You Say you want a Revolution?
Transforming Education and Capacity Building in Response to Global Change

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by

Karen O'Brien, Jonathan Reams, Anne Caspari, Andrew Dugmore, Maryam Faghihimani, Ioan Fazey, Heide Hackmann, David Manuel-Navarrete, John Marks, Riel Miller, Kari Raivio, Patricia Romero-Lankao, Hassan Virji, Coleen Vogel, and Verena Winiwarter.

Contact author:
Karen O'Brien
Department of Sociology and Human Geography
University of Oslo
P.O. Box 1096 Blindern
0317 Oslo, Norway
Email: karen.obrien@sosgeo.uio.no
Tel: +47 90063814
Fax: +47 22855253

Abstract: This paper considers the changes in education and capacity building that are needed in response to environmental and social challenges of the 21st Century. We argue that such changes will require more than adjustments in current educational systems, research funding strategies, and interdisciplinary collaborations. Instead, it calls for a deeper questioning of the assumptions and beliefs that frame both problems and solutions. We first discuss the challenges of transforming education and capacity building within five key arenas such as interdisciplinary research, the primary, secondary and tertiary education systems, researchers from the developing world, and the public at large and politicians. Our starting point is that any type of revolution that is proposed in response to global change is likely to reflect the educational perspectives and paradigms of those calling for the revolution. We differentiate between a circular revolution (as in the "plan-do-check-act cycle" often used in change management) versus an axial revolution (moving to a different way of thinking about the issues), arguing that the latter is a more appropriate response to the complex transdisciplinary challenges posed by global environmental change. We present some potential tools to promote an axial revolution, and consider the limits to this approach. We conclude that rather than promoting one large and ideologically homogenous revolution in education and capacity building, there is a need for a revolution in the way that leaders working with education and capacity building *look at* systems and processes of change. From this perspective, transformative learning may not only be desirable, but critical in responding to the challenges posed by global environmental change.

Key words: education, capacity building, global environmental change, transformation.

"You say you want a revolution
Well, you know
We all want to change the world…
You say you got a real solution
Well, you know
We'd all love to see the plan...
The Beatles (1968)

1. Introduction

There is extensive scientific evidence that human-induced changes to the environment are threatening to "a safe operating space for humanity" (Rockström et al., 2009, p. 472) and that processes such as climate change could have dramatic consequences for humanity (UNDP, 2007/2008). Many consider that there is an urgent need to respond to global environmental challenges, and diverse solutions and approaches have been put forward, ranging from transformation of energy and agricultural systems to transformation of development paradigms, power relations, and values and worldviews (Beddoe et al., 2009; Crompton and Kasser, 2009; Leiserowitz et al., 2006). Underlying many of the arguments for transformative responses to global environmental change is a growing recognition that the complex environmental and social challenges of the 21st Century require a different approach to education and capacity building. In fact, it has been argued that nothing less than a 'revolution' in education and capacity building is needed to confront the challenges posed by global environmental change (RESCUE, 2009). Indeed, Albert Einstein is often attributed with the reminder that "we cannot solve our problems with the same thinking we used when we created them."

Transformative changes in education and capacity building can play a critical role in developing understandings and actions to address the complex, non-linear and potentially irreversible environmental changes associated with human activities (Sterling 2001; Fazey, 2010). There are, for example, calls for transforming the current and dominant framing of knowledge from a "closed, uniform, linear and placeless system of insights and aptitudes" to an open knowledge system that brings in a holistic perspective to the dynamics of complex interactions of social-ecological systems (RESCUE, 2011, p. 27). This requires interdisciplinary and transdisciplinary approaches to both education and research, as well as the development of new capabilities, including humility and openness towards other systems of thought and sources of knowledge (RESCUE, 2011).

However, there are concerns that most universities and research institutes are limited in their delivery of the type of interdisciplinary knowledge needed to address environmental problems, and few have approached knowledge from a transdisciplinary perspective. Furthermore, they are not delivering as quickly as scientific findings suggest is necessary. The question is, what actions need to be taken? What kinds of capacities need to be built? What

exactly does a revolution in education and capacity building entail? These are some of the questions that were addressed by the Working Group on "Towards a Revolution in Education and Capacity Building," which was part of the RESCUE project (Responding to Environmental and Social Challenges for our Unstable Earth), a Frontiers of Science initiative funded by the European Science Foundation (ESF) and European Cooperation in Science and Technology (COST). As a foresight project, a key emphasis was on the future of education, and in particular on moving from first-order changes that amount to "doing more of the same, but better" to second- or third-order changes that involve re-thinking systems by "seeing things differently" (Sterling, 2001, p. 28).

In this paper, we discuss the "revolution" in education and capacity building that is deemed necessary in response to urgent environmental and social challenges. We first argue that any type of revolution that is proposed in response to global change is likely to reflect the educational perspectives and paradigms of those calling for the revolution. Diverse attitudes towards a revolution were visible within the Working Group itself. We next explore the challenges of transforming education and capacity building within five key arenas. We differentiate between a circular revolution (doing similar things repeatedly) versus an "axial" revolution (moving to a different way of thinking about the issues). An axial revolution rests first and foremost on creating conditions for transformation through non-conventional tools and approaches that allow individuals (including academic staff, administrators, researchers and policy-makers) to question current assumptions and beliefs, whether about the future of education or the future of the planet. Finally, we consider some of the potential tools to promote an axial revolution in education and capacity building, including a "Futures Literacy" method for identifying creative solutions to the new challenges for education and capacity by revealing implicit assumptions about how we tend to think about the future.

It became clear through this work that one's anticipatory assumptions and beliefs shape decisions and actions, including the curriculum and agendas for education and capacity building. Addressing these assumptions can thus serve as an important point of departure for identifying creative and innovative actions for education and capacity building in response to global change (Mezirow, 2000; Wickson et al., 2006). However, revolutionary changes in education and capacity building are unlikely to occur if the task continues to be considered as nothing more than a technical problem, which is defined by Heifetz et al. (2009) as one that has known solutions that can be implemented through current know-how. They are instead contingent upon recognizing the "adaptive challenge" involved in change processes – a challenge that can only be addressed through changes in people's beliefs and mindsets (Heifetz et al., 2009; Kegan and Lahey, 2009). There are thus considerable barriers to operationalizing transformative changes in education and capacity building, not because of a lack of tools, approaches and technical solutions, but due to resistances to exploring one's own (individual and collective) assumptions, which often involves confronting existing priorities, interests, habits and loyalties that can be threatened by processes of change.

