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STAQ paper

Climate Change, Sustainability and Science Education: A Way Forward

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(3467 words)

Introduction

The world and its peoples are facing multiple, complex challenges and we cannot continue as we are (Moss, 2010). Earth's "natural capital" - nature's ability to provide essential ecosystem services to stabilize world climate systems, maintain water quality, support secure food production, supply energy needs, moderate environmental impacts, and ensure social harmony and equity – is seriously compromised (Gough, 2005; Hawkins, Lovins & Lovins, 1999). To further summarize, current rates of resource consumption by the global human population are unsustainable (Kitzes, Peller, Goldfinger & Wackernagel, 2007) for human and non-human species, and for future generations. Further, continuing growth in world population and global political commitment to growth economics compounds these demands. Despite growing recognition of the serious consequences for people and planet, little consideration is given, within most nations, to the social and environmental issues that economic growth brings. For example, Australia is recognised as one of the developed countries most vulnerable to the impacts of climate change. Yet, to date, responses (such as carbon pricing) have been small-scale, fragmented, and their worth disputed, even ridiculed. This is at a time referred to as 'the critical decade' (Hughes & McMichael, 2011) when the world's peoples must make strong choices if we are to avert the worst impacts of climate change.

Climate change impacts

MacCracken (2011) states that climate change and its associated impacts will be perverse – affecting everything and everyone - young and old, healthy and infirm, rich and poor, some a little, others a lot. Some impacts will affect us directly, such as extreme heat waves, cyclonic storms and severe drought. Many impacts, however, are likely to be less direct such as increases in insurance premiums or council rates to cover ongoing and increasing mitigation and recovery costs. While a small number of changes may lead to localised gains and opportunities, many changes are likely to have negative effects. Nonetheless, we cannot continue to ignore climate change, even if it seems that fighting terrorism or restructuring the national budget seem to have become more politically and socially urgent. Climate change is not a speculative construct that only our grandchildren will experience in the future.

If Australia is to effectively tackle climate change, it needs to engage at multiple levels and in numerous ways around climate change matters. One critical way is to engage *scientifically* with climate change science, though I argue later that simply more science and, by extension, more science education is not enough. As Cook (2014) comments 'it's been hot before' is faulty logic – issued with worrying regularity from powerful political and media interests - that skews the climate debate. Such comments that the climate has changed over eons, that it was warmer at the time of Christ and colder during the medieval 'dark ages' – an over-used rationale for skepticism or denial of human-induced climate change - ignores decades of robust, peer-reviewed research that dignifies 97% of climate research as endorsing the consensus that humans are responsible (Intergovernmental Panel of Climate Change, 2013).

As Boon (2014) states, climate change ignorance is an unacceptable legacy for our children and grandchildren as it is becoming clearer that children and future generations will most acutely feel the effects of climate change. A recent analysis of environmental threats to children's health in Australia (Hughes & McMichael, 2011), for example, identifies a range of potential climate change impacts. A short list includes:

- changing patterns of infectious and vector-borne diseases such as dengue fever
- heat stress and health impacts of extreme weather events such as fires, floods and cyclones
- effects of changing plant growth on allergen levels and asthma
- water and food insecurity
- pressure on mental and emotional health due to drought, climate change concerns, and traumatic exposures to fires, floods, and storms.

Living Sustainably

Nevertheless, while climate change is a serious threat to human advancement now and into the future, it is not our main problem. Rather, climate change is a symptom of unsustainable development models, dependent on continuous economic growth, that structure how we live. While bringing many observable benefits there is also an abundance of hidden or denied consequences. Thus, issues of poverty, income disparity, global movements of refugees and asylum seekers, and the status of fourth-world populations living poorly within first-world societies are part of the contemporary sustainability agenda. Further, while many people consider that sustainability is primarily about environmental issues, more holistic understandings that emphasise the interconnections between the social, economic and environmental dimensions of development are necessary in order to ameliorate negative trends and impacts, and to transition to more sustainable ways of living. The overall effect of unsustainability on a global scale is that our fragile, complex and interconnected environments are at risk from accelerating habitat loss and massively increased resource extraction that destroys habitats and landscapes. As physicist, environmental activist and eco-feminist, Vandana Shiva, remarked in her Reith Lectures (BBC, 2000), 'sustainability demands that we move out of the economic trap that is leaving no space for other species and other people'.

The role of education

One way to try to understand the complexity of sustainability is to look at it as a 'wicked problem' (Rittel and Webber, 1973). A wicked problem is one that cannot be easily defined, is a site of conflict, has multiple perspectives and requires multilayered, often hard-to-formulate solutions. Resolution of wicked problems requires multidisciplinary insights and contributions from all sections of society, not just policymakers, politicians or scientists. After all, we are all in this together; it's everyone's business.

