Relations between Science Education and Environmental (Science) Education

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Introduction

Yvonne Meichtry, Northern Kentucky University

This symposium is an outcome of a NARST 2000 meeting held for interested participants to discuss their interests in environmental education, relevant support networks, and potential roles for NARST. Participants of NARST who attended the meeting concluded that it was necessary to pursue the
establishment of an environmental science education special interest group within NARST. An Ad Hoc Committee on Environmental Science Education (ESE) has subsequently been established. Other efforts made to promote and support the work of environmental (science) educators include the organization of conference sessions which focus on ESE, the development of ties to other groups within NARST with relevant interests, and the creation of a listserv to share information and dialogue.

The challenges faced by science educators and environmental educators in respect to the distinctions and interrelationships between the two fields have been many. The teaching of environmental education has traditionally occurred in science classrooms. Yet, scholarly work in the field of environmental education has often created a paradox for science educators. Separate professional organizations which exist for the two fields, relating the two knowledge bases, and receiving support from the science education academic community for work accomplished in the field of environmental education are challenges that have been faced. The challenges evident for environmental educators have been the changing definition of EE throughout history and the variety of definitions that exist in current day thinking, the multidisciplinary nature of EE which has caused a fragmentation and inconsistent approach to this field, and the marginalization of EE in school curriculum.

The intent of this symposium is to inform, to raise questions, and to begin a dialogue to help clarify the distinct, yet interrelated epistemologies of science education and environmental education (EE). The first paper, written by Bill Carlsen, examines the use of the local environment as a tool to connect the familiar and the new through inquiry-based teaching. He poses a particular model of inquiry, derived from a sociological context, to engage students in authentic science practices.

Paul Hart provides a critical examination of the problems evident with integrating the dimensions prevalent in EE in science education (SE). He identifies these dimensions as social, political, economic, personal, cultural, ethical, and moral and discusses the reconceptualization of science education that will be necessary to accomplish their integration in SE.

The third paper, by Ali Sammel, explores the compatibility of different paradigms of EE with the reform-based science curriculum. Sammel discusses Ontario’s new science curriculum and EE and draws conclusions about the adequacy of the new science curriculum in meeting EE’s goal of bringing about significant, fundamental individual and social change.

David Zandvliet describes a holistic view of EE that he defines as applicable to all subject areas and grade levels. He discusses the overall goal of EE, the role of science in accomplishing this goal, the importance of using the natural environment as a context for investigating real world problems, and the socio-developmental skills and cognitive attributes that can and should be obtained through learning experiences held in natural settings.

The fifth paper, by Justin Dillon, presents a critical commentary about ideas presented in a special edition of an international science education journal, of which he served as editor. This special edition examined the relations between EE and SE, the role of science teaching in the teaching of EE, and the relationship of current models of SE with teaching and learning of EE in practical contexts.
The Sociological Context of Environmental Science and its Use in Rethinking Scientific Inquiry

William Carlsen, The Pennsylvania State University

A perennial and understandable concern of environmental education is defining itself in relation to science education. Environmental educators argue that their responsibilities transcend the traditional focus of science education, with its emphasis on schools and schooling and its reluctance to look beyond the laboratory to concerns that are ethical, economic, emotional, political…. in a word, social. Environmental educators do not want their efforts co-opted by mainstream science education and bristle at the suggestion that their work would be "improved" by closer attention to rational, objective scientific research and a general purging of discussions about advocacy, power, and values. The epistemological stance of science–that it is objective, rule-governed, predictable, definitive–is inconsistent with what many environmental educators find most compelling about their work and how children understand the environment.

It is easy to understand why environmental education might adopt a siege mentality with respect to science and its educational proponents. EE has been slammed for distorting the nature of science, for picking and choosing the scientific facts it uses, and for getting those facts wrong (Independent Commission on Environmental Education, 1997; Sanera & Shaw, 1999). Although there is an argument to be made for striving to improve the science in environmental education, my concern in this paper is very different. I would like to argue that there is much that science educators can learn from environmental education about science, the nature of science, and scientific inquiry.

Of course, environmental education comes in many flavors, and my focus here will be on approaches that are explicitly science-oriented. I will draw most heavily on experiences with our NSF-funded project, Environmental Inquiry: Learning Science as Science is Practiced. The model of inquiry used in that project is based on a conception of “authentic” scientific practice derived from contemporary sociology of science (Collins, 1985; Cunningham, 1998; Cunningham & Helms, 1998; Kelly, Carlsen, & Cunningham, 1993; Latour & Woolgar, 1986; Longino, 1990). Additional examples and insights are taken from work by Greenall Gough (1992, April; Greenall Gough & Robottom, 1993), and Helms (1998).

