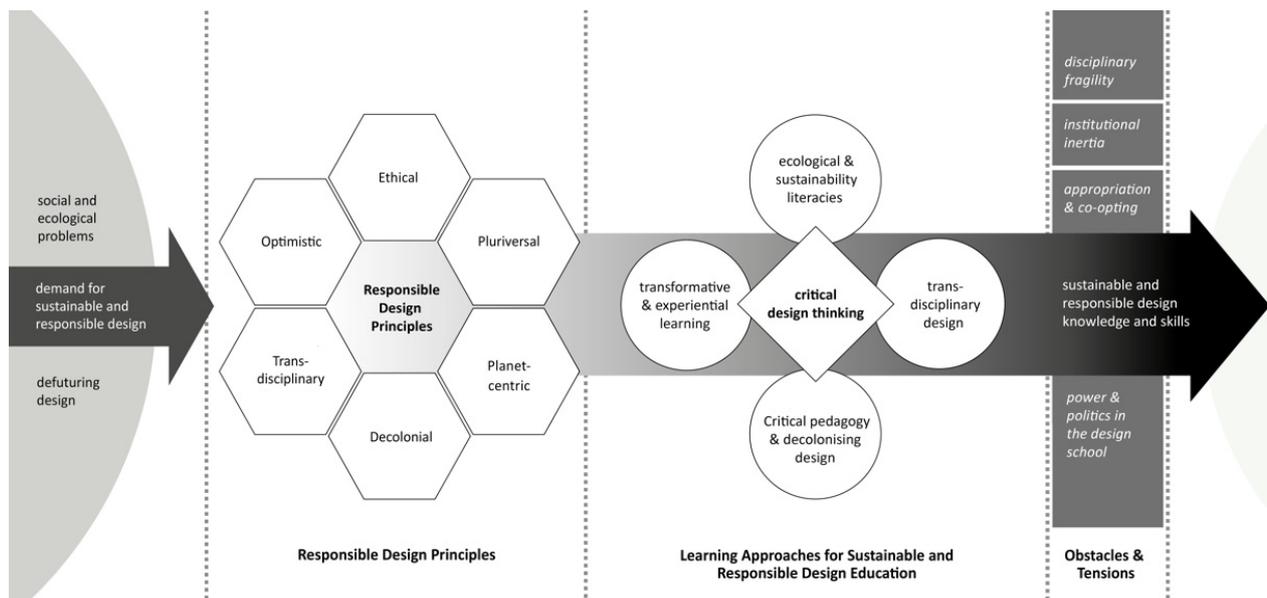
Figure 4. Navigating Obstacles for Sustainable and Responsible Design Education Transitions.

8.1. Deliberation and Debate in SRD Transitions

Eco-social problems are wicked problems [99] (p. 155) and have no one right and wrong answer. In supporting encounters with contested and politicised knowledge on issues of sustainability and social design, educators can encourage discussion and debate as part of the learning process. Debate as a teaching method supports critical thinking and students' ability to construct arguments using key concepts [1,100]. While introducing critical texts, educators can help manage tensions in the classroom with strategic neutrality [101]—allowing students to raise questions based on critical readings (as one of a variety of approaches). We note that this tactic should not be confused with the false idea of neutral education—as educators in the critical pedagogy transition have demonstrated, education that reproduces the status quo has its own politics [102,103]. It is important to recognise, however, that debates on eco-social issues are typically qualitatively different from knowledge traditionally generated in design education oriented toward aesthetic concerns and functionality from a user/human-centred design perspective. Eco-social design education depends on more expansive engagements with interdisciplinary knowledge in intersection with personal values—including some key concepts described below.

8.2. Threshold Concepts and SRD Complexity

Threshold concepts and practices can be employed to communicate new ideas and practices. They can be embedded in teaching and used for evaluation of learning. Threshold concepts are described as "key ideas, concepts or processes in a discipline that need to be understood by students before they can understand other parts of the subject that follow from them" [104] (p. 14). They function as "a portal or gateway to subsequent understanding" and are considered "bounded, integrative, irreversible, transformational, and involve troublesome knowledge . . . associated with any new conceptual understanding in a given field or discipline" [Ibid, 8]. Threshold concepts can engage deeper, epistemic learning by supporting new ways of thinking about complex problems. Evolving threshold concepts (with greater inputs from other discipline knowledge) both open up design (one could argue makes it more vulnerable) and simultaneously adds greater robustness to how we integrate new understanding. As the discipline integrates new values, the scope of enquiry also grows. We identify some key threshold concepts and threshold practices in SRD education below (Table 2):

Table 2. Some Proposed Threshold Concepts in SRD education.