Education across the lifespan is recognised as a crucial investment in transitioning to sustainably with a key role in guiding the changes required to reduce consumption to sustainable levels and in empowering people for change (UNESCO, 2009). Rickinson, Lundholm & Hopwood (2009) comment that a life-course perspective on education and learning is necessary "to think about what we know and what we need to know about environmental learning during infancy, childhood, adolescence, adulthood, middle age, retirement and old age" (p. 106). Thus, all education institutions – from early childhood centres, schools, community education, through to colleges and universities – need to provide effective ways to publicise and educate communities with concepts of sustainability and environmental responsibility, through student learning and via their larger societal connections (Chesterman, 2008). A key content characteristic is

recognition that healthy humans and healthy environments are interdependent thus putting the state of the planet front and centre.

Humanity, however, requires a different kind of education from mainstream education, which many see as being part of the sustainability problem (Orr, 1992), that is, education and learning that supports economic growth, individualism, rising consumerism, and gives lesser attention to social and environmental justice. Recognition of the shortcomings of contemporary education demands transformative approaches to education (Mezirow, 2006) embedded in social change and empowerment. Bonnett (2002) calls for the exploration of sustainability as a frame of mind' (p. 9), a metaphysical transformation that qualitatively shifts outlook and relationships where 'the attitude of sustainability is not a bolt on option but a necessity' (p. 19). *How well does contemporary education, including science education, meet this purpose?*

Science for sustainability?

Currently, significant investments in Australia and internationally are being made into Science (as part of the wider STEM (Science, Technology, Engineering and Mathematics) focus as a key way for creating ideas and opportunities to alleviate the adverse by-products of our current unsustainable ways of living. More efficient mass transport systems, low emissions cars, water-savings technologies and renewable energy investments are a few examples. The contention of this paper, however, is that STEM approaches to sustainability offer limited solutions, in light of the speed and scale of the challenges we are facing. While useful, STEM approaches are restricted, aimed more at problem fixing – reducing negative impacts - than imagining and creating dramatically new ways of conceiving of, and enacting, sustainability. The world has known for decades that we must integrate economic, social and environmental dimensions of development requiring more than a focus on scientific and technological fixes. Since the core of sustainability is the coupling of social and ecological systems, social scientists must be part of sustainability conversations from the very beginning when questions that require investigation are formulated, not appended onto the process after the questions have been posed (Bael, 2010).

Science/STEM Education for Sustainability: A critique

Contemporary literature in Education for Sustainability (EfS) informs us that integrated, holistic approaches rather than narrower Science/STEM approaches, offer the best opportunities for successful and widespread EfS because they encourage inclusivity and collaboration, and support sustainability as 'everyone's business'. Further, approaches that integrate the science sciences recognise the pivotal idea that unsustainable development is derived from socially-produced behaviours, and hence require socially-derived solutions that depend on social critique and social practices that help citizens work together for the common good. As Holbrook (2009) admonishes, "education for SD [Sustainable Development] has little to do with accumulating a body of scientific knowledge and is far more aligned with the development of personal and social aptitudes leading to responsible citizenship" (p.44).

Yet, despite calls from as early as the 1970s for interdisciplinary approaches to addressing unsustainability - primarily the inclusion of social sciences education - scientific approaches continue to dominate, focused on building scientific and technological knowledge and skills as the main way to deal with, manage and alleviate the adverse by-products of unsustainable ways of living. As noted earlier, the world has known for decades that we need to integrate economic, social and environmental

dimensions of development if sustainability is to be achieved. It is well past time for discipline integration to become a widespread reality in how we educate for sustainability. This is not to say, however, that Science/STEM teaching and learning for sustainability has no place. What I am saying is that it is not sufficient for dealing with our current challenges; my call here is for Science/STEM educators to better contribute to education for sustainability by being inclusive of social scientists and their ideas and perspectives.

What is Education for Sustainability?

EfS is not a new form of education. Its precursor, environmental education, has a 40-year history, with the Tbilisi Declaration (UNESCO/UNEP, 1977) stating, “environmentally-educated teachers are the priority of priorities”. The Declaration noted that environmental education was life-long, interdisciplinary, holistic, focused on interrelationships and interconnectedness between humans and natural systems, and directed towards construction of an environmental ethic (McBeath & McBeath, 2009).

Characteristics of contemporary integrated, holistic and transformative EfS include critical thinking and reflection; systems thinking; values and futures-oriented learning; and participatory, action-based pedagogies where decision-making and action-taking occurs in local contexts (Australian Government, 2009). The United Nation’s *Learning for the Future* (2012) characterises EfS (known as Education for Sustainable Development (ESD) in Europe) as having three key attributes. It: 1. is an holistic approach that seeks to integrate thinking and practice; 2. envisions change through exploring alternative futures, learning from the past and inspiring engagement in the present, and 3. seeks to achieve transformation by creating changes in the way people learn and in the systems that support learning. When applied in practice, EfS supports pedagogies that encourage learners to critique current conditions and mindsets, propose solutions that promote sustainability, and importantly, take action. Even preschoolers are capable of understanding and responding to sustainability issues, and can learn to participate and “make a difference” (Davis, 2010). Action-oriented EfS means that scientific literacy goes beyond scientific problem-solving and encompasses socio-scientific decision-making aimed at creating an active, informed citizenry.