Inquiry and Epistemology

The role of prior knowledge in science learning. The environmental sciences provide rich terrain for student engagement in scientific inquiry. Although a key postulate of conceptual change teaching is to begin with students’ prior understandings (Kelly, 1997; Posner, Strike, Hewson, & Gertzog, 1982), nominally inquiry-oriented science teaching often focuses on subject matter that is conceptually alien to students. Without even inchoate conceptual frameworks about cellular or molecular processes, for example, biology students’ “original” investigations are too infrequently productive or fruitful from a conceptual change perspective.
Investigations of local environments bridge the familiar with the novel. Even if the specific phenomena being investigated are unfamiliar—say, the “health” of a stream adjacent to a campus—students have knowledge about the local context that they can draw upon: knowledge about nearby businesses and industry, climate patterns, whether mosquitoes are a problem in the spring, whether the stream dries up in the summer. Knowledge about these phenomena is a resource that can be used in learning relevant scientific concepts, such as species diversity and its relationship to habitat; more importantly, by focusing on a local problem and by considering its formulation in a social context, students’ prior understandings (some of which are narrowly scientific, many of which are not) are acknowledged and legitimated as conceptual resources. Teaching with such an orientation involves more than a willingness to probe students’ beliefs about conventional curricular concepts—electrical circuits, photosynthesis, cells, the gas laws—it involves organizing the curriculum around subjects that matter to society. The benefits of doing so include cognitive opportunities for students to use prior knowledge in learning new scientific content.

Methodological invention in school science. The role of “discovery” in science, although still popular in media accounts, is not central to contemporary philosophical accounts of science (Kuhn, 1970), sociological accounts of science (Brannigan, 1981; Woolgar, 1976), or conceptual change accounts of science learning (Posner et al., 1982; Strike & Posner, 1992). Epistemologically, science is probably more appropriately viewed as a process of evidence-based argumentation and persuasion rather than discovery (Kuhn, 1993). Nevertheless, the model of scientific inquiry experienced by students in school science all too often resembles what Chalmers (1982) and Millar (1989) call naïve inductivism: observations precede theory and theory precedes experimentation. For example, in one common school science investigation, students design experiments to “discover” that plants grow toward light. Usually they also learn that the teacher knew this beforehand and had an explanation that didn’t require the experiment at all.¹

An alternative approach is to assume that science novices (be they children beginning their studies or experienced scientists working in a new problem area) generally begin with well-established protocols for conducting their initial work in a particular domain. These protocols are the products of existing scientific communities, and mastering them is a prerequisite for having one’s claims taken seriously (Collins, 1985). In our own work, examples of protocols for secondary environmental science investigations include lettuce seed bioassays for assessing the toxicity of chemicals in the environment (Trautmann, Carlsen, Cunningham, & Krasny, in press) and methods for assessing the integrity of riparian habitats using remote sensing (Carlsen, Trautmann, Cunningham, & Krasny, in preparation). These protocols are methodologically invariant, but the results of their application to local environmental phenomena are intentionally unknown to students and their teachers beforehand. In that respect, they are similar to many other protocols used by environmental science educators around the world, such as FeederWatch, GREEN, Globe, and others (see, e.g., TERC, 1997).

¹ I don’t mean to suggest that students shouldn’t do activities like this, just that we should be hesitant about characterizing them as experiments and their results as discoveries. If the purpose is to demonstrate a well-known phenomenon, why not simply call the activity a demonstration?
From a sociological perspective, environmental research protocols are useful because they provide science classrooms with novel data without the fiction that scientists invent experimental methods out of thin air. The students’ job is not to demonstrate that they have “discovered” already-established knowledge, certified by the teacher and the textbook; it is to construct a persuasive argument about what original data mean to them, and should mean to others. If they are successful, they will achieve, within their community, recognition that they are proficient and that their scientific work can be trusted. However, this is accomplished through persuasion, not by comparing their results to a right answer. In this respect, the often-ambiguous results of children’s environmental studies are much more authentic representations of scientific work than the 10,000th replication of Boyle’s law.