2.   *Perspectives matter: current approaches to education and capacity building*

Since the 19th Century, a powerful and highly successful model for education and capacity building has predominated, which has consequently been exported to all corners of the world. This model has been built around the demands of the industrial era, and includes the development of disciplinary expertise, academic autonomy, and transmission of knowledge and information to develop a society that promotes progress and achievement. In recent years, this model has (in many parts of the world) included a greater role for the private sector, with an emphasis on standardization, learning outcomes, and performance indicators. As Sterling (2001, p. 40) argues, "[t]his managerial approach in education reflects mechanistic beliefs in determinism and predictability—which leads in turn to a belief in the possibility and merits of control." The approach favors educating people to adapt to change, rather than building their capacity to shape and create change (Sterling, 2001).

However, in light of scientific and social advances, strong evidence is accumulating that a new phase of systematic education and capacity building will be needed, which integrates a diversity of methods and goals at all levels (Esbjörn-Hargens et al., 2010). From the practices of K-12 education to institutions for higher education, and from the learning and knowledge diffusion activities of scientific research to adult learning and skill acquisition, the challenge is to synthesize and apply the latest findings from a range of fields, including cognitive science, teaching methods, creativity and collaborative knowledge creation to transform education such that it can meet the challenges and uncertainties of global environmental change. New approaches to education and capacity building are now seen as the foundation for responding to environmental change. Suggested approaches include radical inter-and trans-disciplinary education ("RITE") (Goodsite et al., this issue), and a greater emphasis on systems analysis, higher-order thinking, and "resilience thinking" (Fazey et al., 2007; Walker and Salt, 2006). Knowledge, it has been argued, can no longer be seen as separate and independent from actors and policy processes (Jäger et al, and Tàbara & Chabay, this issue), and new methods and approaches to collecting, managing, and interpreting data are regarded as necessary to understand dynamic changes (Pahl-Wostl et al., this issue).

A new type of education and capacity is arguably needed, but what this entails is debatable and depends upon who is asking the question, and where they are coming from in terms of perspectives and educational paradigms. There is a broad spectrum of potential approaches to education in relation to environmental change and sustainability. Sandell et al. (2005) reviewed the educational philosophy supporting environmental education (EE), ecological education (Eco E) and education for sustainable development (ESD). A more recent educational philosophy is education for a sustainable future (ESF). This spectrum of approaches to education and sustainability is discussed by Faghihimani (2012) and summarized below.

Environmental Education (EE), also called fact-based environmental education, developed during 1960s and is based on an ontology that views humans as separate from nature. Nature is thus something that can be managed and controlled by humans, and environmental problems are attributed to resource exploitation and production processes in society. These

problems are characterized as scientific and knowledge-based problems that can be solved by research, information gathering, and action. Environmental issues are studied largely within natural science disciplines, with factual information delivered from teachers to students, where the latter are considered passive recipients of knowledge. With its main concern being the quality of environment, EE has largely neglected social, economic and political aspects of environmental problems, and there has been little room for contributions from the social sciences and humanities, or from the broader stakeholder community.

Ecological Education (EcoE), sometimes considered normative environmental education, evolved during 1980s, influenced by the eco-philosopher, Arne Naess. It represented a new orientation that included the social sciences and humanities in education about environmental challenges. In this approach, environmental problems reflect existing conflicts between society's desires and the laws of nature. Environmental problems are related to values, and thus can be solved by influencing people's worldview and attitudes. In contrast to EE tradition, this orientation considers humans as part of nature. However, the normative discourse of EcoE often dismisses other perspectives, and fails to allow students to develop their own understanding and lines of reasoning. Although participatory approaches to education are encouraged, the teacher is still considered "the one who knows best" (Sandell et al. 2005, p. 176). Consequently, EcoE is not considered to be aligned with pluralistic, democratic approaches to education.

Education for Sustainable Development (ESD), which developed during the 1990s, assumes that human and nature are bound in a cycle of events and traditions, and the causes of environmental problems are conflicts between humanity's wide range of achievement goals. These problems have been considered as political issues that should be dealt with democratically. The goal of ESD is to assist students in developing their ability to criticality evaluate various alternative perspectives on environmental sustainability. Students are engaged in an active and critical learning process and a broad range of learning materials are integrated. ESD has been considered the discourse that characterizes modern environmentalism, reflecting the latest generation in the evolution of educational traditions related to the environment (Hesselink, 2000; Huckle, 1991). However, a lack of sufficient clarity about the philosophical umbrella of the ESD approach, which comes from the pluralistic nature of the concept, has made it difficult to implement ESD within existing educational systems. For example, there are problems in integrating sustainability with educational theory, policy and practice.

Education for a Sustainable Future (ESF) is a more recent concept that developed in the beginning of the 21st century. This approach argues that it is not only development that needs to experience a paradigm shift to achieve sustainability, but also that paradigms of education have to fundamentally change (Blewitt and Cullingford, 2004). ESF considers education to serve as a new way of looking at sustainable change and development, but in contrast to ESD, it sees a change in education as a prerequisite for sustainable development in human society. This includes lifelong and continuous learning, with a participatory learning process based on

learning with peers. ESF proponents criticize the ESD tradition for being outer-directed and too instrumentally oriented. They insist on 'considering the inner dimensions of valuative psychological and perceptual change' (Blewitt and Cullingford, 2004).

Choosing one paradigm as the starting point for a revolution risks simply replacing one educational framework with another. Such attempts can fall prey to their own dualisms, or promote a counter-hegemonic ideology that is resisted and marginalized. The existence of hegemonic and counter-hegemonic ideologies creates polarization and mistrust that may favor conserving the status quo over experimenting with innovative approaches and methods. Wals and Corcoran (2004) note that when responding to the challenge of sustainability in higher education, the emergence of conflicting perspectives is both inevitable and desirable (when properly managed). Yet the selective elevation of one particular frame, they argue, rarely leads to satisfying, long-lasting results (see Wals and Corcoran, 2004). Scott (2009) argues that there is a need for greater openness to new approaches, and different ways of thinking and working. This includes being open to new or unfamiliar ways of doing research, "whilst constructively engaging with work already archived" (Scott, 2009, p. 162).

