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## THE ECOLOGY OF EDUCATION: KNOWLEDGE SYSTEMS FOR SUSTAINABLE DEVELOPMENT AND SUSTAINABILITY

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### Abstract

*Research in knowledge systems for sustainable development (KSSD) seeks to determine how science and technology can be put into effective action at a local level. Teachers in education for sustainability attempt to achieve the same goal. KSSD research has indicated that success is context driven, that panaceas are inappropriate and that knowledge systems at best provide solutions in evolution. In this paper, we describe a teaching framework that we are developing to support KSSD researchers and teachers in education for sustainability based in ecology of education. While a need for ecology in education may be apparent, there is concurrently an equally important need for ecology of education. We argue that one cannot teach ecology in education adequately without an appropriate ecology of education. This paper first explains why teachers need to know this and then describes how teachers of education for sustainability can implement and assess this approach in the classroom.*

**Key words:** ecology; education; sustainability; systems; teaching.

### Introduction

Teaching sustainability is not easy. The definition of what sustainable development and sustainability is and how to best achieve it through education is still uncertain. Teachers are not sure what to teach, nor are they sure of how to teach it (Jickling, 2000; Johnson & Mappin, 2005; Wals & Jickling, 2001). For students the issues surrounding global sustainability and possible global futures are very emotive and value-laden, such that most prefer a collaborative approach over a traditional teaching methodology (Hicks & Bord, 2001; Ono, 2005). Overall, the current efficacy and validity of environmental education around the globe is poor. Current environmental education continues to take a human-centered approach and makes little to no linkage between humans and nature (Bonnett, 2007) even though human-nature linkages need to be addressed (Clark, 2007; Kates & Parris, 2003). Furthermore, environmental education does not adequately

address the necessary improvement in global human-human relationships (Barraza, Duque-Aristizabal, & Rebolledo, 2003) equally essential to a sustainable future (Kates & Parris, 2003).

In this paper we describe what is a potentially more valid and effective approach to education for sustainable development (ESD) and sustainability. It is a more natural approach, one reminiscent of our earliest human lineage of community living and collaborative learning, yet it employs some of the newest principles from the complexity sciences. It is an approach that moves education for sustainability away from the exclusive realm and responsibility of environmental education toward a multidisciplinary methodology that involves a concerted effort from, and shared responsibility by many teachers as some have advocated (Johnson & Mappin, 2005). In this paper we expand on an alternative somewhat contemporarily underutilized vision of teaching and learning, the nascent aspects of which have been developed by a number of education research scholars such as Paul F.-Brandwein (see Bennett & Bennett, 2004), Stephen Sterling (cf. 2003), Carlos A. Torre (1995a, b, 1996, 2003, 2005a, b, c, d, e, 2006, 2007, 2008, 2009; Torre & Joyce, 2007; VanderVen & Torre, 1999; VanderVen, Torre, & Maholmes, 2002) and, most recently, by André F. Pilon (2009) that may help to solve some of the difficulties with teaching and learning sustainable development and sustainability.

For example, Brandwein viewed school–family–community, postsecondary systems, and culture as distinct ecosystems that can reinforce each other and help to teach both knowledge and values not only regarding the environment but also with respect to the communities within which we live. Drawing on over thirty years of environmental education and teaching research scholarship, in his 1995 book *Science Talent in the Young Expressed within Ecologies of Achievement*, published posthumously, Brandwein wrote,

*The ecology of education comprises three inter effective ecosystems – that of the family–school–community, the culture, and the postsecondary systems. When these three ecosystems interact harmoniously, they form an ecology of achievement that offers all the young opportunity for their special endowments... to flourish*” (Brandwein, 1995, p. xi, after Bennet & Bennett, 2004).

In this tradition, as described in this paper, we seek to expand this view into a broader more global ecology of education, one that links the local to the global in action toward a sustainable future.

The UN’s Brundtland Report provides the standard but somewhat general definition of sustainable development as, “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (UN, 1987). More recently, Hegarty (2008) has provided a definition of sustainability that seeks to more accurately reflect the multidimensional nature of the issue:

*Sustainability relates to the continuity of economic, social, institutional and environmental aspects of human society, as well as the non-human environment. Sustainability means that as a society we are aware of the impact of our actions on others and on the planet, that we take responsibility for these actions and are transparent in our processes (p. 682).*

However, both sustainable development and sustainability remain conceptually elusive, as illustrated by how the term has been variously utilized in a variety of disciplines in varying contexts that range from forestry management to sustaining maximum yields in fisheries to envisioning steady state economies in sustainable societies (Brown, Hanson, Liverman, & Merideth, 1987; Jahnke & Nutzinger, 2003). Stemming from the ambiguity regarding generally applicable operational definitions, it has, perhaps not surprisingly been difficult to develop and implement valid and effective curricula for sustainable development and sustainability in schools (Johnson & Mappin, 2005).