What is a persuasive argument? The use of protocols is only a first step in a view of science-as-argument: the collection of data on novel problems using established methods. If the results of environmental research are not known to teachers a priori, how can the results of student research be evaluated?

From a straightforward epistemological perspective, one standard might be to evaluate arguments with respect to their rationality: that is, are conclusions based in some philosophically coherent and explicit fashion on appeals to data, using discipline-specific rules? In science education, Russell (1983) has proposed a methodology for undertaking such evaluations, using prior work by Toulmin (1958) and Peters (1966; 1967). Recent sociolinguistic studies by Kelly and others (Carlsen, 1997; Kelly, Druker, & Chen, 1998) have demonstrated that this standard can be applied in science education research. However, the analysis of the rationality of claims using sociolinguistic methods requires careful study of the verbatim transcripts of videotaped lessons—hardly a practical tool for use in the give-and-take of ordinary classroom life. Furthermore, there is little reason to believe that students and teachers in science classrooms rely on formal philosophical analysis to evaluate truth claims.

Accounts from sociology of science suggest that the process of fact-making in science—traditionally an epistemological concern—is a considerably more nuanced and socially situated process than philosophical accounts might suggest. Scientists “make” facts in part by removing the contingencies from their claims and by making challenges prohibitively expensive for their competitors (Latour & Woolgar, 1986). If it suits their purposes, they are not above using their positions (Schaffer, 1989) or the media (Gieryn & Figert, 1990) to bolster their claims.

The gold standard in science for the evaluation of scientific arguments is peer review, a practice that has been almost unused in science education. We have found that peer review among secondary students can be reliable and useful (Carlsen, Cunningham, & Trautmann, 2000, April), as part of environmental science research projects and technology design challenges. Peer review can be undertaken within an individual classroom (perhaps beginning with one-on-one face-to-face “pair review”), at an invitational research congress, or online using a computer-administered system that is anonymous in both

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2 We are presenting two other papers at NARST 2001 that provide more recent data on the use of peer review in environmental science education.
directions. In the absence of known “right answers”–a common issue in environmental research by students–peer review offers a pragmatic and sociologically authentic strategy for the evaluation of data-based arguments.

**Values and Science**

“Value-laden” versus “scientific?” Environmental education has been criticized for being overly issue-driven instead of information-driven; political instead of scientific; preachy; even anti-human in its portrayal of people as intruders on the earth–in short, laden with questionable values but dressed in the clothing of science. Despite these criticisms, EE practitioners have steadfastly maintained a commitment to teach environmental science only within a larger framework that emphasizes human values, decision-making, and action: themes originally identified in international conferences in Belgrade and Tbilisi (UNESCO, 1978). Values and commitments–and their use in analyzing issues and taking action–are central to conceptions of environmental literacy (Hungerford, Litherland, Peyton, Ramsey, & Volk, 1996).

In their guidelines concerning “depth” in environmental education materials, the NAAEE has reiterated its view that achieving greater conceptual understanding does not merit purging environmental education of value considerations: EE materials should foster awareness of the natural and built environment; an understanding of environmental concepts, conditions, and issues; and an awareness of the feelings, values, attitudes, and perceptions at the heart of environmental issues. (North American Association for Environmental Education, 1996)

In this respect, environmental education sets a good example for science education. As a field, we often seem uncomfortable with the extent that societal values infiltrate scientific work. Although we acknowledge the importance of constitutive values in science (such as the desirability of reporting data truthfully), science education has relatively little to say about the ways in which contextual values from the larger society shape research programs and scientific work. Defining demarcation criteria between science and non-science remains an important part of the science curriculum, and the relationship of science to external values (e.g., attitudes about gender, race, religion) is left largely at the level of “science helps society.”

This is too bad, for a couple of reasons. First, science constantly defines and redefines its own boundaries within society, reshaping itself as needed to protect its interests (Gieryn, 1999). The notion that it achieves objectivity through methods that are isolated from social norms and interests is simply not true, and the perpetuation of that myth through the science curriculum probably only undermines public confidence in science.

A second and more important reason to put values on the table in science education is that the strategy offers the prospect of better science. Helen Longino has proposed what she calls a contextual
empiricist model of inquiry, in which the values influencing claims are not obscured. Instead, they are made explicit considerations in weighing competing claims:

That theory which is the product of the most inclusive scientific community is better, other things being equal, that that which is the product of the most exclusive. It is better, not as measured against some independently accessible reality but better as measured against the cognitive needs of a genuinely democratic community. This suggests that the problem of developing a new science is the problem of creating a new social and political reality. (Longino, 1990, p. 214)

In environmental education, this reality can involve viewing scientific knowledge as historically, culturally, politically, and economically situated: what Kemmis, Cole, and Suggett (1983) and Greenall Gough and Robottom (1993) call a “socially critical orientation” to the curriculum.