3. *The limits of our own perspectives*

The presence of a diversity of perspectives on education for sustainability, each with their values and implicit frameworks, can make transformative change difficult. It was recognized that even within the Working Group, the perspectives and paradigms that each participant brought to the group acted as a filter that influenced interpretations of both the problems and solutions. The members of the Working Group, eight men and seven women representing a range of ages and nationalities, came from diverse disciplinary backgrounds ranging from geography, science and technology studies, leadership studies, and history to physics, landscape ecology and medicine. To explore the span of perspectives that existed within the group, the subjective attitudes of working group members towards a revolution in education and capacity were assessed using Q-methodology, an empirical research method for the scientific study of human subjectivity, originally developed by Stephenson (1953) in the 1930's and furthered through the work of Brown (1991/1993).[1] A concourse of 32 statements was developed to represent the range of approaches and attitudes towards changes in education (see O'Brien et al. 2010). Statements were based on examples from the literature on education, and from responses to questions about the challenges of interdisciplinarity and educational transformation posed to working group members. The statements were then

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[1] Q-methodology views subjectivity as a person's communication of their point of view, which is anchored in self- or internal frame of reference. It gives researchers the possibility to investigate subjectivity systematically; to become aware of, uncover and give meaning to subjective experience about a particular theme. It includes a distinctive set of psychometric and operational principles that are combined with statistical applications of correlation and factor analysis techniques. This combination allows researchers to utilize an exact quantitative means for investigating subjectivity. Q methodology does not capture the subjective perspectives of individuals, but rather the attitudes that are represented within the larger group.

sorted by participants into a grid with a Likert scale distribution (ranging from highly disagree to highly agree). The sorting was conducted by working group participants, and a factor analysis was then carried out on the sorted grids. The results of the factor analysis revealed four approaches that potentially represent distinct attitudes towards a revolution in education and capacity building.

1. *The reformist approach* argues that education can be changed by creating new arenas and methods for promoting multi- and inter-disciplinary interactions. A revolution in this sense requires institutional and curricula changes. Removing barriers and changing incentives is considered a prerequisite for a successful revolution.
2. *The political approach* is a critique of mainstream education that calls for deep structural changes in the way that education is carried out. A revolution from this perspective requires approaches that challenge dominant structures and paradigms, including the hierarchical approach to educating students by filling them with facts and expertise.
3. *The social approach* focuses on education as a means for creating informed and educated citizens that can participate effectively in democracy and the creation of a just society. This type of revolution emphasizes the development of human agency through dialogical, participatory approaches that engage students with practical, 'real-world' problems.
4. *The perspectival approach* draws attention to the importance of recognizing that there are different approaches and understandings of education. A revolution in this sense involves transforming the teachers and administrators as well as the students. It can be considered a reflexive process of continuous change.

Although this study was very preliminary, it does suggest that participants came to the group with different ideas about the goals and strategies to be pursued. This diversity of views on a revolution in education and capacity within the Working Group indicated to us that the revolution is not just about changing the external system(s) from one particular assumed point of view, but that it is also about changing the way that actors *look at* the system of education and capacity building. This is potentially relevant to not only those directly involved in education and capacity building, but also a broader spectrum of society that engages indirectly with education (e.g., parents, policy makers, businesses).

4. *A 'circular' revolution?*

The mandate for the RESCUE Working Group on "Towards a Revolution in Education and Capacity Building" was to promote integrative education and research that recognizes the challenges presented by a dualistic worldview that separates nature from human culture (RESCUE, 2009). A number of key questions were given to the Working Group to address, including: How can we intensify the discourse between natural and physical sciences and social and human sciences? What are the barriers that deter the young researchers from interdisciplinary routes and the incentives to bring them on this route? How can we create and nurture individual and institutional mechanisms to ensure transdisciplinary educative

approaches? More important, how can the European Science Foundation (ESF) and its partners add their voices to change the university's *mindset* and curricula in insuring proper interdisciplinary research and education?

The Working Group shared a sense of the need for an education system that does much more than prepare people for jobs. The group envisioned universities that would focus more on producing responsible citizens who are critically engaged with social and environmental challenges, rather than passively accepting them as predetermined or given. After numerous discussions and an exploration of the literature, the group came up with a list of factors that could be integrated into a "revolutionary" vision for higher education and research, and some of barriers to realizing them (see Table 1):

INSERT TABLE 1 HERE

The resulting list could have usefully served as a basis for looking for examples of inspiring case studies, innovative policies, and other initiatives designed to overcome such obstacles/barriers in Europe and other parts of the world. Indeed, the group was aware that there are existing programs, departments, centres, and initiatives that are doing the kind of knowledge work that is considered desirable on a much broader scale (see RESCUE 2012). This would have produced best-practice overviews, lessons learned and a set of recommendations for actions at individual, organizational and systemic levels of policy making.

But what of the revolution? Would such a report convince those with the power and responsibility to shape education and research training to take the recommendations seriously? Why would they, when chances are that they have probably heard them many times before? In fact, there have been numerous recent reports and other sources that reflect and recommend exactly these kinds of issues (see, for example, Læssøe et al. 2009). Indeed, the list presented in Table 1 is neither new nor innovative, but rather a repetition of many earlier attempts to 'revolutionize' education to meet the challenges of global environmental change. There was a general sense that the results of such interventions were indeed useful, but that they are not gaining traction because those with the power to implement such recommendations at universities, research councils, and other institutions often have competing priorities.

The repeated calls for more interdisciplinary research, new framings of environmental problems, more stakeholder participation, and so on can indeed be considered a revolution – but only in the sense of "revolving in a circle". In other words, it represents a continuous motion around an unchanging and even unrecognized or invisible axis, exemplified by the Plan-Do-Check Act cycle in process management (see Young, 2009). Rather than promoting another circular revolution, the Working Group considered the need for an axial revolution, where the axis reflects a core set of unquestioned assumptions and beliefs. An axial revolution would not invalidate the need for small, incremental changes, but would rather support them

by identifying non-obvious barriers to implementation, including barriers related to specific paradigms.

For example, one implicit assumption relevant to education and capacity building in response to global environmental change may be the dualistic understanding of human-environment relationships that represents the ontological basis for modernity and positivist science (Castree, 2008). Although theoretical perspectives seeking to transcend this dualism can be traced to both natural sciences (von Bertalanffy 1968; Prigogine 1977) and social sciences (Murdoch 1997; Manuel-Navarrete and Buzinde 2010), many approaches to the problems discussed above nonetheless fall prey to "maintaining a dualistic separation of ourselves and nature, economics and ecology, subject and object, present and future" (Sterling 2011, p. 108), and point towards the need for deeper inquiries into the assumptions and beliefs underlying such approaches. Bohm (1992) pursued such an inquiry and found incoherence in perceptions and the fragmentation of thought to be at the heart of such issues.

