Sustainability in environmental education: New strategic thinking

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Abstract

Recently environmental education (EE) literature has been supportive of pluralistic rather than goal-oriented learning. Researchers argue that sustainability is not fixed but socially constructed and that sustainability issues should not be represented as indisputable targets. Countering this trend in environmental education research, this article argues that unsustainability should be treated as a concrete challenge that requires concrete solutions. The author will argue that there is a need for clear articulation of (1) what (un)sustainability is; (2) what are the key challenges of (un)sustainability; and (3) how the sustainability challenges can be meaningfully addressed. This article will outline a number of helpful frameworks that address obstacles to sustainability, ranging from population growth to unsustainable production and consumption practices. Solutions include investment in family planning to counter the effects of overpopulation, and alternative production frameworks, such as Cradle to Cradle that differs from the conventional frameworks. This article will conclude with the broader reflection that without goal-oriented critical learning explicitly providing sound models of sustainability, open learning may never permit transcendence from unsustainability. This article will develop a number of comprehensive frameworks targeted at solutions to sustainability issues both from ethical and practical perspectives.

Keywords Circular economy; Cradle to Cradle; Education for sustainable development (ESD); Environmental education; Sustainable consumption

1 Introduction

Research of sustainability in environmental education (EE) and education for sustainable development (ESD) ranges from elementary schools, including those integrated within established courses such as biology and history, to professional and university-level courses, including (sustainable) business and management. The idea of environmental literacy in education (Lowe 2002) is based on the assumption that education for sustainability has to include the social, economic, and political dimensions of our interaction with natural systems, proposing concrete frameworks through which sustainability can be addressed. The Higher Education Funding Council of England (HEFCE), for example,

considers education to be a major contributor to society's efforts to achieve sustainability 'through the skills and knowledge that its graduates learn and put into practice, its research and exchange of knowledge through business, community and public policy engagement' (http://www.hefce.ac.uk/whatwedo/lgm/sd/). Examples of initiatives supported by the The council is waste and energy reduction projects (http://www.sustainabilityexchange.ac.uk/). In June 2014, the Higher Education Academy in the UK has published a report Education for sustainable development: Guidance for UK higher education providers. This report refers to 'sustainability literacy' as 'knowledge, understanding, skills and attributes fostered through learning for and about sustainability' (http://www.qaa.ac.uk/en/Publications/Documents/Education-sustainabledevelopment-Guidance-June-14.pdf). This is largely reflective of the objectives set in the The 1970s, following the publication of the Limits to Growth report (Meadows et al. 1972) which defined EE as a learning process that increases people's knowledge and awareness about the environment and associated challenges develop the necessary skills and expertise to address the challenges, and fosters attitudes, motivations, and commitments to make informed decisions and take responsible action (The Belgrade Charter 1975). The intention was to use education as a tool to address a range of sustainability challenges.

Recently, EE/ESD literature has been supportive of pluralistic rather than goal-oriented learning. Publications in leading journals such as The Journal of Environmental Education and Environmental Education Research have emphasized that we do not and cannot know what the most sustainable way of living is, emphasizing the importance of stimulating and engaging divergent perspectives, views, and values (e.g., Van Poeck and Vandenabeele 2012). Thus, EE and ESD researchers have discussed sustainability in terms of 'openness,' 'plurality,' 'reflection,' and democratic learning without specified ends (e.g., Jickling 2005; Jickling and Wals 2013; Morley et al. 2014). 'Social learning' was thus advocated in order to avoid authoritative tendencies (Wals 2009) or even 'eco-totalitarian' (Wals and Jickling 2002) in which learners are positioned as marionettes for the 'good intentions of environmentalists or environmental educators' (Breiting 2009, 200). Wals (2010) has argued that sustainability is characterized by uncertainty and warned that the quest for sustainable actions and outcomes needs to be tempered in favor of more reflexive and plural learning. Learning processes, it was argued, should not be based on predetermined outcomes, for instance, in the form of knowledge, skills or behavior but rather on 'posing difficult questions' (Biesta 2006) and 'telling good stories' (Jickling 2005). These scholars often assume that sustainability is not fixed but socially constructed and not something that can

be anticipated, planned, and regulated according to the predetermined guidelines doubting whether there is one 'right' way to be sustainable (e.g., Van Poeck and Vandenabeele 2012).