Domain	Threshold Concept	Threshold Practice
systems	complex adaptive systems	systemic design
	complexity	system mapping
	emergence	network visualisation
	non-linear	gigamapping
	life cycle analysis	
	circular economy	
	cradle to cradle	
	critical materials	
sustainability	Anthropocene	life cycle analysis
ecological literacy	planetary boundaries	system mapping
	ecosystems	cradle to cradle
	biomimicry	slow design
	transition	durable design
	systemic change	transition design
	unintended consequences	design economies
	multi-species	open design
	embedded system	design justice
	ecological economics	systemic design
	inter & intra generational equity	transition design
energy	rebound effect	carbon footprint
energy literacy	embedded emissions	system mapping
	eco-efficiency	transition design
	eco-effectiveness	energy descent planning
	Jevons Paradox	
	Net Zero	
consumption	informed choice	respectful design
	consumer sovereignty	speculative design
	social construction of self	circular design
	positional consumption	service design
	choice editing	
	sufficiency	
justice	intersectionality	design justice
	racism	design ethnography
	sexism	respectful design
	diversity	
decolonisation	appropriation	participatory design
	discrimination	co-design
	colonisation	respectful design
	democracy	design justice
	participation	decolonising design
	agency	design ethnography
ethics	consent	inclusive design
	consent of the non-human	enabling design
	multi-species	
	precaution	
	ecocide	

Some domain concepts are also threshold concepts. This list is by no means exhaustive.

We are not suggesting that all SRD educators need to have advanced understanding of all the threshold concepts and practices above. But SRD educators should have advanced contextual knowledge and be able to guide students to appropriate analytical tools and frameworks. An understanding and respect for complexity is fundamental in SRD as a foundation for exploring unintended consequences of design practice. Communities of inquiry, at various scales (international and local), can help integrate new threshold concepts into teaching practice. They work on a local level for teaching teams on large modules. New concepts and priorities can be nurtured with dedicated transition management to facilitate learning and institutional change.

A persistent problem in SRD is the erasure of complexity associated with SRD debates. Research suggests that creative and cultural workers typically have distinct cultural values often associated with left aligned politics [104] (p. 1) with relational and eco-social perspectives. But an *interest* in eco-social issues and *concern* for the environment is not the same SRD scholarship, research, and expertise. Where those with institutional power define how narrowly or broadly "socio-environmental problems" are defined, the transformative potential of SRD is diminished. Witnessing the appropriation and denigration of the field is the motivation for the attention to threshold concepts. The rigour and transformative potential of the work of SRD theorists, researchers and educators is undermined where the complexity of SRD education is erased or simply reduced. This makes responding to eco-social problems even less likely. Statements by the UK Design Council on the insufficient skills in the UK Design industry demonstrate that SRD education (see 1.1) must be developed with more rigour. Threshold concepts can be used as indicators of relative levels of engagement and understanding.

8.3. Lessons and Practical Tactics in SRD Transitions

Educators wishing to embed SRD teaching in their curricula face many challenges. There are currently few design programmes worldwide, particularly at undergraduate level, that give the same prominence to sustainability and responsibility that they do to aesthetics or commercial imperatives, for example. In our experience, senior management teams are rarely actively hostile to SRD teaching, but instead take a managerial and pragmatic overview that sees curriculum change competing with other day-to-day commitments on staff time and resources. For SRD advocates this may feel frustrating—but while rapid and radical structural change is rare, it is possible to make significant advances where sufficient capacity exists. Listed below are several strategies that have had demonstrated success in our own implementation of SRD.

1. Form a working group of like-minded academics from within your school or department (a community of enquiry as describe above in Section 8.2). Create a few initial, achievable, time-limited actions, and schedule regular meetings to ensure conversations are purposeful, rather than general. When the group feels its proposals are robust enough to withstand scrutiny, invite students to meetings to give feedback. Avoid presenting work-in-progress to other staff members if you believe their input will be unhelpful; instead wait until you have evidence that supports your proposals (see points 2–4 below).

2. Gather evidence of demand for SRD teaching from students. Universities value the wishes of their 'customers' above all else. Demonstrating that you are responding to student demand is therefore a highly effective way of creating buy-in from senior management. Conduct discussion groups and create surveys to understand what students would like to see in their curricula, and present findings in a way that emphasises the opportunities for improvements in student satisfaction, retention, and feedback.

3. Similarly, gather evidence of demand from industry. Universities also place high value on the wishes of employers and other industrial partners. Demonstrating that you are responding to external demand is another highly effective tactic. If discussion groups or surveys are inappropriate in this context, use informal conversations at degree shows, guest lectures, work-placement visits, etc to build a collection of 'anecdotal' evidence. Present this evidence in a way that emphasises the opportunities for improvements in student employability.