To move beyond this particular type of "circular" revolution, it may be necessary to identify an alternative approach, i.e. changing the axis by questioning current beliefs and assumptions regarding the delivery of education. The Working Group thus chose to examine ways to reveal the incoherence and fragmentation in perceptions—including our own perceptions—of how educational systems can be revolutionized. What would this imply? This would involve a fundamental change in the way of thinking about or visualizing or perceiving assumptions, or a change of paradigms (see Figure 1). A paradigm shift would mean different things to different people, depending on their current assumptions and beliefs about the way that the world works (e.g., mental models, worldviews, reference frames, etc.). However, an axial revolution would in general move towards transformative learning, including the production of knowledge that is synthetic and epistemologically reflective.

INSERT FIGURE 1 HERE

Exploring the literature on change in general, and in particular on the distinction between technical problems and adaptive challenges discussed by Heifetz et al. (2009) and Kegan and Lahey (2009), it becomes clear that an axial change represents a transformative shift in cognition and consciousness. Yet it is a type of transformative change that avoids sharp discontinuities with the past, but mobilizes people to identify what is essential and precious to protect, discard what is unnecessary, and run experiments that will enable the discovery of alternative ways of approaching the future.As Heifetz (2010) notes, a successful adaptation to such a challenge enables a system to take the best from its history into the future, such that it is both conservative and progressive.

5. *Five arenas for facilitating transformative change*

As discussed above, a revolution in education and capacity building could be directed towards a variety of paradigms, groups or objectives. Rather than focusing on any particular paradigm, five potential arenas for an axial revolution were considered. The selection of these five arenas emerged through discussions, as well as through a review of the literature on education and capacity building in global change research. We recognize, however, that the selection of these five was influenced by our predispositions, and consequently we may have missed some key arenas.

i. Building capacity to do the interdisciplinary and systems research required to understand and manage Earth System Challenges

There is clearly a need for a comprehensive and strategic approach to capacity building to address complex Earth System problems (Leemans et al., 2009). The key challenges for research were identified through the ICSU Visioning Process, whose aim was to develop an integrated approach to what is now called global sustainability research and its coordination/management at an international level (ICSU, 2010). Meeting the grand challenges for global change research requires an increased commitment to the development of interdisciplinary education and curricula (Reid et al., 2010). Such initiatives have been promoted through national and international declarations, and individual institutional policies (Wright, 2002). However, while it is recognized that increased interdisciplinarity is necessary for addressing the challenges of global environmental change, there are gradations of going beyond disciplinarity: multi-disciplinary, cross-disciplinary, interdisciplinary, and trans-disciplinary (Stein, 2007). Often a barrier to realizing the more inter- and trans-disciplinary approaches is the lack of a meta-framework for coordinating, holding, and aligning the data sets, methods, and insights from the various disciplinary approaches.

Transdisciplinary research is currently emerging in the research landscape as an approach that focuses on a problem that is, as described by Wickson et al. (2006, p. 1048), 'in the world and actual' as opposed to 'in my head and conceptual'." This implicitly assumes the notion of creating change and contributing to solutions, based on the integration of different disciplinary methodologies and, ideally, epistemologies, which involves collaboration with stakeholders and the broader community (Wickson et al., 2006). According to Wickson et al. (2006, p. 1053), transdisciplinary research [and thus by definition education] processes emphasize the importance of reflection:

> "When researchers become engaged in the problem they are investigating assumptions of objectivity will inevitably come into question. This means that it becomes important for the researcher to reflect on how their own frames of reference/values/beliefs/ assumptions etc. have shaped the conceptualization of the problem, as well as the development of the method of investigation and the solution."

The barriers to both interdisciplinarity and transdisciplinary education remain numerous, and have been widely discussed in the literature. These include a combination of structural,

cultural and cognitive barriers and problems related to disciplines as social institutions (Buanes and Jentoft, 2009). It has been argued that the structural barriers are the easiest to address, whereas cultural barriers are more persistent: "What makes disciplines so inflexible and interdisciplinarity so difficult is not only that disciplines are formed around one or a few aspect visions, but that they also harbour strong truth perceptions that are so much taken for granted that any empirical test is unnecessary" (Buanes and Jentoft, 2009, p. 451). Furthermore, there is a tendency to view "scientific knowledge" as a truth that needs to be communicated to "users", often ignoring other types of knowledge or perspectives. The move from "science for society" to "science with society" calls for a new approach, or what Jasanoff (2010) refers to as "technologies of humility."

ii. Transforming the university education system that trains potential researchers and educates citizens about resilience and sustainability

University education systems have been the main channel for developing and disseminating understandings of global environmental change. However, it has been argued that "sustainability does not simply require an 'add-on' to existing structures and curricula, but implies a change of fundamental epistemology in our culture and hence also in our educational thinking and practice. Seen in this light, sustainability is not just another issue to be added to an overcrowded curriculum, but a gateway to a different view of curriculum, of pedagogy, or organizational change, of policy and particularly of ethos" (Sterling, 2004, p. 50).

It has also been argued that institutions of higher learning should foster a vision of education that has comprehensive integrity. This involves teaching different stories, including stories that enable students to interact more creatively with the emergent processes of the universe, providing not only the understanding and sense of direction for sustainability, but also evoking the energy needed to create this new situation (O'Sullivan, 2004). Efforts to promote higher-order thinking and 'resilience-thinking' through problem-oriented teaching methods has been shown to be effective (Fazey, 2010; Walker and Salt, 2006).

Education systems are undergoing enormous changes in response to social, economic, and technological changes, and different types of approaches and reforms have been proposed and tested (see Corcoran and Wals, 2004). For example, "[t]eacherless or virtual-teacher learning is described by enthusiasts as a revolution in the making" (Giridharadas, 2009). In relation to sustainability issues, a number of good practices for open knowledge and learning systems have been identified which integrate a diversity of actors, institutions and intellectual resources (see ESF 2012). These practices demonstrate the role that flexibility and vision can play in creating prototypes for transforming university education systems.

iii. Address the primary and secondary education systems to create awareness of sustainability

It is increasingly recognized that today's children will inherit a complex world with a legacy of environmental problems linked to past and current economic and social development pathways. Consequently, many argue that education for sustainable development needs to start in early childhood and continue throughout primary and secondary school to provide foundations for higher education and lifelong learning. A report by the European Panel on Sustainable Development (EPSD, 2010) recognizes the potential for sophisticated thinking by young people on environmental issues, and emphasizes the importance of supporting education in both formal and non-formal (semi-structured) settings. The report points out that early childhood education can act as a catalyst for supporting learning at any age, particularly when it nurtures creativity and innovation. Similarly, a report to the European Commission advocated an ambitious program for inquiry-based science education, whereby students (ages 5 to 16) are "encouraged to develop a sense of wonder, observation, and logical reasoning" (Léna, 2009).