This article takes a different perspective, arguing for more goal-oriented approaches born out of concern about the immensity of environmental challenges and the urgent need to address them (e.g., Bonnett 2004, 2012). This article will argue that some approaches to sustainability offer better practical solutions, while a search for pluralism does not necessarily help advance the cause of sustainability. If all learning outcomes are considered equally valid as long as they have emerged from a pluralistic process, this might even lead to an 'anything goes' relativism (Wals 2010) and abandonment of the quest for sustainability (Cherniak 2012).

In the sections below, the following will be articulated of (1) what (un)sustainability is; (2) what are the key challenges and causes of (un)sustainability; and (3) how the sustainability challenges can be meaningfully addressed.

To address the first question we need to recall the report of the Higher Education Academy mentioned above. Sustainability and ESD are linked to the process of equipping students with the knowledge, understanding, skills, and attributes needed to work and live in a way that safeguards environmental, social, and economic well-being, both in the present and for future generations. This definition, however, does not address the needs of the non-humans. In an alternative definition, the central concept identifies environmental sustainability to be the central area of concern. This definition does not exclude social and economic sustainability, assuming that environmental sustainability is intertwined with challenges ranging from poverty elevation to social equality. Ethically, it is assumed that similar to racism, sexism, and slavery, discrimination, and extermination of non-human species either as a direct or indirect effect of human activities is morally wrong:

> Natural species are the primary expressions and repositories of organic nature's order, creativity, and diversity. They represent thousands of millions of years of evolution and achievement. They show incredible functional, organizational and behavioral complexity. Every species, like every person, is unique, with its own history and destiny. When humans take so many resources or degrade so much habitat that another species is driven extinct, we have taken or damaged too much

and have brought a meaningful story to an untimely end (Cafaro and Primrack 2014). In this perspective, biodiversity loss as a result of human economic development and the use of animals within the industrial production system (CAFO's) that ignores their welfare are examples of such unsustainable practices. By locating sustainability within this environmental domain, climate change, pollution, natural resource crises, and extinction of species can be identified as key elements of unsustainability. Population and consumption growth are its key drivers as well as areas where solutions can be found (e.g., Rees 2010; Washington 2013). The author will argue that without the acceptance of unsustainability as a concrete challenge that requires decisive solutions, the challenge of addressing unsustainable practices becomes insurmountable.

2 Environmental problems

One of the greatest paradoxes of sustainable development (and by extension, much of ESD) is that wider economic equality is propagated, without ethical and practical considerations of the long-term effects of both population growth and global increase in consumption. Indeed, as Washington (2013) has asserted, the greatest two 'elephants in the room' are population growth and consumption. It is questionable whether population growth and economic welfare can be sustained without further compromising the needs of future generations and ignoring the needs of non-humans (Miller et al. 2014). The deep ecology perspective that assigns intrinsic value to non-humans (Naess 1973) and efforts of conservationists to protect the remaining wild habitats can hardly be addressed by more economic development (Laurence et al. 2014). If economic development resulting in population and consumption growth has created current ecological problems in the first place, it cannot be used as part of the solution (Washington 2013; Kopnina and Blewitt 2014). Population and consumption increases will lead to depletion of resources and perpetuation of poverty. The objectives of elevating poverty without addressing the current unsustainable levels of consumption in the developed world (following the well-known fact that we might need a few planets Earths to sustain an American lifestyle) are likely to lead to breaching ecological limits (Rees 2009, 2010).

While ''raising the standard of living" may be nebulous shorthand for the worthy aim of ending severe deprivation, translated into shared understanding and policy the expression is a euphemism for the global dissemination of consumer culture—the

unrivaled model of what a ‘‘high standard of living" looks like. But to feed a growing population and enter increasing numbers of people into the consumer class is a formula for completing Earth’s overhaul into a planet of resources: for ever more intensified uses of land and waterways for habitation, agriculture, and farming; for the continued extraction, exploitation, and harnessing of the natural world; and for the magnification of global trade and travel’ (Crist 2012: 141–142).