Despite these difficulties, sustainable development and sustainability is something we must collectively achieve on a global scale if we wish to perpetuate the human species here on earth. Given the limited progress made so far, there appears to be a growing call for a new, more effective kind of ESD and sustainability at all levels; from schools (K-12) and universities, to the education of corporate culture, to the education of political governance (Auld, Bernstein, & Cashore, 2008; Barraza, Duque-Aristizabal, & Rebolledo, 2003; Bonnett, 2007; Federico, Cloud, Byrne, & Wheeler, 2003; UNESCO, 2005; WWF, 2006).

We argue that if we are to achieve a transition toward sustainable development and sustainability as a global society, teachers and school boards must collectively and collaboratively adopt a broader scope of education and action, one beyond environmental advocacy and one that is both informational (educational in the traditional sense) and transformational (changing behaviors and attitudes). That is, education must not only address all the knowledge dimensions of sustainability such as environmental change, poverty, and human rights, perhaps even more importantly, it must also help students to actively engage in the various behaviors and attitudes related to the improvement of these dimensions of sustainability. To accomplish this broader, imminently important objective the very method of education must change. As we detail further, a new methodology, one based in ecology of education must be developed through collaborative research. We argue that an ecology of education methodology is likely the best suited to transfer information to students in such a way as to not only impart knowledge but also generate the more esoteric attributes of wisdom, value inquiry and critical thinking engaged in community action. These are some of the very attributes which the UN has called for as teaching/learning objectives in its Decade of Education for Sustainable Development (UNESCO, 2005).

Perhaps somewhat inadvertently, the real world implementation of the foundational elements for this type of transformative education, one that is based in but expands on the ecology of education perspectives of Brandwein, Torre, Sterling and Pilon, have begun to emerge with the sustainability science initiatives at Harvard University (Clark, 2007) and their research with what are called knowledge systems for sustainable development (KSSD) and boundary organizations (Cash et al., 2003). Boundary organizations are collaborative communities created to bridge the divide between knowledge and local action by co-creating valid and effective KSSD. Research indicates that boundary organizations acting at the local-level are best suited for research, development and implementation of KSSD (Berkes, 2007; Cash et al., 2003). A real-world KSSD/boundary organization example is the Pacific ENSO Applications Center (PEAC) which has been a key boundary organization to Southern Africa and the Pacific region by acting as a "hub that connected NOAA climate scientists, the National Weather Service, university scientists, managers of water, emergency services, and agriculture and private

firms. PEAC effectively coordinated the production of an array of forecasting tools that linked global climate models to local hydrologic, coastal, and agricultural conditions” (Cash, et al., 2003, p. 8089).

The fundamental purpose of KSSD has been to link knowledge to action in support of sustainable development and sustainability (Cash et al., 2003). A boundary organization includes managers that interface and manage the interaction and relationship development between communities of experts and communities of decision makers (Jasanoff, 1987; Guston, 1999; Cash, 2001; Cash et al., 2003). One of the initial duties of the boundary managers is to first collaboratively develop the rules, procedures and norms of accountability by which the stakeholders in the boundary organization will abide (Cash et al., 2003).

The primary and perpetual challenge to boundary organizations is that effective and valid KSSD are context driven, evolve over time, and are beyond grand schemes or political panaceas (Anderies, Rodriguez, Janssen, & Cifdaloz, 2007; Meinzen-Dick, 2007; Ostrom, 2007). That is, solutions that work in one setting may not work in another, and may only work for a given time. ESD and sustainability must likewise remain open-ended and evolutionary in process.

Boundary organizations serve to demonstrate the credibility, salience and legitimacy of the knowledge through the generation of commitment and accountability *on both sides of the divide* (Cash et al., 2006; Cash et al., 2003). Going back to the PEAC example,

*PEAC created salient information through close engagement with local managers and decision makers. Regular meetings, workshops, and other communication not only educated water managers, farmers, emergency management officials and the fishing industry about ENSO, but allowed PEAC to learn what information managers need and to adjust questions and answers accordingly. This dialogue produced locally specific forecasts that mobilized expert knowledge about ENSO events in ways that helped local decision makers (e.g., how river flow will change or how rainfall patterns will deviate from the norm on one side versus another side of an island). By promoting communication that bridges the boundary between producers and users of forecasts, PEAC has increased the credibility and legitimacy of the information produced. PEAC's products gained credibility by using data from local resource managers whom local decision makers trust. PEAC's forecasts gained legitimacy by using a process that was transparent, inclusive, and served the interests of the major stakeholders* (Cash et al., 2003, p. 8088).

While the emphasis of the KSSD/boundary organization objectives appears to have been initially cast “to effectively harness S&T [science and technology] for sustainability” (Cash et al., 2003, p. 8086), thus suggesting a unidirectional focus and singular mandate for boundary organizations, we argue that there remains an even greater potential for them. They could serve a larger role and purpose toward achieving global sustainable development and sustainability by generating effective and valid *bilateral* communication, translation and mediation between communities of knowledge and communities of action. In other words, as further detailed in this paper, we see KSSD and boundary organizations as the foundation for an expanded ecology of education for global sustainable development and sustainability.