Communities of Practice

Finally, we should note the development in recent years of educational theories that define learning as a process of shared participation in a community of practice (Wenger, 1998), rather than an individualistic process of discovery and truth-establishing. Seen through lenses like Lave and Wenger’s “legitimate peripheral participation,” the work of children, teachers, and other adults in collaborative stream studies, wetlands restoration, and biological control projects represents much more than an “application” of scientific knowledge to the solution of real-world problems. Such projects can be authentic communities of scientific practice that produce educational outcomes unattainable in more conventional educational settings. Studies of local environmental problems give students a sense of “purposeful doing” (Helms, 1998), of participating, of science in a social context.

How Policy Research in Environmental Education has Informed Curriculum Development in Science Education in Canada

Paul Hart, University of Regina

Introduction

The purpose of any curriculum used by schools is the achievement of certain desired end states and virtues by their students. These end states and virtues derive from societal values. While this seems reasonable, we are increasingly reminded that social values change and that preferred views of the world in democratic and pluralistic societies are various and heterogeneous. Thus, we are beginning to recognize a broadened range of value premises from which educational decisions can be made.

There is mounting evidence that the curricular ideologies which have dominated science education for decades are undergoing significant challenges. Atkin (1998) for example describes alternative programs from an OECD study of innovation in science, mathematics and technology education (SMTE) which he says reflect major changes that are under way internationally in curricula for these subjects. Olson, James,

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3 See, for example, “EE Criticisms and Responses—Point/Counterpoint” in The Environmental Education Advocate (1996, Fall) or online at http://www.uwsp.edu/cnr/neiap/ neeapservices/newsletters/
and Lang (1999), who also assessed these projects, suggest that the curriculum framework must be broadened beyond STME to include social dimensions (such as environmental concerns) and the interests of students (James, 1997). Many of these projects were informed by new conceptions of learning, notions of comprehensive or systemic reform, new views of the organization of science beyond traditional disciplines, a new focus on personal and social issues in the classroom, and new views of the role of teachers (Black and Atkin, 1996).

Reasons for science curriculum change include problems with the perception of science among young people, problems with international test scores broadly interpreted as a problem of standards, distress about social and community-based issues such as adolescent health and environmental deterioration, and a desire to make science and mathematics more authentic, that is, more genuine and pertinent for students and more like “real” science, as practiced by scientists (see Solomon, 1999). Change is advocated even in countries like Japan and Germany, admired from afar, but undergoing profound changes, radical in their departure from past practice (Atkin, 1998). So deep-seated is the malaise afflicting education in the physical sciences, says Solomon (1999), that analysis of the problem must begin with a critical look at science itself. This kind of criticism, coupled with the challenges posed in the OECD projects, raises deep questions concerning the epistemological and ontological basis for science education policy and practice. Many of these questions, it seems to me, align with issues of disciplinarity and social value that also define political and curricular struggles in environmental education.

The purpose of this paper is to examine critically the problems of integrating and broadening science education using perspectives from environmental education. The problem of incorporation of an STSE (science, technology, society, environment) emphasis in the Pan-Canadian science curriculum development process provides an opening for debate about conflicting pedagogical positions. Although the notion of STS as an integrating, broadening, more practical, and relevant frame for science education is not a new concept (see Hodson, 1992), the addition of an environmental dimension (i.e., the E in STSE) brings into sharp relief certain epistemological and pedagogical issues involved in changing science curriculum policy and practice.

Although STS itself is by no means a coherent, consistent, and unproblematic curriculum emphasis, it is promoted as the means to achieving balance and integration in Canadian provinces such as Alberta (see Hodson, 1992), Saskatchewan, and British Columbia as well as in the Curriculum Consortium of Canada’s four Atlantic provinces. The addition of social/environmental issues to these curriculum deliberations raises questions of the curricular appropriateness of forms of social critique which take the debate about integration well beyond the politically safe objective consideration of scientific and technological issues. The introduction of socially critical dimensions to issue-based science curricula also raises pedagogical issues which go straight to the heart of teaching as a moral and a political enterprise.
The Canadian Context

The Pan-Canadian science curriculum development process was initiated in 1993 by the Council of Ministers of Education, Canada (CMEC) most likely in response to the “nationalization” of curricula in countries such as the United States (in terms of national standards), Australia, and the United Kingdom. Although education in Canada is a provincial rather than a federal jurisdiction, arguments about the merits of “harmonization” have resulted in interprovincial collaborations among provincial ministries of education and the subsequent publication of a Pan-Canadian Framework of Science Learning Outcomes (CMEC, 1997).