While proponents of ecological modernization theory believe that technological development and economic growth are part of the solution, critics consider this part of the ideology that perpetuates unsustainable practices. Yet, at present, EE and ESD journal publications rarely address practical and ethical implications of prioritizing social and economic agendas at the expense of environment instead seeming to engage in discussions about the importance of pluralistic and democratic approaches. More discussions also characterize climate change summits that have done little more than ‘[promise] more talks about talks’ (The Economist 2012:62).

Despite efforts at mitigating climate change, emissions reductions have not materialized (Pinske and Kolk 2009:109). The latest report from the UNEP and IPCC (2014) reveals that in 2012, GHG emissions were 20 % higher than in 2000. In order to find solutions to the climate change, the role of the powerful industrial lobbies that have a stake in promoting climate skepticism needs to be addressed both by the public, governments, and businesses (Kopnina and Blewitt 2014). The solution lies in longterm investment in renewables, particularly wind and solar sources. Educational practices should then be channeled to recognize the vested interests of the established power holders and developing sufficient understanding to engage with renewable sources.

Another significant environmental issue is biodiversity loss. According to the International Union for the Conservation of Nature (IUCN), over 19,000 species out of the 53,000 assessed to date are threatened with extinction. Within the next 40–50 years, the coral reefs, upon which about one-quarter of the ocean’s species depend, will have been disappeared. The convergence of population growth, expanding agriculture, deforestation, and climate change is likely to create immense challenges for humanity and will certainly worsen the biodiversity crisis. The UN’s 3rd Global Biodiversity Outlook report (http://www.cbd.int/gbo3/) stresses that ocean pollution and deforestation are proceeding at an unprecedented rate, destroying rich habitats upon which many species depend.

So far, the rate of extinctions has not slowed down and more radical solutions are

necessary in order to address biodiversity loss (Crist 2012; Laurence et al. 2014).
The Limits to Growth report (Meadows et al. 1972) has demonstrated that an economy built on the continuous expansion of consumption as well as population growth is not sustainable in the long term. Despite these warnings, mainstream sustainability often ignores the 'elephant in the room'—population growth which tends to exacerbate sustainability challenges (Washington 2013). Critical scholars have argued that if population growth continues (or even stabilizes at the current level), something radical needs to happen with the way we currently produce and consume (Laurence et al. 2014). The critics have argued that the assumption that managing nature for human benefit will preserve ecological integrity is ungrounded and does not address the root causes of biological destruction, such as the paradigm of unlimited economic growth, unabated consumption, and ever-increasing human numbers (Miller et al. 2014). It seems impossible to decouple the current system of production and consumption from the underlying political and ideological processes of neoliberal democracy.

Since the Industrial Revolution, many great discoveries and transformational inventions have been made. Unfortunately, some of them have backfired. There are many examples of technology-caused disasters that have occurred since the turn of the twentieth century. Aside from industrial disasters, one of the great sustainability challenges is the everyday pollution such as particulate matter emitted by cars, or massive amounts of plastic waste found in the oceans, seas, lakes, rivers, and city parks. Traditional corporate responses to this challenge have been to minimize the damage by being eco-efficient.
However, as we shall discuss below, the 'Circular Economy,' the 'Cradle to Cradle,' and 'The Blue Economy' approaches suggest that the current eco-efficiency framework tackles problems without addressing their source, sustaining a fundamentally flawed system.

3 Addressing problems

3.1 Teaching deep ecology and animal rights

Ethically, such efforts at sustainability often lead to the quest for technological fixes without addressing the ultimate costs to the ecosystem and to individual species, both in relation to conservation of wild species and the treatment of animals in the industrial food

production system. In education, anthropocentric ideology seems counterproductive to the aim of conservation (e.g., Root-Bernstein et al. 2014) and animal rights concerns (e.g., Regan 1986). Research shows that successful conservation and concern about animal welfare is based on behavioral change, and thus, education is essential for its success (e.g., Gorski 2009; Schultz 2011). Example of education for deep ecology is the work of La-Chapelle (1991) and Glasser (2004) on experiential and outdoor education.