## **The ecology of education: optimum conditions for transformative learning**

Ecology has always been about the study of the relationships between living organisms and their environment. The scope of ecology in education has, however, expanded over the years from focusing primarily on the science of ecology to an increasing emphasis on teaching students environmental advocacy (Johnson & Mappin, 2005). The study of ecology has thereby effectively expanded to include the sociopolitical and philosophical dimensions of value inquiry relative to human-nature relationships. While the growing need for ecology *in* education, (especially pertaining to environmental advocacy) might be obvious, as we describe in this paper, there is an equally important need to implement an expanded ecology *of* education. Specifically, we argue that the best way to teach environmental advocacy through ecology *in* education is to combine it with a novel ecology *of* education.

We define the ecology of education as the environmental context, both physical and social, within which teaching and learning occurs. An ecology of education in the physical sense speaks to the place in which teaching/learning occurs. An ecology of education in the social sense refers to the character of the dynamics of interactions between teachers and learners, which in this view makes all participants teachers and all participants learners in a collaborative community.

Our focus in this paper is on developing the ecology of education as a learning system that addresses more the “how” of relationships for learning, rather than the content or the “what” of teaching sustainable development and sustainability. Thus, as described further, an ecology of education involves problem based learning within a collaborative community and social science research-based context. An ecology of education is understood in terms of process and process goals and the conditions to which to aspire to best learn the behaviors and attitudes necessary for global sustainable development and sustainability. Thus, it addresses KSSD directly by asking what the most valid and effective learning system conditions are for developing relationships toward a sustainable future. For example, it is widely recognized that behaviors and relationships that reduce exploitation of the environment and of other humans are prerequisites for a sustainable future (Kates & Parris, 2003).

Underlying this ecological approach is the assertion that human nature is amiss with life in schools because these are, often, artificial environments both physically and socially, which run counter to our human biological and social heritage. The vast majority of our biological and social evolution is essentially that of pre-agricultural, pre-industrial heritage when humans lived in small, interdependent, egalitarian bands and clans. Consequently, we do poorly in large formal bureaucratic hierarchies with features so common to schools and school systems such as one-way impersonal communication, information and decision-making denied the majority, and factory and machine-like behavior (cf. Morin, 1999).

An ecology of education provides the essential learning environment to cultivate the necessary wisdom and confidence within students to effectively manage the unprecedented level of information, data, and commercial/political propaganda they are so often exposed to through the media, internet, etc. Additionally, such an approach addresses the multidisciplinary complexity of the challenges related to sustainable development and sustainability in that it seeks to bring the multiplicity of stakeholder interests and expertise into the collaborative learning community setting.

Perhaps the most promising starting point for the research and development of an ecology of education as a transformative learning modality for sustainable development and sustainability is within the context of established KSSD/boundary organizations. Specifically, we suggest that the inclusion of expertise in cultural psychology, value inquiry and action learning/research within the boundary organization interface is an optimal starting-point for research.

KSSD/boundary organization research has, to date, been conducted in the field addressing some of the real-world complex challenges of sustainable development and sustainability (Cash et al., 2003). This, in our view, makes them ideal environments within which to conduct research in an ecology of education because this research would seek to build-upon and extend these established relationships. We argue too, that the implementation of S&T for sustainable development and sustainability, as has been the primary objective of KSSD/boundary organizations to date, would be more ethically grounded if a collaborative social support/inquiry network of social science researchers would be included. Moreover, if students (K-12/college/university) and non-expert community stakeholders were included in an ecology of education/boundary organization research process then there would likely be increased KSSD/boundary organization success in both the short and long-term. In the short-term there would be improved success because the increased inclusiveness improves the transparency of the process. In the long-term the transformative learning the young non-expert learners would experience would help to render future generations with behaviors and attitudes more equitable with global sustainable development and sustainability. In this view then, schools would become members of and participate in boundary organizations, not only on a local level but also along a collaborative global network.

### **Cultural psychology, value inquiry and action research in an ecology of education**

In this section we briefly discuss why cultural psychology, value inquiry and action research are important dimensions of an ecology of education learning approach in KSSD/boundary organizations.

An ecology of education is, to a large degree, described by the tenets of cultural psychology. The focus of cultural psychology is on the processes rather than the structure of cultures. Regarding sustainable development and sustainability, the social processes within and between cultures that help move those cultures away from domination processes and toward those of democratic partnerships have been deemed necessary for a sustainable global future (Kates & Parris, 2003). Cultural psychology considers that the individual is an active agent, rather than a passive recipient, in social and cultural processes. In cultural psychology, as in an ecology of education, the culture-individual relationship is conceived as dialectical and dialogic, not as one-way. Questions within cultural psychology (and an ecology of education) include, “How are ‘culturally important’ ideas and values (such as fairness or democracy) talked about, explained through narratives? How does the individual’s active interaction with such narratives frame their own explanations?” (Haste & Abrahams, 2008, p. 379). Cultural psychology also points to the educational goal of an ecology of education, namely, student development where “‘development’ comprises increasing sophistication in the use of such narratives and in the processes of dialogue and interaction” (p. 379).