Reid et al. (2008) examine the role of participatory learning and discuss how it can be used to develop and share knowledge, skills and experience and contribute to cognitive gains, action competence and community building. However, research on environmental learning has only recently emerged as an area of focus (Rickinson et al., 2009). Although Rickinson et al. (2009) call for greater attention to the role of values and emotions in environmental learning, much can be learned from practitioners of integral education, who consider the role of belief and value systems in the classroom and their relationship to transformative learning (Esbjörn-Hargens et al., 2010; Dea, 2010). Learning to learn can be considered a foundation for dealing with complex and dynamic environmental changes. Indeed, environmental education and sustainability education at earlier levels can create the groundwork for the development of complex, systemic thinking and generating ecological citizenship (Schreiner et al., 2005).

iv. Capacity building and education of researchers in developing countries

As discussed in the ESF Forward Look on Global Change Research in 2002, " there is an obligation on the EU and on national agencies to develop multilateral efforts to aid capacity building in the developing world, including the support of young researchers" (ESF, 2002, p. 7). Developing countries are a "special target audience" because (i) the primary integrated Earth System science challenge is that of livelihoods and development, and (ii) institutions in developing countries, even though based on the western model, might contribute with non-Westernized insights and paradigms, that are more open to transdisciplinary approaches to knowledge production. To address the important role of education and capacity building in developing countries, numerous international collaborative programs have been developed. For example, the Global Change System for Analysis, Research and Training (START) was initiated to help build endogenous capacities in developing regions of the world so that they can participate effectively in research projects of the international global change programmes. START also promotes interdisciplinary research through its regional networks. Despite these efforts, there is a tendency to promote or mimic northern agendas in many developing countries, rather than develop an endogenous narrative and agenda on what is needed for

capacity building. This tendency can be attributed to several factors: High-income countries have more financial and human resources – and power – to conduct research in high, middle and low-income countries; to promote their research and education agenda through foundations, funding agencies, and academic organizations; and to pay for the most up-to-date journals and publications, statistical tools, data, etc. that scholars from low income countries cannot afford. Indeed, many insightful studies from scholars from middle and low income countries are simply not accessible to the dominant English-speaking and European audiences. The resulting tendency to follow the mainstream discourse can create problems for context-relevant innovations in education and capacity building.

v. Educate the public at large and the politicians on those topics

The link between human behavior and environmental degradation is clear, and it is also clear that education has an impact on human behavior. Consequently, education is a key element in any response to environmental change (Qvortrup, 2009). This draws attention to adult education and lifelong learning, participatory learning, as well as the promotion of transdisciplinary thinking (Esbjörn Hargens et al., 2010; Kegan, 1989; Kegan and Lahey, 2009; Reid et al., 2008). Gardner (2008) argues that changing conditions in the world call for new educational forms and processes that take into account new understandings of the human mind and brain. In *Five Minds for the Future*, he emphasizes the needs for disciplinary expertise, the capacity to synthesize, and the creative, respectful and ethical minds (Gardner, 2008). Educating the public as well as politicians on global change issues requires acknowledging different types of intelligences and meaning-making systems.
It also involves acknowledging the ideologies and power relations entangled in any institutionalized form or systems of education. Furthermore, as Kegan and Lahey (2009, p. 16) note, "[t]hree adult meaning systems—the socialized mind, self-authoring mind, and self-transforming mind—make sense of the world, and operate within it, in profoundly different ways". Consequently, there may be a need to communicate sustainability issues differently to different worldviews (Brown, 2005).

Upon examination of these five potential arenas for a revolution in education and capacity building, where might one find the leverage point(s) that can enable a targeted intervention to have an impact across audiences? Each is a complex, interlinked set of systems and thus not easy to change. This can leave us with more questions than answers, and can also bring to the surface significant differences in paradigms and approaches. Such challenges suggest a need for transformative learning, which is "the process by which we transform our taken-for-granted frames of reference (meaning perspectives, habits of mind, mind-sets) to make them more inclusive, discriminating, open, emotionally capable of change, and reflective so that they may generate beliefs and opinions that will prove more true or justified to guide action" (Mezirow, 2000, p.7-8). Transformative learning includes the capacity to become critically aware of one's own assumptions and expectations and their context, as well as those of others, when making interpretations.

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6. *Promoting an Axial Revolution*

The previous sections examined some of the different arenas in which a revolution in education and capacity building might be carried out. While it is easy for organizations and individuals to rhetorically promote new approaches and paradigm shifts, the capacity to actually embrace and enact new ideas is often limited by existing but unnoticed or unexamined assumptions and beliefs. Such assumptions and beliefs are, according to Kegan and Lahey (2009), manifestations of an "immunity to change," which protects hidden commitments, motivations and underlying "big assumptions" that obstruct individuals and organizations from seeing changes. The revolutionary responses needed to meet the challenges of global environmental change, in contrast, seem to require what Kegan and Lahey (2009, p. 20) refer to as a "self-transforming mind" that is capable of inquiring not only *within* the frame of agenda and design, but also of inquiring *about* the design itself, which implies an openness to considering the limits of a current design or framework.

It has been recognized that capacities to creatively imagine and explore different options for the future is often limited; there is instead a strong tendency to rely on contingency and optimization models for anticipating the future (Miller, 2007). This limitation suggests a potential blind spot in current approaches to education and capacity building: our inability to recognize that we are stuck in our own specific paradigms, with specific assumptions, beliefs and values about education and capacity needs. This implies that rather than "launching" a revolution with specific objectives and desired outcomes, a revolution is more likely to emerge from within the education system itself, through learning. As Sterling (2009, p. 106) notes, "the question is whether formal education can and will be part of this learning. The answer hangs on whether the educational community—policy makers, theorists, researchers and practitioners—can itself experience some quality of transformative learning and awakening so that the education provision that in turn then evolves can be transformative, rather than, as at present, conformative." Unfortunately, it may not be possible to mandate transformative learning, thus the paradox remains: "education is held to be a key agent of change, and yet is largely part of the unsustainability problem it needs to address" (Sterling, 2009, p. 110).