The knowledge of both social and biological factors is necessary, as in the application of ecological knowledge to protect biodiversity; we also need to consider global interconnections, power differentials, and ultimate versus proximate drivers of biodiversity loss (Kirby 2014). The locus of the problem in processes associated with industrial development, patterns of production and consumption, and population growth.

3.2 Addressing overpopulation

A whole range of social and environmental problems, including poverty, could be if not solved but definitely helped by stabilizing population growth (Washington 2013). If educators fail to recognize overpopulation as a threat to sustainability and fail to teach students how to think about ethical and practical implications of population dynamics, all other efforts at teaching sustainable production and consumption are likely to fail in the long term. Engelman (2012) has proposed a number of strategies to counter overpopulation, including:

1. Assure access to contraceptives and family planning.
2. Guarantee education through secondary school for all.
3. Eradicate gender bias from laws, economic opportunity, health, and culture.
4. Offer age-appropriate sexuality education for all.
5. End all policies that reward parents financially based on their number of children.
6. Integrate teaching about population, environment, and development into all school curricula.
7. Put full pricing on environmental costs and impacts.
8. Adjust to population aging, rather than trying to delay it through government programs aimed at boosting birth rates.
9. Convince leaders to commit to ending population growth through the exercise of human rights and human development.

Educational programs yet need to develop explicit links between sustainability and

population and educate students both in the developed and developing world on the importance of securing a common future for us all. This is perhaps the greatest challenge considering how sensitive and politically correct the issue of demographics has become.

3.3 Addressing consumption

Individual consumer's sphere of influence can be too small to initiate significant change, and many consumers may be simply unwilling to consider sustainable options when offered many (cheap) choices of products. Many green consumption specialists have suggested that efforts encourage the sustainable living to depend on structural changes that require political and corporate leadership. Consumer choice editing or restriction of unsustainable products can help eliminate unsustainable choices (Blowfield 2013). Sharing economy, also called collaborative consumption, involves the new sharing that reduces waste and becomes more self-sufficient and reduces the need for buying more products. In part inspired by the 'de-growth' promoter and the well-known journalist of sustainable business Charles Eisenstein (2014), the so-called gift, sharing, or collaboration economy has emerged. The philosophy of the gift economy is represented on http://www.gifteconomyparty.org/:

> People think that 'we need money.' We live in this mindset, and that is why everything is the way it is on this planet right now. The so-called scarcity is money-based. There is no real scarcity. There is more than enough land, water, food, and resources on this planet for everyone. It has to be said again: ALL scarcity is money-based.

This growing trend is felt in Western communities placing an emphasis on connecting people to their communities, saving money and being environmentally conscious through these new forms of sharing (http://sharingistheanswer.com/?8jMJS2t7&mid=5709). This trend is exemplified by Web sites advertising anything from warm showers (https://www.warmshowers.org/) to free homestays (http://stay4free.com/how; https://www.couchsurfing.org/) and other forms of sharing (http://sharewiki.org/en/Nomadbase). Free stuff includes anything from consumer electronics (http://www.freecycle.org/) to clothes (http://swishing.com/about_swishing/) and free books (http://www.bookcrossing.com). Sharing and collaboration can also reduce the need for monetary transactions illustrated by Web sites on dumpster diving (http://trashwiki.org/en/Skipping_Waste); zero trash (http://

zerowastehome.blogspot.nl/p/about.html; https://www.recyclebank.com/about-us/how-itworks); and even zero money (http://www.justfortheloveofit.org/blog-44427*the-gift economy) initiatives.

These types of 'innovative' economies were traditionally present (and still present in many developing) societies. While this trend is largely exemplified by neo-hippy-trending middle-class youth in Western countries, it also has a rather marginal following of anarchistic and utopian groups practically unknown in developing countries. However, this 'revolutionary' movement toward dematerialization deserves more than a skeptical glance, considering the fact that Western-style consumption is deemed to be one of the greatest sources of unsustainability. The teaching of the collaborative and sharing economy is integrated into many courses that currently discuss anything from alternative business models to general courses on sustainability.