Interfacing these views of cultural psychology with the tenets of the philosophy of value inquiry within an ecology of education approach, we argue, is the best foundation with which to engage participants within the collaborative setting of KSSD/boundary organizations. The philosophy of value inquiry, called the “future of philosophy” (Ginsberg, 2001, p. 1), like the philosophy of ethics, considers what is good in general and what is the highest good (Chang, 2001). This process helps “assist the world to appreciate the valuational [*sic*] existence of the human being” (Ginsberg, 2001, p. 4.) and helps replace the “anything goes” of relativism with the primacy of human rights described by pluralism and, by extension, the rights of all humans with respect to sustainability and the human-environment relationship. A consequential product of value inquiry within a collaborative learning approach is the development of critical thinking and moral development in which, “critical thinking can be regarded not only as a higher-order cognitive skill but also as a competence for critical participation in modern society” (Schuitema, Ten Dam, & Veugelers, 2008, p. 84). Similarly, the UN has identified these attributes as important goals for ESD (UNESCO, 2005).

The final dimension of an ecology of education approach is achieved when cultural psychology and value inquiry are combined with action/learning research methodology. The vision here is that smaller boundary organizations (employing action research methodology) are connected to a larger collaborative network in action research and learning. These multiscale action research modules, we argue, will, as previous action research has suggested (Reason & Bradbury, 2006), empower educators and learners to begin to work in highly dynamic, “fluid”, contexts as opposed to fixed and regimented pedagogical type settings. As mentioned previously, solutions to the challenges of sustainable development are themselves “fluid” in that they are context specific in both space and time (Anderies, Rodriguez, Janssen, & Cifdaloz, 2007; Meinzen-Dick, 2007; Ostrom, 2007), thus action learning provides the learning experience and skill-set compatible with ongoing open-ended problem solving conditions. An important feature of action research is that its methodology provides an opportunity for both direct educational (informational) as well as indirect meta-learning (transformational). For example, the collaborative feature and the participatory action dimension together help to reduce participant fear by developing hope and courage within the experience of the collaborative learning (Pyrch, 2007). Action learning includes self-research in the collaborative context that is directed at empowerment and emancipation, along both collective and individual dimensions (Boog, 2003). Most importantly, the action research component within ecology of education “gets the ideas moving” in that it generates collaborative action by learners within their communities, and along networks from the local to the global (Reason & Bradbury, 2006).

Thus far we have introduced the proposal that the KSSD that are generated by boundary organizations including social science experts, members of the non-expert local community and students (K-12, college/university), in networks that link local and international participants, is the next necessary evolution in an ecology of education that can form the basis of a more effective and valid ESD and sustainability. We have described ecology of education as being informed and guided by the tenets and research methodology of cultural psychology, value inquiry and action research.

In the remaining sections of this paper we provide a brief overview of some additional reflections on an ecology of education approach in an ESD and education for sustainability.

### *The ecology of education and the human need of place*

While this paper has emphasized group process and experience through action as the learning context, an ecology of education also seeks to explore the physical context of learning. That is, it involves learners in the collaborative development of the physical learning environment in an effort to make it a place free of commercialization and depictions of consumption and materialism, thus moving toward a place of learning that is physically more congruent with sustainable development and sustainability and thereby a closer reflection of the natural (cf. Alparone & Rissotto, 2001; Hacking, Barratt, & Scott, 2007; Spencer & Woolley, 2000).

### *The ecology of education and the human need for self-determination and terror management*

What is our core motivation for doing the things we do? Why do we exploit the environment and other humans? According to "Terror Management Theory" (TMT) the underlying goal of all of our motivations is self-preservation, a product of our ancestral past based in survival (Pyszczynski, Greenberg, & Solomon, 1997). All our behavior is motivated, according to the TMT, by our fear of death. In sharp contrast, "Self-Determination Theory" (SDT), proposes that other types of human motivations exist (Deci & Ryan, 2000). It suggests that the underlying goal of some human motivation is the growth-oriented needs for autonomy, competence, and relatedness. As Muraven and Baumeister (1997) suggest, not all behavior can be subsumed under a terror theory. Nor can it likely be completely explained by self determination. There is, for example, the evidence regarding altruistic human behavior, which does not appear to be motivated by self-interest neither by management of terror or self-determination (Warneken & Tomasello, 2006). Nonetheless, our fears and low-self esteem can encourage our materialism and our excessive consumer behavior (Mandel & Smeesters, 2008; Rindfleisch & Burroughs, 2004; Rindfleisch, Burroughs, & Wong, 2008). The vision of an ecology of education seeks to generate transformative learning away from overconsumption and materialism by developing behaviors and attitudes rooted in higher self-esteem, hope and courage.

### *The ecology of education and self-organizing dynamic systems*

An ecology of education seeks to interface the various knowledge of participants and the perspectives from a variety of cultures in collaborative settings that are exploratory, reflective and democratic.