This science curriculum framework, intended to guide provincial curriculum development, is based on an elaboration of the construct, scientific literacy. However, the focus is on four foundational goals including knowledge, attitudes, and skill, but giving primacy to STSE. One can only imagine the complexity of debate among provincial curriculum specialists struggling to break free from traditional models of curriculum development using STSE as a means of integrating traditional science subject areas.

The most interesting aspect of the curriculum development process, from the environmental educator’s point of view, was the relative ease with which environmental education was incorporated into almost every aspect of the Pan-Canadian document. According to one member of the interprovincial negotiating team (Mitschke, 2000), there was, surprisingly, little resistance to the following as one of five major goal statements:

Consistent with views expressed in a variety of national and international science education documents, the following goals for Canadian science education . . . (include a) science education (that) aims to . . . prepare students to critically address science-related societal, economic, ethical, and environmental issues (CMEC, 1997, p. 5).

Of the four foundational statements, Foundation 1: Science, Technology, Society, and the Environment was described in the document as the “driving force of the framework” (CMEC, 1997, p. 9). This foundation addresses the nature of, and relationships between, science and technology and the social and environmental contexts of science and technology. To understand these relationships, according to the authors of this curriculum framework, “it is also essential to understand the values inherent to science, technology, a particular society and its environment” (CMEC, 1997, p. 10).

The recurrent reference to values will be addressed later in the paper. The important point here is that environmental education permeates the Pan-Canadian curriculum and that it is explicitly tied to attitudinal goals. For example, Foundation 4 (Attitudes) states that students will be encouraged to develop attitudes that support the responsible acquisition and application of scientific and technological knowledge to the benefit of self, society, and the environment (CMEC, 1997, p. 10).”

According to the PCC document, one of the ways in which science can contribute to attitudinal growth is to foster stewardship. A key concept in environmental education, stewardship is one of six attitude indicators that grounds the development of general learning outcomes which comprise most of the 261 pages of the Pan-Canadian science framework. Learning outcomes are organized by grade level under
each of the foundational statements. For example, at the end of grade 3 it is expected that students will “undertake personal actions to care for their immediate environment; at the end of grade 6 . . . describe positive and negative effects resulting from applications of science and technology in their own lives . . . and the environment; at the end of grade 9 . . . analyze social issues (in terms of) advantages and disadvantages for sustainability; and at the end of grade 12 . . . evaluate social issues . . . in terms of advantages and disadvantages to sustainability considering a variety of perspectives. These general learning outcomes are then detailed as hundreds of more specific learning outcomes many of which relate directly to environmental education.

The Curriculum Context

What may be said of the current Pan-Canadian science framework is that it appears to provide for a broadening of the goals and purposes of science education. The inclusion of environment in the curriculum, given its history in provincial science curricula, provides potential for innovation. According to Olson (1982, 1999), in order to understand the fate of innovative ideas in schools, it is necessary to understand, in House’s (1974) terms, the phenomenology of the teacher’s world. The key point, says Olson (1982), is that the explanation of teachers’ action lies in the meaning constructed by the teacher based on his/her experience in context. Unless the process by which curricula are constructed can account for the teacher’s personal program, nothing will change in school practice (Foshay, 1993). A major trend in STME, beyond the incorporation of social dimensions and student interests is the voice given to teachers and students (Olson et al., 1999). Innovative projects across OECD countries (see Black and Atkin, 1996; Raizen and Britton, 1997) illustrate how placing SMTE in a social dimension means dealing with topics and institutional practices in ways vastly different from the traditional focus on subject matter content. Changing the teaching focus leads directly to issues of teacher professionalism which can only be addressed by creating conditions where teachers’ voices are genuinely heard by policy and curriculum researchers (see, for example, Atkin, 1998; Eijkelhof, Franssen, and Houtveen, 1998; Robertson, Cowell and Olson, 1998; Sáez and Carretero, 1998).