This process of creating "new" epistemological frameworks adequate to the complexity of modern issues has been studied by numerous educators, scientists and researchers (e.g., Kegan, 1994; Mesilow, 2002). In recent times, the increasing complexity and speed of change has generated approaches that aim to address new knowledge creation in our current context. The working group members brought a familiarity with a number of such processes and tools to the inquiry, including tools for addressing our "inner" blind spots. Based on a review of a broad literature on change processes, this was considered to be an important prerequisite for a self-organizing revolution in education and capacity building (Boudon 1984; Gunderson and Holling 2002; Von Foerster 2003; Scharmer 2009). Scharmer's "Theory U" approach points to one way of reorienting the axis about which we seem to continuously revolve (Scharmer, 2009). Rather than drawing exclusively on the past to understand how to create the future,

Scharmer shows how we can "pre-sense" or presence what may want to "emerge from the future." However, to suspend the habitual downloading of patterns from the past and listen in to the future requires significant work, at many layers of depth, reconnecting with issues that are submerged or not visible or apparent. It also requires us, individually and especially collectively, to see what is around us with fresh eyes, and an open mind. Scharmer's work makes it possible to reconceive how we think about the future, and is one example of how to change the axis about which the revolution might spin. Moreover, it points to an idea that has not been part of most "revolutionary discourses" on education and capacity building (although one could argue that it is indeed closely related to Freire's (1972) idea of "consciencisation").

Looking at the future is a common and necessary endeavor for educators, policy makers and funders alike—not to mention global change researchers. This activity requires "anticipating" the future, and research in this area indicates that the quality of the anticipatory system and its internal models is a critically important determinant of the quality of decision-making (Miller, 2007). In other words, decisions are only as good as the anticipatory system, thus wise and effective leadership that involves discovering the best strategies and making the best choices depends on the quality of one's anticipatory systems. How then do we investigate anticipatory systems, including our own? The Working Group chose to explore this question through a Futures Literacy process (Miller, 2007).

Futures Literacy (FL) is a systematic approach to improving anticipatory systems that emerges from the field of futures research, which focuses on real or imagined changes or differences from the status quo or present. Futures Literacy starts from the observation that every choice (e.g., whether to establish a new transdisciplinary program on sustainability issues) is shaped by anticipatory systems. These anticipatory systems can be thought of as models that allow time to speed-up, moving us ahead to an imaginary moment in the future when sustainability issues are at the forefront of economic and social policies, or when most learning takes place across informal social networks. The explicit purpose of FL is to structure the discovery of what we do not know, and to imagine changes in the conditions of change through collective learning processes (Miller, 2007). Acquiring FL is a learning-by-doing process that systematically addresses the distinctive attributes and skills needed to improve anticipatory systems. In the case of a revolution in education and capacity, the FL method can be used to identify unseen possibilities and new strategies for creating an education system that can meet the adaptive challenges posed by environmental change. It also helps to bring out tacit assumptions that limit anticipatory systems.

This line of thought led to the design and pilot implementation of a half-day workshop on "visioning a capacity revolution" (VCR) that was run with the Working Group and two other target audiences. Feedback from participants indicated that the workshop opened up insights into the degree to which assumptions were filtering and limiting decision making processes in a variety of areas related to the overall goals of the working group. As one participant described it:

Our "creations" of a future society – as brief and incomplete as they were – shifted the kinds of questions I ask about the role of sciences, of research, in shaping society. Integrating the sciences, and really getting the social sciences involved in framing sustainability research questions, seemed all important; now I wonder whether it is enough. Why don't we use the abundance of knowledge we do have at our disposal? … And this in turn raised a series of questions for me about alternative forms of educational organization that can promote equality, foster individual creative abilities and make learning available to anyone who wants to take advantage of it, not necessarily in specialized institutions as we currently know them. From there I started thinking about knowledge networks, invisible colleges, embedded universities and wondering what it would take to tweak the "cultural reproductive" functions of universities and other educational institutions: what if, for a start, universities made it compulsory for all students to participate in a futures literacy workshop, if for no other reason than to open up new cognitive spaces for choosing what they want to learn and why they want to learn it? (Heide Hackmann, June 8, 2010)

The VCR workshop provided the Working Group with a concrete example of how to begin addressing the adaptive challenge that we face, first and foremost by revealing the "hidden axes" around which our own perceptions of a revolution revolved, and which influenced our own subjectivity and blind spots. For example, some of us had some unquestioned beliefs about the future, assuming that it already exists within the parameters presented by Earth Systems model projections; one goal of education and capacity building was thus to adapt to this future. Realizing that there are different ways of defining and constructing the future can have profound implications for what we see and do in the present. Indeed, by taking a different perspective on the future and allowing for possibilities not yet conceived, one can begin to envision new ways to approach the challenges of global environmental change, and new opportunities for education and capacity building. This is not to say that there was unanimity within the Working Group regarding the approach or conclusions. In fact, this tension itself could be used to reveal where our fixed viewpoints, unquestioned assumptions, and blind spots might rest. While there was limited evidence that members of the Working Group changed their assumptions and beliefs as a result of the half-day workshop, the simple recognition that we actually do have fixed beliefs and firm assumptions that influence how we approach education and capacity building in response to global challenges was itself telling.

7. *Conclusions and recommendations*

Most adaptive challenges are also technical problems, and it is clear that any revolution in education and capacity building calls for both changes in individual and collective assumptions and beliefs, but also for the implementation of strategies and measures that address the technical aspects of the problem, including incentives, funding, curricula, etc. Yet, existing systems cannot be changed by simply pulling some levers or turning some controls – indeed, one can argue that planning, structuring and predicting the outcome of any revolution is impossible. As Meadows (1999) notes, a key leverage point for systems change is to address the mindset or paradigm out of which the system arises. This is no easy task, as individuals and organizations are often resistant to change, particularly if it involves risks or

threatens existing priorities, interests, habits and loyalties (Kegan and Lahey 2009). In fact, a key challenge is that the "system" (in this case, for education and capacity building) appears to be working fine to those with the power to change it. As Heifetz et al. (2009, p. 17) succinctly put it: "Enough important people like the situation exactly as it is, whatever they may say about it, or it would not be the way it is."