Metaphors from complex dynamic systems science can play an important role in the ecology of education. For instance, the concepts of interdependence of system networks and self-organization offer powerful instructional guidelines by providing a model for group dynamics and learner participation (Torre & Voyce, 2007). Metaphors from dynamic systems have proven to be very instructional in that they can provide a new worldview for learners based in the reality of the integrated dynamics of natural systems of which learners can view themselves an integral part (Sterling, 2003).



### *Social integration, health and well being*

Humans value a sense of belonging to a group and, at the same time, a sense of independence (Brewer & Chen, 2007). An objective with the ecology of education approach is to develop both of these in learners at the same time. Paradoxically, research indicates that strong social ties can help motivate an individual to develop behaviors that help generate autonomy, and that this sense of autonomy is highly beneficial for sustainable development of that individual and of the group(s) to which that individual feels belonging. In other words, social groups such as those of a school class involved in a collaborative boundary organization sustainable development project can be utilized to develop motivations toward individual autonomy in learners and these motivations toward autonomy can loop back to support and benefit the overall objectives of the group. As per Ryan, Huta, and Deci (2008, p. 139), these autonomous motivations are:

- (1) Pursuing intrinsic goals and values for their own sake, including personal growth, relationships, community, and health rather than extrinsic goals and values, such as wealth, fame, image, and power.
- (2) Behaving in autonomous, volitional, or consensual ways, rather than heteronymous or controlled ways.
- (3) Being mindful and acting with a sense of awareness.
- (4) Behaving in ways that satisfy basic psychological needs for competence, relatedness, and autonomy.

While helping to generate autonomy in students may seem counter-productive to working together toward global sustainability, research indicates that individuals with the above listed motivations toward personal growth score higher on tests for subjective well being and also rate higher on tests for ecological responsible behavior (Brown & Kasser, 2005). A sense of subjective well being reduces materialism and consumption behaviors (Rindfleisch, Burroughs, & Wong, 2008). Thus, teachers of sustainability need to know that individual goals of autonomy support collective group goals. Furthermore, there is a clear positive correlation between our social ties, social networks and social integration with our physical and psychological health (Berkman, Glass, Brissette, & Seeman, 2000). We conclude that the list of four motivations above specifically and student/group integration in general represent teaching goals that must be utilized as part of the framework for an ecology of education.

### **Why teachers need to know, and how they can implement and assess the ecology of education**

We have attempted to describe some of the factors that we see as critical to the development of ecology of education. While parameters such as participation and pluralism may be understood on an intellectual level, there may be some remaining discomfort amongst teachers about effective and valid assessment and perhaps, even, questions about the academic relevance of an ecology of education approach for students who could perhaps better use their time learning biology, physics, language and mathematics.

Just as the challenges of sustainable development and sustainability are multi-dimensional, the solutions required to solve them ask for a multi-disciplinary approach involving human-human and human-environment relationships concurrently (Clark,

2007; Kates & Parris, 2003). Thus, the ecology of education in ESD and sustainability puts knowledge and research in biology, physics, language and mathematics into practice within a collaborative social context. This sets-up a reciprocally beneficial relationship loop between knowledge (gained through informational learning) and wisdom (gained through experiential and transformational learning).

Given the advantages of ecology of education as described in this paper, how can teachers begin to implement such a learning system in the classroom? While there are a growing number of internet-based national and international organizations (both governmental and non-governmental), that are converging on the development and implementation of curricula for sustainable development and sustainability, we feel the most effective approach to implementation is at the community level. That is, the administration of the school and the school board (either self-directed or as directed by the community) must take the initiative at the local level and participate in a multi-stakeholder boundary organization project at the local level. Once established, the project can connect to boundary organizations in parallel community projects for sustainable development likely most easily through an internet based collaborative forum.

Lastly, how can teachers effectively and validly assess a student's success with learning about sustainable development and sustainability? Conversely, how are a teacher's efficacy and validity assessed? While an ecology of education is exploratory and open-ended and the exact conceptual definition of sustainable development and sustainability will remain uncertain, the demands of the challenges of sustainability and the integrity of the learning process itself calls for some form of testing. Some form of evaluation of both teachers and students is necessary to determine whether progress toward sustainable development and sustainability is being made. As we have described in this paper, ecology of education in general takes the form of an action research project that attempts to solve a community based problem regarding sustainable development. Thus, if the problem is to some degree solved, that can of course be assessed; but what about the process of change in the students and teachers learning? Certainly teachers can be trained and tested in the tenets of cultural psychology, value inquiry and action research. Students can be tested on the biology and physics related to a sustainable development challenge. However, in general terms, an ecology of education seeks to generate transformative learning, developing behaviors and attitudes rooted in higher self-esteem, hope and courage and improved relationships with others and with nature. What about these more metaphysical, yet equally important changes? To this end, we are researching and developing an inventory in the form of a psychometric instrument with cross-cultural applicability that can be utilized to best establish a baseline and measure progress toward individual characteristics consistent with sustainable development and sustainability (Wensing & Torre, 2009). Called the global sustainability inventory (GSI) it is a collage of research proven psychometrics that collectively measure human-nature and human-human relationships. The GSI is comprised of psychometrics such as the nature relatedness scale (Nisbet, Zelenski, & Murphy, 2008), the HEXACO personality scale (Ashton & Lee, 2007) as well as the subjective well being/ecological responsibility/mindfulness scales (Brown & Kasser, 2005; Brown & Ryan, 2003) amongst others (Wensing & Torre, 2009). The GSI is unique in that it seeks to capture and measure the multidimensionality of behaviors and attitudes as described in human-human and human-nature relationships that are equitable with sustainable development and sustainability. It is in that sense a global measure for global sustainability.