Whether teacher voices were heard across Canada during the Pan-Canadian curriculum process is difficult to say. Federal government consultations leading to Canada’s Green Plan (Government of Canada, 1990c) as well as National and Provincial Roundtables on Economy and the Environment (Government of Saskatchewan, 1992) apparently responded to concerns of Canadians that environment was a legitimate social and educational concern in the country (Government of Canada 1990a, 1990b, 1990c). Several initiatives of the federal Ministry of Environment that focused on environmental citizenship and sustainable development have produced educational materials which were widely distributed to Canadian schools. However, with no federal mandate for education, forms of consultation have depended on a diversity of provincial/territorial mechanisms.

The amount of teacher involvement in the Pan-Canadian curriculum process varied widely across jurisdictions (Mitschke, 2000). My own experience in these consultation meetings, in the province of
Saskatchewan, where many teachers were involved in discussion of PPC proposals at several developmental stages, provided compelling evidence that what counts is how seriously newly articulated goals for science education are taken by the people affected by them (Black and Atkin, 1996). Having been involved in the provincial process where the STSE concept had been resisted strenuously ten years earlier, it was interesting to witness the almost missionary zeal with which teachers were not prepared to sacrifice “their” STSE emphasis in the name of interprovincial compromise which Mitschke (2000) believed might be needed in order to accommodate a Pan-Canadian range of viewpoints on science curriculum emphases.

In Canada, science education reforms have focused mainly on the intended curriculum (i.e., goals, standards, frameworks). The enacted curriculum has received little attention because Ministry of Education responsibility (i.e., to produce guidelines) ends where the teacher’s responsibility begins. Commenting on teachers’ encounters with national science reform in the United States, Lynch (1997) found a great deal of anecdotal evidence and some hard data to support the notion that teachers do not understand educational reform or they do not believe it. Because reform is complex and can produce few concrete examples of what reformed classrooms might look like, the alignment of teachers’ core beliefs with a curriculum’s conceptual framework is crucial to enactment/implementation. Teacher values, often tacit and deeply personal, are often unaffected by persuasion (Pajares, 1992), or power (Hiller, 1995). Only systemic changes which transform entire systems into more educationally and emotionally rich communities of learners (Little, 1993; Newmann, 1993; Oakes, 1992) and engage teachers in meaningful intellectual encounters are likely to influence teacher beliefs, empower teachers to enact goals which they find meaningful or create new communities of learners allied for meaningful change (Lynch, 1997). Despite the rhetoric on change the truth is that teachers must construct their own meaning about the value of innovation through participation in it, then use teaching styles that correspond with their tenaciously held beliefs.

**Broadening the Context; The Environment Dimension**

Discussions about curriculum innovation and professional development that privilege teacher beliefs and values are complicated by environmental and social dimensions of traditional science teaching culture. Solomon (1999) describes the term scientific culture as one which is beginning to replace both ‘public understanding of science’ and ‘scientific literacy’ as primary goals of science curricula in some European documents. The term includes connotations of culture as a kind of knowing which is familiar to the general public. Olson et al. (1999) describe science teacher culture in terms of values - personal and professional -- which reflect the realities of the role. Bamford (1999) describes cultural literacy in terms of teachers who go beyond the accepted teacher role of cultural transmission because of their reflective ability to decode personal cultural experiences. In other words, a teacher must know how taken-for-granted assumptions and implicit knowledge influence her valuing of what teaching involves. From an ecophilosophical or ecopolitical viewpoint, in order to consider the possibility of cultural literacy, it is also necessary to examine perceptions of human ties with the natural environment.
The changes implied by environment in the science curriculum are philosophical as well as practical and go far beyond the simple addition of environmental science units to a science curriculum. Bamford (1999) suggests that more fundamental changes in human thinking are required, changes which involve challenging many of the taken-for-granted values seen as part of the current dominant worldview. The paradox is that teachers are part of the problem precisely because they ‘carry’ and legitimate dominant cultural values. To escape such enculturation involves teacher education (see Westbury, 1995, 2000), preservice and inservice, where teachers are encouraged to critically examine their cultural practices and develop images, metaphors, and skills to envisage and implement alternative cultural orientations (Bamford, 1999). The challenge is that we are dealing with values yet to be conceived, as Gough (1991) suggests - we need to create our own ‘sustainable fictions.’