It is clear that any real changes will require shifts in where the power rests, which calls for a new type of leadership that extends beyond that associated with traditional positions of authority (Heifetz 2010). In discussing the role of leadership in education, Fullan (2005, p. 51) calls for "the deliberate fostering of developmental leaders who act locally and beyond, all the while producing such leaders in others." This includes moving beyond popular "problem-solving theories" that take existing power structures for granted (Cox 1981) to promote critical theories that foster human flourishing and the development of systems thinking. The latter in particular can be considered both necessary and helpful to addressing the complexity of worldviews associated with higher learning, organizational learning, and transformative change, in that it increases the level of abstraction or overview, moving away from reductionist and fragmented approaches to issues (Sterling, 2004). Fullan (2005) argues that a critical mass of such "systems thinkers in action," i.e., leaders working at all levels, throughout the system, can cause the system itself to transform.

We know that the challenges for education and capacity building in the context of global environmental change cannot be met by "business as usual," or by extrapolating experiences from the past into the future. There is a need to think differently, and ironically the way to do this is through experiential processes, where individuals are encouraged to release assumptions and question underlying beliefs. Such changes will normally not result in a revolution, but rather an evolution, or a continuation of improvements to the logic and operational attributes of existing systems. They can be considered a type of transformation, or a process whereby distinctively "new" systems come to replace or dominate old ones. Transformations do not, as mentioned earlier, involve the creation of a totally new system, but instead embrace both conservative and progressive elements (Heifetz 2010).

The revolution that is needed to meet the challenges of global environmental change through education and capacity building must be unconventional and daring. It must be unconventional, in that it cannot focus only on exterior changes in structures (e.g., institutional reforms, curriculum changes, new incentives for collaboration, etc.), but must also address interior shifts in consciousness among diverse actors involved in education and capacity building (e.g., identifying blind spots, questioning beliefs and assumptions, thinking differently about the future). It must be daring, in that it should challenge leaders in research, education and capacity building to engage in reflexive processes, potentially disturbing their own "axes" and creating new ways of addressing the challenges posed by global environmental change. Rather than promoting one large and ideologically homogenous revolution in education and capacity building, there is a need for a revolution in the way that leaders working with education and capacity building *look at* systems and processes of

change. From this perspective, transformative learning may not only be desirable, but critical in responding to the challenges posed by global environmental change.

8. Acknowledgments

9. References

Beddoe R, et al., 2009. Overcoming systemic roadblocks to sustainability: the evolutionary redesign of worldviews, institutions, and technologies, Proc Natl Acad Sci USA 106, 2483–2489.

Blewitt, J., Cullingford, C., 2004. Sustainability Curriculum: The Challenge for Higher Education, London, Earthscan.

Bohm, D., 1992. Thought as a System, London, Routledge.

Boudon, R. 1984. Theories of Social Change. Cambridge, Polity Press.

Brown, B. 2005. Communication of Sustainability. Kosmos Spring/Summer 2005, 17-20.

Brown, D., 1991/1993. Primer on q-methodology, Operant Subjectivity, 91-138.

Buanes, A., Jentoft S., 2009. Building bridges: Institutional perspectives on interdisciplinarity, Futures 41, 446-454.

Castree, N., 2005. Nature, London, Routledge.

Corcoran, P.B. and Wals, A.E.J. (Eds.), Higher Education and the Challenge of Sustainability: Problematics, Problems, and Practice. Dordrecht, Kluwer Academic Publishers.

Crompton, T., Kasser, T., 2009. Meeting Environmental Challenges: The Role of Human Identity, WWF-UK, Panda House, Godalming, UK.

Dea, W. 2010. Igniting Brilliance: Integral Education for the 21st Century. Tucson: Integral Publishers.

EPSD. 2010. Taking children seriously: How the EU can invest in early childhood education for a sustainable future. European Panel on Sustainable Development (EPSD), Report No. 4, 2011-12-17, Centre for Environment and Sustainability, GMV.

Esbjõrn-Hargens, S., Reams, J., Gunnlaugson L., 2010. The emergence and characteristics of integral education, in Esbjõrn-Hargens S., Reams J., Gunnlaugson, L. (Eds.), Integral Education: New Directions for Higher Learning, Albany: SUNY Press, pp. 1-16.

European Science Foundation, 2002. ESF forward look on global change research, European Science Foundation Policy Briefing 2, September 2002. http://www.esf.org/publications/forward-looks.html

Faghihimani, M., 2012. Higher education and commitment to environmental sustainability, Master thesis to be presented in August 2012, University of Oslo.

Fazey, I., 2010. Resilience and higher order thinking, Ecology and Society 15(3), 9.

Fazey, I. et al., 2007. Adaptive capacity and learning to learn as leverage for social-ecological resilience, Frontiers in Ecology and Environment 5(7): 375-380.

Freire, P., 1972. Pedagogy of the Oppressed, New York, Continuum.

Fullan, M., 2005. Leadership and Sustainability: System Thinkers in Action. Thousand Oaks, CA, Corwin Press.

Gardner, H. 2008. 5 Minds for the Future, Boston, Harvard Business Press.

Giridharadas, A., 2009. Putting the students in control, *International Herald Tribute*, Saturday-Sunday, November 7-8, 2009, p. 2.

Gunderson, L.H. and C.S. Holling (eds). 2002. Panarchy: Understanding Transformations in Human and Natural Systems. Washington, Island Press.

Heifetz, R., 2010. Leadership, in Couto, R.A. (Ed.), Political and Civic Leadership: A Reference Handbook, London, Sage Publications, pp. 12-23.

Heifetz, R., Grashow, A. Linsky M., 2009. The Practice of Adaptive Leadership: Tools and Tactics for Changing Your Organization and the World, Boston, Harvard Business Press.

Hesselink, F., 2000. Managing European learning processes towards sustainable development, Prospects 30(1), 87-95.

Huckle, J., 1991. Education for sustainability: Assessing pathways to the future, Australian Journal of Environmental Education 7, 43–62.

ICSU, 2010. Regional environmental change: Human action and adaptation, International Council for Science, Paris.

Jasanoff, S., 2010. A new climate for society, Theory, Culture and Society 27, 233-253.

Kegan, R., 1994. In Over Our Heads, Cambridge, MA, Harvard University Press.

Kegan, R. and Lahey L.L., 2009. Immunity to Change: How to Overcome it and Unlock the Potential in Yourself and your Organization, Boston, Harvard Business Press.

Læssøe, J., Schnack, K., Breiting, S. and Rolls, S., 2009. Climate Change and Sustainable Development: The Response from Education. International Alliance of Leading Education Institute, The Danish School of Education, Aarhus University.