Convergence between science/STEM education and EfS

In a recent article in the prestigious journal, *Science*, (July 2014), the case was made for the shared purposes of science educators and environmental educators (EE) (also read ‘educators for sustainability’) to engage people in addressing our sustainability challenges. The authors (Wals, Brody, Dillon & Stevenson, 2014) comment that science education with its focus on teaching knowledge and skills, and EE/EfS which stress the incorporation of values and changing behaviors, have become increasingly distant. They cite the example of the natural sciences and environmental education which, when taught separately, give a disjointed answer to society’s demands for a sustainable society. These authors make a strong case for the convergence of science education and environmental education, noting that without linkage with the sciences, EE will not be able to find responsible and realistic ways of dealing with the contradictions and uncertainties raised in scientific debates surrounding questions of sustainability. Equally, I argue (Davis, 2012) that science education is limited without recognition that the social sciences offer understandings of the root causes of unsustainability, and provide moral and ethical frameworks for changing worldviews. Simply continuing the pursuit of ‘scientific’ solutions to the world’s problems is itself part of the problem, aimed more at problem-fixing than imagining and creating dramatically new ways of conceiving and enacting sustainability. Integrated approaches that link Science/STEM education with socially-oriented EE/EfS is

recognition that sustainability is a human problem, not simply a scientific, engineering or technical problem.

Research in early childhood EfS

If readers think integrating science with the social sciences is way too difficult, I can tell you that it's child's play! My specialist area is early childhood education for sustainability. The children, teachers and communities that I have engaged with over the years offer a range of interesting case studies of EfS practice where sustainability issues and topics are addressed locally in childcare centres, kindergartens, schools and the local community. Such issues and topics include learning where food comes from (Japan), using digital technologies to engage with community officials and parents to help clean up a local park (Korea), campaigning against battery hen farming (Sweden), and an array of projects involving water and energy conservation, materials recycling, understanding food cycles through gardening, learning about and protecting local habitats, protecting and caring for wildlife, and embedding Indigenous perspectives into sustainability learning (several Australian and international cases). [See edited texts by Davis & Elliott, 2014 and Davis, 2010 for details of these projects and more examples]. Simultaneously, the children involved in these case study projects have learnt scientific knowledge and processes, combined with ways to engage as active and informed citizens 'making a difference' in matters of local importance. It's not too young to start EfS!

Where to from here?

One of the key drivers for EfS in recent times has been the *United Nations Decade of Education for Sustainable Development* (UN DESD) (2005-2014) (UNESCO, 2005), a major international initiative that Australia signed up to in order to address sustainability. As a result, many excellent examples in EfS in action have been undertaken; however, we owe it to our children and grandchildren to do much more.

The next international effort designed to build on the UN DESD is the *Global Action Programme (GAP) on Education for Sustainable Development* (UNESCO, 2013). The GAP will focus on five priority areas from 2015. These are:

1. *Policy support* to integrate EfS into international and national policies in education and sustainability.
2. *Whole institution approaches* that promote EfS at all levels of education and in all settings.
3. *Strengthening the capacity of educators*, trainers and other change agents to become learning facilitators for EfS.
4. *Supporting children and young people* in their role as change agents for sustainability through EfS.
5. *Accelerating the role of local communities* in searching for sustainability solutions through EfS.

These priorities offer a framework for enacting new forms of education and learning to address unsustainability. It is hoped that closer alignment between Science/STEM education and EE/EfS will emerge sooner rather than later. Looking beyond the narrow scope of current curricula is a necessity and becoming more urgent.

Final comments

To summarise the arguments forwarded in this piece, our current economic growth models, where damaging exploitation of the natural world and exploitation of human beings are closely interwoven, are unsustainable. With continuing environmental degradation and future disasters seemingly inevitable, a billion people living in poverty, and new waves of environmental refugees having the potential to undo 20 years of

poverty reduction around the globe, the world is facing significant, complex and interlinked development challenges. Integrated approaches are necessary that examine the nexus of social, environmental and economic dimensions of human activity, and that do not diminish options for future generations

With these challenges as the backdrop, this paper calls for the gap between science and the social sciences to be closed, and with it, the gaps between science education (and STEM, more broadly) and EE/EfS. It is no longer appropriate for Science/STEM education to be chiefly about the teaching and learning of science content, theories, laws and skills. Science educators must recognise that sustainability is fundamentally a human problem, not simply a science and technology problem. EE/EfS specialists, educators from social science disciplines, and science educators well versed in social education, should all be collaborating in the design and delivery of education that addresses our sustainability challenges. The case for integration is undeniable; the time for convergence is already past, but late is better than never.

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