Stables and Scott (1999) describe this challenge in terms of critical environmental literacy (see also Stables, 1998). They extend Hodson’s (1992) idea of critical scientific literacy, at least in terms of issues-oriented curriculum integration, by problematizing environmental issues as essentially social-scientific. They also extend Olson et al.’s (1999) argument about teacher-centredness by problematizing the notion of teacher culture within humanistic and modernistic traditions. I would add, following Solomon (1999), that given the extent of practical problems with the perception of science education, criticisms emanating from the fields of metascience and postmodern philosophy may be relevant to some of this dissatisfaction.

Stables and Scott (1999) challenge teachers and educators to actively seek deeper understanding about how and why our scientific, technological, and artistic endeavors are grounded, not only historically and culturally, but morally. This is an important distinction between science and environmental education because it adds the requirement, beyond personal and social moral principles, that what we do needs to be inherently right for the planet, hence environmentally moral, as well. Thus, critical emancipatory knowledge for the planet cannot rest on understanding social theory alone, but also on the kinds of understanding of environmental issues that empower students to take action in the cause of sustainability (see also, Olson, 1992). This distinction has implications for the form of STSE that environmental educators will read into the Pan-Canadian science framework. The implication for a broadened science curriculum is that, beyond functional and cultural literacy, only critical environmental literacy can result in genuine reflection on teachers’ own fundamental modernist/humanist assumptions.

**What the ‘E’ in STSE Brings to Science Curriculum**

My recent research activity, which probes the relationship between teacher thinking/practice and children’s ideas about environment, contributes to the notion that even the most innocuous elements of school life can been seen to have deep moral significance (Hart, 1996, forthcoming). Schools are places where moral aspects of life pervade almost every practice. Even though they are often tacit and implicit and so ordinary that they are often overlooked by researchers, moral values can have a profound impact on, for example, children’s ideas about the environment. Our observations, originally framed within the
knowledge-attitude-behaviour heuristic that has dominated environmental education research (see Hart and Nolan, 1999), have led us to believe that ethics, particularly those related to moral values, may be even more important than knowledge in motivating teacher action in environmental education.

Although as researchers, we have become aware of a connection between environmental sensitivity and personal/social moral values, we also are acutely aware of the moral complexity of classroom experiences. As Jackson, Boorstrom, and Hansen (1992) have cautioned, there is nothing obvious about the moral significance of much that goes on within classrooms. What we can say is that we have learned to appreciate the complexity of “seeing” the moral intentions in environmental education activity and to develop some level of confidence over time, and as a result of continuous and critical discussion, in the moral properties that were there to be disclosed.

Our enquiry into environmental education in Canadian school has led us to believe that Canadian teachers do not care much about policy debates or curriculum decisions that result in frameworks such as the Pan-Canadian science curriculum, although they respect the authority of such frameworks. Their primary concern is caring for children and they say that they teach what they believe “their” children ought to know. Our observations of the effectiveness of teachers have been relocated from a focus on curriculum and knowledge toward teachers’ determination and commitment to pedagogical and moral principals. However, we did not “see” these teachers as moralistic - imposing moral judgments - but as people who were interested in cultivating certain virtues such as respect, fairness, and responsibility relevant to personal, social, and environmental existence (Ungoed-Thomas, 1996).

It is the vision of these virtues which receives support in Canadian society and which underlies most of what goes on in schools (Government of Canada, 1990c). Few teachers know about the principles of environmental education as defined in core policy documents such as the Belgrade Charter (UNESCO-UNEP, 1976), the Tbilisi Declaration (UNESCO-UNEP, 1978), the Brundtland Report (WCED, 1987) or Agenda 21 (UNCED, 1992). They are not likely even to declare familiarity with their own national strategies (in Canada, a national strategy is currently being constructed) or with exemplars such as the Scottish strategy (see SoEnD, 1993; Smyth, 1996). However, they are patently aware of their own authority/responsibility derived from social and normatively determined trust and ethically contextualized as a set of obligations for personal and social behaviour. And, apparently, they see no contradiction in extending certain personal and social values such as respect to encompass environmental values (Hart, forthcoming). Somehow, these teachers appear to have made an intellectual leap from social consciousness to environmental responsibility: they have, as we say in environmental education, somehow internalized the ethic of care that bridges the gap between anthropocentrism and ecocentrism. They have environment “in their bones” and as such it will “be” in their curriculum.