## Conclusion

The evolution of the conceptual basis for an ecology of education described in this paper can be followed through the years in other literature (cf. Bennett & Bennett, 2004; Sterling, 2003; Torre, 2003, 2005, 2006, 2007, 2008; Vanderven, Torre, & Maholmes, 2002) and is culminating in a forthcoming text presentation (Torre, 2009). In this paper, we have attempted to consolidate some of the key elements that describe what we see as the necessary evolution of the ecology of education approach to improving KSSD.

Lastly, just as KSSD at best provide solutions in evolution, so too the development of ecology of education is open-ended. As human conditions here on earth change, the values that guide us will likely change as well. We believe that an ecology of education at all levels of learning can help lead us through that change into a positive, peaceful and sustainable future.

## References:

- Alparone, F. R., & Rissotto, A. (2001). Children's citizenship and participation models: Participation in planning urban spaces and children's councils. *Journal of Community & Applied Social Psychology*, 11, 421-434.
- Anderies, J. M., Rodriguez, A. A., Janssen, M. A., & Cifdaloz, O. (2007). Panaceas, uncertainty, and the robust control framework in sustainability science. *Proceedings of the National Academy of Sciences of the United States of America*, 104, 15194-15199.
- Ashton, M. C., & Lee, K. (2007). Empirical, theoretical, and practical advantages of the HEXACO Model of personality structure. *Personality and Social Psychology Review*, 11, 150-166.
- Auld, G., Bernstein, S., & Cashore, B. (2008). The new corporate social responsibility. *Annual Review of Environmental Resources*, 33, 413-435.
- Barraza, L., Duque-Aristizabal, A. M., & Rebolledo, G. (2003). Environmental education: From policy to practice. *Environmental Education Research*, 9(3), 347-357.
- Bennett, S. K., & Bennett, D. B. (2004). Paul F.- Brandwein 2004 lecture: Regarding the ecology of science: connections to environmental and distance education. *Journal of Science Education and Technology*, 13, 137-146.
- Berkman, L. F., Glass, T., Brisette I., & Seeman, T. E. (2000). From social integration to health: Durkheim in the new millennium. *Social Science & Medicine*, 51, 843-857.
- Berkes, F. (2007). Community-based conservation in a globalized world. *Proceedings of the National Academy of Sciences of the United States of America*, 104, 15188-15193.
- Bonnett, M. (2007). Environmental education and the issue of nature. *Journal of Curriculum Studies*, 39, 707-721.
- Boog, B. W. M. (2003). The emancipatory character of action research, its history and the present state of the art. *Journal of Community & Applied Social Psychology*, 13, 426-438.
- Brewer, M. B., & Chen, Y.-R. (2007). Where (who) are collectives in collectivism? Toward conceptual clarification of individualism and collectivism. *Psychological Review*, 114, 133-151.