Marketing psychologists, business economists, and even retailers have long discovered the opportunities offered by the knowledge of human nature in devising clever marketing strategies to entice the consumers to their product. Yet, few social scientists and educational specialists have considered the threats and opportunities offered by generalizing certain human propensities (for a detailed discussion of environment and human nature see Kaplan 2000; Rees 2010; Kopnina 2013). Defining the universals or certain features of our human behavior may be difficult, as they are culturally variably expressed. Yet, it is useful to think of propensities or persistent characteristics which manifest themselves under conditions of advanced industrial development causing unintended side effects, such as—among other things—the spread of consumerism that seems to be stronger than cultural, religious, and other traditional controls. Examples of such universals, such as a propensity for technological innovation, can be either harmful or constructive. The use of technological innovation to improve the production and medical technologies leads to both increased population growth and more extensive land use.

3.4 Realizing environmental impacts

Some behavior, such as recycling, directly causes environmental change. Other behavior is indirectly significant, like having a savings account in a bank that makes unsustainable

investments. The deeper causes of environmental problems lie within the international development policies, commodity prices, and patterns of investment. Similarly, private and public sphere environmentalism can differ greatly in their impact.

However, private actions may stay insignificant, given the relatively small impact of one individual. While private actions are certainly helpful and necessary (certainly, 'walking your talk' is very important), public actions can have a much greater impact. Lobbying with the government for positive change in public transport policy can have a much greater effect than just taking a bus.

The indirect impact of policies supporting health and global consumption has a detrimental effect on the long-term availability of resources (Rees 2009). One challenge that might be easier to tackle then population growth is the manner of production and consumption. In the following section, the most promising approaches to production and consumption will be introduced, followed by the reflection on how they can be applied in education.

3.5 Industrial ecosystem

The key content of education for environmental literacy is what Barry Commoner (1971) called the Four Laws of Ecology: Everything has to go somewhere, everything is connected to everything else, there is no such thing as a free lunch, and nature knows best. Lowe (2002) has reflected that most of our serious environmental problems arise directly from a failure to understand those basic ideas, and thus, these ideas should be integrated into programs promoting environmental literacy. Based on Commoner's (1971) ideas, Frosch and Gallopoulous' (1989) introduced the concept of an 'industrial ecosystem,' based on the observations of ecosystem functions and emphasized the optimization of energy and material flow within an industrial system.

In this framework, business in the 'ecosystem' affects and is affected by the others, creating a constantly evolving relationship. Isenmann (2003) has noted that the concept of an industrial ecosystem is valuable in education as a metaphor of 'nature as a model' can be easily translated for educational, pedagogical, and didactical 'eye-opening' purposes. Focusing on connections between operators within the 'industrial ecosystem,' Graedel (1996) has developed the industrial ecology approach aimed at eliminating undesirable byproducts.

Industrial ecology combines aspects of various disciplines to study material and energy flows through industrial systems.

Industrial ecology is sometimes referred to as the 'science of sustainability,' and is similar to biomimicry. Biomimicry is defined as a 'new science that studies nature's models and then imitates or takes inspiration from these designs and processes to solve human problems' (Benyus 1997). Biomimicry relies on three key principles. First, nature, as a model, refers to the study and emulation of nature's forms, process, systems, and strategies to solve human problems. Second, nature as measure refers to the use of an ecological standard to judge the sustainability of technical innovations. Third, nature as mentor uses ecocentric stance in viewing and valuing nature for what we can learn from its diversity.

3.6 Cradle to Cradle

In Cradle to Cradle: Remaking the Way We Make Things, McDonough and Braungart (2002) support the framework that does not reach for sustainability as it is usually defined but seek to create industrial systems that are essentially positive and waste-free. The Cradle to Cradle (C2C) was dubbed by some the 'next Industrial Revolution.' This alternative production model proposes to re-design products so that after their useful life has ended, they can serve as 'food' for new products.

McDonough and Braungart ask us to contemplate not just minimizing the damage the way eco-efficiency does but eliminating waste altogether. As opposed to conventional eco-efficiency, the C2C framework stresses eco-effectiveness. C2C identifies three key principles, which should inform human design: waste equals food; renewable energy; and celebrating natural diversity. Waste does not exist in nature because the processes of each organism contribute to the health of the whole ecosystem. For example, bacteria feed on the organic waste of both the trees and the animals that eat their fruit, depositing nutrients in the soil in a form ready for the tree to use for growth. One organism's waste is food for another.