Leemans, R., 2009. Developing a common strategy for integrative global environmental change research and outreach: The Earth System Science Partnership (ESSP): Strategy paper, Current Opinion in Environmental Sustainability 1, 4-13.

Leiserowitz, A. A., Kates, R., Parris, T. M., 2006.Sustainability values, attitudes, and behaviors: A review of multinational and global trends, Annu. Rev. Environ. Resour. 31, 413-44.

Léna, P., 2009. Editorial: Europe rethinks education, Science 326, 501.

Manuel-Navarrete, D., and Buzinde, C. 2010. Socio-ecological agency: From "human exceptionalism" to coping with "exceptional" global environmental change. In Redclift, M., and Woodgate, G. (Eds.) The International Handbook of Environmental Sociology, Cheltenham: Edward Elgar, pp. 136-149.

Meadows, D. Leverage Points: Places to Intervene in a System. Sustainability Institute. http://www.sustainer.org/pubs/Leverage_Points.pdf

Mezirow, J., 2000. Learning as Transformation: Critical Perspectives on a Theory in Progress, NY, Jossey-Bass.

Miller, R., 2007. Futures literacy: A hybrid strategic scenario method, Futures 39, 341-352.

Murdoch J. 1997. Inhuman/nonhuman/human: actor-network theory and the prospects for a nondualistic and symmetrical perspective on nature and society. Environment and Planning D: Society and Space 15(6), 731 – 756.

O'Brien, K., Reams, J., Caspari, A., Dugmore, A., Faghihimani,M., Fazey, I., Hackmann, H., Manuel-Navarrete, D., Marks, J., Miller, R., Raivio, K., Romero-Lankao, P., Virje, H., Vogel,C., Winiwarter, V., 2010. You Say you want a revolution? Transforming education and capacity building in response to global change, RESCUE report, ESF.

O'Sullivan, E., 2004. Sustainability and transformative educational vision, in Corcoran, P.B. and Wals A.E.J. (Eds.), Higher Education and the Challenge of Sustainability, Dordrecht: Kluwer Academic Publishers, pp.163-173.

Prigogine, I. 1977. Self-organization in Non-equilibrium Systems. New York, Wiley Interscience.

Qvortrup, L., 2009. Editorial: Educating citizens of the world, Education Alliance Quarterly, September 2009. (The Danish School of Education, Aarhus University).

Reid, A., Jensen, B.B., Nikel, J., Simovska, V., 2008. Participation and Learning: Perspectives on Education and the Environment, Health and Sustainability, Dortrecht: Springer.

Reid , W.V., Chen, D., Goldfarb, L., Hackmann, H., Lee, Y.T., Mokhele, K., Ostrom, E., Raivio, K., Rockstrõm, J., Schellnhuber, H.J., Whyte, A., 2010. Earth system science for global sustainability: Grand Challenges, Science 330, 916-917.

RESCUE, 2009. Forward Look Proposal: RESCUE (Responses to Environmental and Societal Challenges for our Unstable Earth), Presented to the European Science Foundation by Professor Reinhart Ceulemans and Professor Roderick Floud, March 2009.

RESCUE, 2012. Responses to Environmental and Societal Challenges for our Unstable Earth (RESCUE), ESF Forward Look – ESF-COST 'Frontier of Science' joint initiative. European Science Foundation, Strasbourg (FR) and European Cooperation in Science and Technology, Brussels (BE).

Rickinson, M., Lundholm, C., Hopwood, N., 2009. Environmental Learning: Insights from Research into the Student Experience, London, Springer.

Rockström, J. et. al. 2009. A safe operating space for humanity, Nature 461, 472-475.

Sandell, K., Öhman, J. and Ôstman, L., 2005. Education for Sustainable Development: Nature, School and Democracy, Lund: Studentlitteratur.

Scharmer, C.O., 2009. Theory U. Leading From the Future as it Emerges, San Francisco, Berett-Koehler Publishers, Inc.

Schreiner, C., Henriksen, E.K., Hansen P.J.K., 2005. Climate education: empowering today's youth to meet tomorrow's challenges, Studies in Science Education 41, 3-49.

Scott, W., 2009. Environmental education research: 30 years on from Tbilisi, Environmental Education Research 15(2), 155-164.

Stein, Z., 2007. Modeling the demands of interdisciplinarity: toward a framework for evaluating interdisciplinary endeavors, Integral Review 4, 91-107.

Stephenson, W., 1953. The Study of Behavior, Chicago, University of Chicago Press.

Sterling, S., 2001. Sustainable education: re-visioning learning and change, Schumacher Briefings 6, Bristol: Green Books.

Sterling, S., 2004. Higher education, sustainability, and the role of systemic learning, in Corcoran, P.B. and Wals, A.E.J (Eds.), Higher Education and the Challenge of Sustainability, Dordrecht, Kluwer Academic Publishers, pp. 49-70.

Sterling, S., 2009. Sustainable Education, in Gray, D., Colucci-Gray, L. and Camino, E. (Eds.), Science, Society and Sustainability: Education and Empowerment for an Uncertain World, New York, Routledge, pp. 105-118.

UNDP, 2008. Fighting climate change: Human solidarity in a divided world, Human Development Report 2007/8.

Von Bertalanffy, L. 1969. General System Theory: Foundations, Development, Applications. Revised edition (March 17, 1969) New York: George Braziller Inc.

Von Foerster, H., 2003.Understanding understanding: Essays on cybernetics and cognition. New York, Springer.

Walker, B., Salt D., 2006. Resilience Thinking, Washington, DC, Island Press.

Wals, A.E.J., Corcoran P.B., 2004. The promise of sustainability in higher education: An introduction, in Corcoran, P.B. and Wals, A.E.J. (Eds.), Higher Education and the Challenge of Sustainability: Problematics, Problems, and Practice. Dordrecht, Kluwer Academic Publishers, pp. 91-95.

Wickson, F., Carew, A.L., and Russell, A.W., 2006. Transdisciplinary research: characteristics, quandaries and quality, Futures 38, 1046-1059.

Wright, T.S.A., 2002. Definitions and frameworks for environmental sustainability in higher education, Higher Education Policy 15, 105-120.

Young, M. 2009. A meta model of change, Journal of Organizational Change Management, 22 (5):524 – 548.

Figure Caption:

Figure 1. A revolution is not just about changing the system, but also about changing the *way of looking* at the system of education and capacity building, including critical reflections on current assumptions and beliefs.