- Brown, B. J., Hanson, M. E., Liverman, D. M., & Merideth Jr., R. W. (1987). Global sustainability: Toward definition. *Environmental Management*, 6, 713-719.
- Brown, K. W., & Kasser, T. (2005). Are psychological and ecological well-being compatible? The role of values, mindfulness and lifestyle. *Social Indicators Research*, 74, 349-368.
- Brown, K. W., & Ryan, R. M. (2003). The benefits of being present: Mindfulness and its role in psychological well being. *Journal of Personality and Social Psychology*, 84, 822-848.
- Cash, D. W. (2001). "In order to aid in diffusing useful and practical information": Agricultural extension and boundary organizations. *Science, Technology, & Human Values*, 26, 431-453.
- Cash, D. W., Adger, W. N., Berkes, F., Garden, P., Lebel, L., Olsson, P., et al. (2006). Scale and cross-scale dynamics: Governance and information in a multilevel world. *Ecology and Society*, 11(8). Retrieved October 16, 2008, from <http://www.ecologyandsociety.org/vol11/iss2/art8/>
- Cash, D. W., Clark, W. C., Alcock, F., Dickson, N. M., Eckley, N., Gustson, D. H., et al. (2003). Knowledge systems for sustainable development. *Proceedings of the National Academy of Sciences of the United States of America*, 100, 8086-8091.
- Chang, J. (2001). Axiology and ethics: Past, present and future. In M. Hayry & T. Takala (Eds.), *The future of value inquiry* (pp. 67-75). New York: Rodopi.
- Clark, W. C. (2007). Sustainability Science: A room of its own. *Proceedings of the National Academy of Sciences of the United States of America*, 104, 1737-1738.
- Deci, R. M., & Ryan, R. M. (2000). The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry*, 11, 227-268.
- Federico, C. M., Cloud, J. P., Byrne, J., & Wheeler, K. (2003). Kindergarten through twelfth-grade education for sustainability. *Environmental Law Review*, 33, 10117-10131.
- Ginsberg, D. (2001). Value inquiry as the future of psychology. In M. Hayry & T. Takala (Eds.), *The future of value inquiry* (pp. 1-7). New York: Rodopi.
- Guston, D. H. (1999). Stabilizing the boundary between US politics and science: The role of the Office of Technology Transfer as a boundary organization. *Social Studies of Science*, 29, 87-112.
- Hacking, E., Barratt, R., & Scott, W. (2007). Engaging children: Research issues around participation and environmental learning. *Environmental Education Research*, 13, 529-544.
- Haste, H., & Abrahams, S. (2008). Morality, culture and the dialogic self: Taking cultural pluralism seriously. *Journal of Moral Education*, 37, 377-394.
- Hegarty, K. (2008). Shaping the self to sustain the other: Mapping impacts of academic identity in education for sustainability. *Environmental Education Research*, 14, 681-692.
- Hicks, D., & Bord, A. (2001). Learning about global issues: Why most educators only make things worse. *Environmental Education Research*, 7, 413-425.
- Jahnke, M., & Nutzinger, H. G. (2003). Sustainability – a theoretical idea or a practical recipe. *Poiesis Prax*, 1, 275-294.
- Jasanoff, S. S. (1987). Contested boundaries in policy-relevant science. *Social Studies of Science*, 17, 195-230.
- Jickling, B. (2000). A future for sustainability? *Water, Air and Soil Pollution*, 123, 467-476.

- Johnson, E. A., & Mappin, M. J. (2005). *Environmental education and advocacy: Changing perspectives of ecology and education*. Cambridge, UK: Cambridge Press.
- Kates, R. W., & Parris, T. M. (2003). Long-term trends and a sustainability transition. *Proceedings of the National Academy of Sciences of the United States of America*, 100, 8062-8067.
- Mandel, N., & Smeesters, D. (2008). The sweet escape: Effects of mortality salience on consumption for high- and low- self-esteem consumers. *Journal of Consumer Research*, 35, 309-323.
- Meinzen-Dick, R. (2007). Beyond panaceas in water institutions. *Proceedings of the National Academy of Sciences of the United States of America*, 104, 15200-15205.
- Morin, E. (1999). *Seven complex lessons in education for the future*. Paris: UNESCO.
- Muraven, M., & Baumeister, R. (1997) Suicide, terror, paralysis, and other pitfalls of reduction self-preservation theory. *Psychological Inquiry*, 8, 36-40.
- Nisbet, E. K. L., Zelenski, J. M., & Murphy, S. A. (2008). The Nature Relatedness Scale: Linking individuals' connection with nature to environmental concern and behaviour. *Environment and Behavior*. Prepublished August 1, 2008, DOI: 10.1177/0013916508318748.
- Ono, R. (2005). Societal factors impacting on images of the future of youth in Japan. *Journal of Future Studies*, 9, 61-74.
- Ostrom, E. (2007). A diagnostic approach for going beyond panaceas. *Proceedings of the National Academy of Sciences of the United States of America*, 104, 15181-15187.
- Pilon, A. F. (2009). The bubbles or the boiling pot? An ecosystemic approach to culture, environment and quality of life. *Environmental Geology*, 57, 337-345.
- Pyrch, T. (2007). Participatory action research and the culture of fear: Resistance, community, hope and courage. *Action Research*, 5, 199-216.
- Pyszczynski, T., Greenberg, J., & Solomon, S. (1997). Why do we need what we need? A terror management perspective on the roots of social motivation. *Psychological Inquiry*, 8, 1-20.
- Reason, P., & Bradbury, H. (2006). *Handbook of action research*. London: Sage.
- Rindfleisch, A., & Burroughs, J. E. (2004). Terrifying thoughts, terrible materialism? Contemplations on a terror management account of materialism and consumer behavior. *Journal of Consumer Psychology*, 14, 219-224.
- Rindfleisch, A., Burroughs, J. E., & Wong, N. (2008). The safety of objects: Materialism, existential insecurity, and brand connection. *Journal of Consumer Research*, 36, 1-16. DOI: 10.1086/595718.
- Ryan, R. M., Huta, V., & Deci, E. L. (2008). Living well: A self-determination theory perspective on eudaimonia. *Journal of Happiness Studies*, 9, 139-170.
- Schuitema, J., Ten Dam, G., & Veugelers, W. (2008). Teaching strategies for moral education: A review. *Journal of Curriculum Studies*, 40, 69-89.
- Spencer, C., & Woolley, H. (2000). Children and the city: A summary of recent environmental psychology research. *Child: Care, Health and Development*, 26, 181-198.
- Sterling, S. (2003). *Whole systems thinking as the basis of paradigm change in education: Explorations in the context of sustainability*. Unpublished doctoral dissertation, University of Bath, UK.