While nature's nutrient cycles comprise the biological metabolism, technical metabolism is designed to mirror them. The concept of industrial metabolism was used by Ayres and Kneese (1969) and referred to understanding material and energy flow at the national level and within urban areas. John T. Lyle (1996) has argued that understanding

these regenerative systems allows engineers and designers to recognize that all materials can be designed as nutrients that flow through natural or designed metabolisms. Ideally, every product can be designed from the outset so that it continues its existence after use by becoming a nutrient within either a biological or technological cycle. Within this framework, designers and engineers can use scientific assessments to select safe materials and optimize products and services, creating closed-loop material flows. In regard to energy, it was noted that despite recent precedent, human energy systems can be nearly as effective. C2C systems—from buildings to manufacturing processes—tap into current solar income using direct solar energy collection or passive solar processes, such as daylight, which makes effective use of natural light. Wind power—thermal flows fueled by sunlight—can also be tapped.

Similar to biomimicry, C2C takes nature's diversity as a prototype for many models for human designs, tailoring designs to maximize their positive effects in order to 'fit' within local natural systems and to enhance the local landscape where possible. McDonough and Braungart have successfully designed a number of urban areas and buildings taking into account local climate, materials, and both human and ecological needs.
However, we should note that the return to pre-industrial designs is not desired by most businesses (as there is little money to be made by asking people to return to their traditional dwellings). Thus, most of the C2C houses are based on designs marked to middle-class consumers, which unfortunately limits its applicability on a global scale. In his blog post, McIntire-Strasburg (2008) hopes that C2C design will flourish if its owners would decide to open-source C2C, or if other business professionals will shift to other similar certification systems.

3.7 Circular economy

Stahel and Reday-Mulvey (1981) put forward the argument for a 'self-replenishing economy,' based on a 'spiral loop system' through product-life extension activities that cycle materials. The term circular economy encompasses more than the production and consumption of goods and services, including a shift from toward renewable energy (Stahel 1984). The circular economy should be 'restorative by intention,' in having a positive environmental impact (Hawken 1993). This framework is well developed by the educational programs sponsored by the Ellen MacArthur Foundation.

The Ellen MacArthur Foundation is a registered charity with the aim of giving the concept of the circular economy a wide exposure. The Ellen MacArthur Foundation works in education, business innovation, and analysis and provides businesses, educators, and policy-makers with the number of useful case studies and practical resources to inspire the transition to a circular economy.

The circular economy reports developed by the Foundation, with analysis by McKinsey & Company established a clear framework and economic case for a transition to the circular economy. The reports highlighted a combined annual trillion dollar opportunity globally in net material cost savings for companies making the transition to circular economy.

The circular economy framework reaches beyond the aim of minimizing the damage (as the destructive system should not be made efficient), but eliminating it altogether. Educational program on circular economy contrasted with an older mechanical worldview that modeled the economy as a linear 'take-make-and-dump' process with 'only a crude and partial feedback device 'the market,' and a one-sided materialistic view of the rational consumer (Webster 2007: 40). Courses on sustainability within this framework can be instructed by the deep ecology education or other frameworks discussed above.

3.8 The Blue Economy

Initiated by former Ecover CEO Gunter Pauli (2010, 2011), the Blue Economy is an open-source movement bringing together concrete case studies, initially compiled by the Club of Rome (Meadows et al. 1972). Pauli founded the open-source Zero Emission Research & Initiatives network (ZERI) in 1994. There are parallels between the Blue Economy and Cradle to Cradle in that waste is not per se an issue, but the concern should be with what is done with it.