4. Gather evidence of what Design Schools at other universities are doing. Focus on institutions that rank higher than your own in various league tables. Where an institution ranks lower than your own, argue that their SRD teaching gives them a competitive advantage that may allow them to rise above your own.

5. Look for structural opportunities to bring SRD criteria into the assessment and Intended Learning Outcomes of modules where these are not the main focus. For

example, in a module that teaches research skills, ask students to undertake a literature review on the Circular Economy or UN SDG's; in a module that teaches semiotics, ask students to identify how brands or products signal their 'greenness'; etc.

6. Encourage students to enter competitions with projects that have an SRD focus, even where this is not a specific criterion of the competition. Such entries are often highly commended and singled out for comment by judges or highlighted in press coverage. In addition, design students' work tends to be of a visually high standard which makes it attractive to university press offices: publicise your students' successes so that your school's senior management gain recognition from others in the university.

7. In research-intensive organisations, seek out opportunities to tailor your research to make it suitable for presentation at SRD-focused conferences, or publication in SRD-focused journals (if it is not currently). Refer to these publications in your teaching, and use programme meetings, annual performance reviews, etc to emphasise your practice of research-led teaching.

8. Encourage your SRD PhD students and Research Assistants to take on teaching responsibilities where permitted by your institution, exposing taught students to their ideas and enthusiasm and cultivating communities of SRD practice beyond PhD experiences into other universities or employment contexts.

9. Encourage students to use formal and informal feedback mechanisms (module feedback, staff-student committees, the NSS, etc.) to advocate for SRD content in their teaching.

These practices have worked to navigate the path constraints we described in Section 7.

9. Conclusions

The development of substantive sustainable and responsible undergraduate design education in the UK has been slow. We have referenced reports published by the UK Design Council and the UK Arts and Humanities Research Council that have both noted UK designers are insufficiently prepared to address current social and environmental challenges. Eco-social harms perpetuated by the various design industries can no longer be presented as "unintended consequences" of design—but should be recognised as a failure of design and design education to engage and adapt suitable strategies to avoid producing ecological and social harms. Despite these entrenched problems, design research has made hopeful progress. If design education can be aligned with current design knowledge our discipline will be better prepared to help in the ways Papanek and other design visionaries have theorised and demonstrated for decades.

In this paper our reflections on our own experiences have resulted in explorations of tensions and possible responsive actions. Quality SRD education depends on advanced engagement with sustainability literacies, critical and transformative learning, transdisciplinary knowledge, and critical design thinking. We have described attempts to create progressive sustainable responsible design education in the UK. The reflections and case studies are based on our own experiences in one country, and we note the limitations of this type of analysis based on a limited perspective. We are working on methods to collect international perspectives in a second paper based on two upcoming workshops.

In conclusion, we emphasise the importance of being open and flexible in the navigation of incidents of disciplinary fragility and all "tensions" encountered in the process of developing progressive agendas. We highlight structures that limit progress as well as the agency we have as educators and designers who are not always aware of the potential locked within the design practices when adequately engaged with transdisciplinary knowledge and sustainability literacies. We note that the ideas in this paper are a starting point, and it would be impossible to include all relevant content for SRD. As the scope of design/designing is challenged and opened, greater opportunities exist for us to extend conversations of plurality and ecology in all design learning, at all levels of education.

As we look to the future, SRD education needs standards for excellence for design to maintain its integrity and develop greater rigour. Students will face complex social

and environmental challenges over their lifetimes. Accreditation of SRD education could be a sensible step for the design education community. Professions often use licencing or accreditation of individuals and/or schools to ensure educators and practitioners are accountable. Sterling's Levels of Learning model can be a mobilised to assess and evaluate SRD education on a spectrum from "no learning" to "third order, transformative learning". The Responsible Business Management community is an example of a discipline making attempting to encourage ethical practice with the creation of regulatory structures. Twenty-five years ago, McCoy called for accreditation to define "baselines for curriculum standards, faculty numbers and qualifications" [87] (p. 224). This process can be enacted in design education with collaboration between the Design Research Society (DRS) Special Interest Groups, universities, design councils and other design institutions. In far too many places, design education has avoided doing the work that would allow it to engage with eco-social issues in substantial ways. Such stasis must no longer be viewed as a benign response. Instead, there are options for integration, exploration, and adaptation in the discipline of design to create and critique effective responses to these complex and long-term eco-social challenges of the 21st century.

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