- Torre, C. A. (1995a). Chaos in the triadic theory of psychological competence in the academic setting. In A. Gilgen & F. Abraham (Eds.), *Chaos Theory in psychology* (pp. 279-294). Westport, CT: Praeger: Greenwood Publishing Group.
- Torre, C. A. (1995b). Chaos, creativity, and innovation: Toward a dynamical model of problem solving. In R. Robertson & A. Combs (Eds.), *Chaos Theory in psychology and the life sciences* (pp. 179-198). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.
- Torre, C. A. (1996). *Creativity: A Dynamical Triadic Model*. Paper presented at the International Meeting of the International Society for Systems Science, Budapest, Hungary.
- Torre, C. A. (2003). *Chaos in the Triadic Theory of Psychological Competence in the academic setting*. Presented at 10<sup>th</sup> Annual Winter Chaos Meeting Branford, CT., USA.
- Torre, C. A. (2005a). Chaos i tvorchestvo: k dinamicheskoy modeli resheniya zadach [Chaos and creativity: On the dynamic model of problem solving]. In I. N. Trofimova (Ed.), *Synergetics and Psychology, Texts, Cognitive Processes*, 3 (pp. 196-224). Moscow: CogitoPress.
- Torre, C. A. (2005b, February). *An ecology of education*. Paper presented at the 12<sup>th</sup> Annual Winter Chaos Conference, Springfield College, MA, USA.
- Torre, C. A. (2005c, March). *Fisiología, Cognición, y las Emociones* [Physiology, cognition, and emotions]. Paper presented at the International Conference on Thinking and Education, University of Puerto Rico & The College Board's, Guadalajara, Mexico.
- Torre, C. A. (2005d, March). *La Ecología de la Educación* [The ecology of education]. Paper presented at the International Conference on Thinking and Education. University of Puerto Rico & The College Board's Guadalajara, Mexico.
- Torre, C. A. (2005e, July). *Physiology, cognition, and emotions*. Paper presented at the International Association for Cognition and Educational Psychology's International Conference. Durham University, England.
- Torre, C. A. (2006, February). *The ecology of education and our biological heritage: How dynamics can get us back to the future*. Paper presented at the 13<sup>th</sup> Annual Winter Chaos Conference, University of Pittsburgh, PA, USA.
- Torre, C. A. (2007, February). *The ecology of education*. Paper presented at the 14<sup>th</sup> Annual Winter Chaos Conference, San Juan, Puerto Rico.
- Torre, C. A. (2008, March). *The ecology of education: Toward an organic paradigm*. Paper presented at the 3rd International Nonlinear Science Conference: Tokyo, Japan.
- Torre, C. A. (2009). *The ecology of education*. Book manuscript in preparation.
- Torre, C. A., & Joyce, C. (2007). Shared accountability: An organic approach. In B. Després (Ed.), *Systems thinkers in action: A field guide for effective change leadership in education. Leading School Improvement*, #10 (pp. 151-177). Blue Ridge Summit, PA: Rowman & Littlefield Education.
- UN. (1987). World Commission on Environment and Development. *Our Common Future* [The Brundtland Report]. Oxford: Oxford University Press.
- UNESCO. (2005). *Education for Sustainable Development United Nations Decade (2005-2014)*. Retrieved June 12, 2007, from [http://portal.unesco.org/education/en/ev.php-URL\\_ID=23279&URL\\_DO=DO\\_TOPIC&URL\\_SECTION=201.html](http://portal.unesco.org/education/en/ev.php-URL_ID=23279&URL_DO=DO_TOPIC&URL_SECTION=201.html)



- VanderVen, K., & Torre, C. A. (1999). A dynamical systems perspective on mediating violence in schools: Emergent roles of child and youth-care workers. *Child and Youth-Care Forum*, 28, 411-436.
- VanderVen, K., Torre, C. A., & Maholmes, V. (2002). *The full service school: Applying Non-Linear Dynamical Systems Theory to school reform issues*. Presented at the 9<sup>th</sup> Annual Chaos Conference, Brattleboro, VT. USA.
- Wals, A., & Jickling, B. (2001). From doublethink and newpeak to critical thinking and meaningful learning. *International Journal of Sustainability in Higher Education*, 3, 221-232.
- Warneken, F., & Tomasello, M. (2006). Altruistic helping in infant humans and young chimpanzees. *Science*, 301, 1301-1303.
- Wensing, E. J., & Torre, C. A. (2009). *The Global Sustainability Inventory as a cross-cultural measure for human characteristics deemed equitable with a sustainable future*. Manuscript in preparation.
- WWF. (2006). *Living planet report (2006)*. Retrieved November 12, 2006, from <http://www.panda.org/index.cfm?uNewsID=83520>

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