3.9 The steady-state economy

Herman Daly (1991, 1994), who was a senior economist at the World Bank from 1988 to 1994, has observed that while the environment establishes absolute limits on how far

the industrial economy can expand, there are no environmental limits on the development of a culture's symbolic systems. Daly has pointed out that 'sustainable development' may be possible if materials are recycled to the maximum degree possible, and if one does not have growth in the annual material throughput of the economy. Daly's ideas are largely based on ecological economics and the notion of the 'steady state economy' which is an economy of relatively stable size, featuring stable population and stable consumption that remain at or below planetary carrying capacity. This means 'economy with constant stocks of people and artifacts maintained at some desired, sufficient levels by low rates of maintenance ''throughput,'' that is, by the lowest feasible flows of matter and energy from the first stage of production to the last stage of consumption' (Daly 1991: 17). The Center for the Advancement of the Steady State Economy (CASSE) develops teaching materials used by many professional and business schools globally (http://steadystate.org/discover/enoughis-enough/teaching-materials/).

4 Summary of constructive sustainability frameworks

Below is an overview of constructive sustainability frameworks that can be adapted or have been adopted in education (Table 1).

Table 1 Overview of frameworks

Thinkers	Concepts/frameworks	Educational application	Seminal work by year
Arne Naess	Deep ecology, both as a philosophy that assigns value to non-humans and as consistent framework	See LaChapelle (1991) and Glasser (2004) on education for deep ecology	Naess (1973)
The Belgrade charter (UNESCO-UNEP)	Conservation education (also outdoor, experiential, etc.)	See, for example, http://www.harriscenter.org/education-with-the-harris-center	Schultz (2011)
Tom Regan	Animal rights	See educational programs https://awionline.org/content/humane-education; http://www.ifaw.org/united-states/our-work/education	Regan (1986) Gorski (2009)
Robert Ayres and Allen Kneese	Industrial metabolism—understanding material and energy flows at the national level and within urban areas.	See https://engineering.dartmouth.edu/~d30345d/courses/IE-at-UNG/IndustrialMetabolism.pdf	Ayres and Kneese (1969)
Barry Commoner	Ecological principles used to structure national economy	See Lowe (2002) for a discussion on Commoner and environmental literacy	Commoner (1971)
Walter Stahel	Circular or loop economy through product-life extension	See Webster (2007) discussing roots of and applications of circular economy in education	Stahel (1984) Stahel and Reday-Mulvey (1981)
Robert Frosch and Nicholas Gallopoulous	Industrial ecosystem	See Isenmann (2003) discussing natural ecosystems as a model for education	Frosch and Gallopoulos (1989)
Paul Hawken John T. Lyle Thomas Graedel Janine Benyus	Circular economy, restorative economy, regenerative design, earth system ecology, biomimicry	See http://www.businessschoolnetwork.eu/course/view.php?id=3_for_Circular_Economy_in_the_Cloud_Rotterdam_Business_School	Hawken (1993) Lyle (1996) Graedel (1996) Benyus (1997)

Table 1 continued

Thinkers	Concepts/frameworks	Educational application	Seminal w by year
Gunter Pauli	Coined the term 'upcycling.' Developed the concept of the Blue Economy complementing the Limits to Growth Report	See course description on the website of Blue Economy http://www.miis.edu/academics/researchcenters/blue-economy	Pauli (201
Michael Braungart and William McDonough	Cradle to Cradle (C2C) design framework. Introduced concepts of technical and biological nutrients	Product Design See Kopnina (2011) discussing C2C at elementary school	McDonoug and Braunga (2002)
Herman Daly	Steady state economy with constant stocks of people and artifacts, maintained at some desired, sufficient levels by low rates of maintenance 'throughput'	See teaching materials by the Center for the Advancement of the Steady State Economy http://steadystate.org/discover/enough-is-enough/teaching-materials/	Daly (199 1994)

Source: Adapted from Tennant and Brennan (2015) and Kopnina and Blewitt (2014)

5 Discussion

A few salient points need to be discussed before these frameworks can be adopted in educational contexts. Simultaneously, these points form a basis for consequent research and educational practice. Promoting sustainability through behavioral change leads us to a difficult question. If Western democracy is redolent with consumerism, how is this to be countered in ways that somehow remain democratic and not subject to a charge of 'eco-fascism' (Madden 1995) or 'eco-totalitarianism' (Wals and Jickling 2002)? In order to counter this charge, we need to note that the current status quo promotes a different kind of 'fascism' (if one is not overt to using this charged terminology)—namely the moral evil of exterminating other species (Cafaro and Primrack 2014). We can draw a parallel with branding multiculturalism (minority rights), or gender equality (women's rights) movement in education can be termed multicultural racism or gender fascism. In fact, those who disagree with racial and gender equality as a moral objective might be fired from their institutions. It is unlikely that there are any EE/ESD researches and practitioners who would openly warn their colleagues of being too taken by social equality, and at least in public the majority of (Western) academics assume that sexism, racism, and slavery are bad. It is thus important to realize the moral character of education for sustainability and inquire why speciesism or discrimination against other planetary citizens is not as passionately condemned. Could ignoring speciesism be part of anthropocentric, neoliberal, discriminatory ideology? The urgency of our environmental situation as well as the realization of long-term self-interest in the preservation of ecological integrity means that there is a price that might have to be paid. Yet, the transition to a more sustainable society does not mean that coercive measures have to be used, as they are not used to convince students that discriminating against other (people) is wrong.

The road to a more sustainable society may be both democratic and ecologically benign, yet philosophical and political tensions between what has been called 'ecological imperatives' and liberal democratic procedures remain a significant challenge for EE/ED researchers. It is thus one of the great challenges of educators for sustainability to find ways in which such education can happen.

As far as technological innovations including biomimicry and Cradle to Cradle are concerned, caution needs to be exercised as not to revert back to unreasonable optimism

espoused by ecological modernization and sustainable development proponents. According to a very useful comment from Michael Bonnett (personal communication, August 2014), for the most part, natural ecosystems have slowly evolved and established an internal equilibrium, but technological advances (and changes in popular taste) can be sudden and bring rapid redundancy to existing industrial practices, completely disrupting previously established equilibria. Against this background, the fine-tuning necessary for Cradle-to-Cradle industrial systems to work might become very challenging, posing the danger of subversion of principles to profit-seeking through new designs.

What is perhaps most important in attempting to meet this challenge is to remember the humbleness of any human design in comparison with thousands of years of natural evolution, as well as a clear understanding that natural growth cannot be subverted by economic systems that support (ultimately) ecologically harmful growth models.
It is also important to note that neither of the frameworks presented above addresses population growth. Without continuous investment in measures ranging from family planning policies to public education campaigns, the efforts at developing deep ecology and conservation education, as well as alternative production models, may fail. The next step should be a serious discussion within EE about demographic factors in relation to sustainability and challenges students to seek socially viable solutions.

6 Conclusion

We have located key sustainability challenges within the environmental domain, identifying population growth and an increase in unsustainable production and consumption as key drivers as well as areas where solutions can be found. We have argued that pluralistic approaches to education tend to ignore the power hegemonies present within neoliberal education. In reproducing neoliberalism that is open to all ideas, but privileges none, marginalizing or radicalizing alternatives that challenge the status quo, EE/ESD without specified ends allows for anthropocentric or unsustainable practices to continue. In other words, educational pluralism in regard to ‘sustainability’ risks disabling students’ ability to face hard questions, by leading them into endless circles of discussion and contestation. Without goal-oriented education targeted at disclosing problems and challenges as well as providing sound models of sustainability, ‘open’ learning may never permit transcendence from unsustainable models. We need to re-orientate perceptions of progress, success, and a

good life away from material acquisition and to exploring and developing a cultural commons that embraces environmental sustainability.

In order to overcome the practical impasse inherent in much of neoliberal education, educators need to realize that each has valuable strengths that can help in the reconstruction of education for sustainability. Alternative and viable solutions to address environmental problems need to be advanced through EE and ESD. Pluralism and democratic learning are very useful in order to teach students to address a variety of perspectives, frameworks, and opinions. But without taking the next step in the direction of the goal-oriented education for sustainability, which includes addressing hard questions ranging from strategies to counter neoliberal power hegemonies to demographic challenges, we cannot expect the students to be equipped to meaningfully participate in co-creating 'our common future.' The frameworks outlined above represent the promises for the future. By teaching students to recognize the key challenges to sustainability as well as seek solutions, we might achieve nothing less than transition to a sustainable society.

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