**Environmental Education and the Social Construction of Curriculum**

The idea that the curriculum should be derived from and/or directed toward social organization, as described recently by Moore (2000), seems to be more compatible with environmental education,
particularly a socially critical approach to environmental education (see, Breiting and Mogensen, 1999; Kyburz-Graber, 1999), than scientific approaches which define curriculum in opposition to the social, whether positivistically or progressively. Positivists, states Moore (2000), want essentially to get society out of knowledge, while progressives, fundamentally, want to get society out of the child. For positivists, knowledge is that which is true for everyone, for progressives, for the individual - one is absolutist, the other essentialist. Both, as forms of asocial empiricism, he says, are wrong because knowledge is intrinsically and inescapably social. The organization of school knowledge is treated as equivalent to a representation of social order and it is impossible to talk about one without involving the other or to avoid the wider conflicts and controversies that this gives rise to.

What is taught in schools can never be a neutral or innocent decision precisely because the educational learning process aims to be ‘transformational’ - to change the person in some way deemed desirable in society. Environmental education, it seems to me, is at least honest in its intention, that is, to be transformative in the sense that environment and environmental issues should be part of the educational discussion about curriculum. The arguments are illustrated in a special edition of the Cambridge Journal of Education, (29)3, where editors Bonnett and Elliott (1999) state explicitly that it would be difficult to identify an issue of greater importance for humankind than its relationship with its environment. Their contention is that education would be irresponsible if it attempted to remain insulated from issues that unsustainable actions of humans generate. The problem, they say, is the degree to which the good oil, the rhetorical goals of environmental education, match the reality of the school and classroom. Properly conceived, environmental education incorporates a philosophical position and an alternative worldview that could/should/must transform the nature of teaching and schooling.

From a critical social perspective, the Pan-Canadian Science Curriculum Framework emphasis on science, despite explicit incorporation of environment in the curriculum through STSE, may in fact restrict environmental education rather than support it. Despite rhetoric to the contrary in these national science curriculum materials, environmental education crosses traditional disciplinary boundaries and involves underlying interests and attitudes innocent or even contrary to broad science issues related to social reproduction. According to Merchant (1992) and to Bonnett (1997) some of the more industrialist motives of science reveal an aggressiveness which contravene the kind of respect for nature that some would argue should be at the heart of environmental education. Bonnett and Williams (1998) describe this tension in terms of the set of values and attitudes which lead us to behave toward the environment in certain ways. Contextualizing environmental education as purely ‘natural’ rather than social leaves these values questions invisible. Thus, central to environmental education is not the scientific-based understanding emphasized in the Pan-Canadian curriculum but the potentially more difficult and politically sensitive task of helping children develop a more sophisticated and critical understanding of the values that inform everyday life (Bonnett and Williams, 1998).

From this criticalist perspective adding the ‘E’ to STS means explicitly adding values to the curriculum, those personal, social, and environmental values eschewed in modern “American” education
(see Foshay, 1993). This does not mean imposing certain moral values on others but making students more conscious of the value-building process as integral to the learning process. Environment in the curriculum means value-laden social and environmental issues must be addressed (see Oulton and Scott, 1998). What is missing in ideas of science within the Pan-Canadian curriculum is the discussion of pedagogical practices that engage the hegemony of tradition in science teaching, including traditional assumptions about learning (see Black and Atkin, 1996).

New learning theories support forms of professional practice in science education that require more than a transferred knowledge base and a set of technical competencies (see Black and Atkin, 1996). Lester (1995), for example, describes certain meta-competencies which represent more comprehensive forms of personal practical knowledge, as narrative ways of knowing (see Clandinin and Connelly, 1999). In this view of learning, technical knowledge is integrated with social and ecological understanding (Thomas, 2000). Such learning theories acknowledge motivation and action (competence) as well as cognitive operations -- a more symbiotic relationship between Bruner’s (1986) theoretical and practical ways of knowing, that is between experience-based and research-based epistemologies and between cognitive knowledge and affective knowledge.

As a reflexively constitutive activity, learning involves the interpenetration of personal and social values with experiential knowledge - a dialectic of knowing and being (Erickson, 1996; Hart and Nolan, 1999) involving what Thomas (2000) calls psychological mediators in the age-old knowledge-behaviour dichotomy (see, Contrell and Graefe, 1997; Zimmerman, 1996).

Because learning is situated in ecological as well as personal and social contexts, a broadening of focus for science education involves looking beyond STS for an even more comprehensive (i.e., holistic) curriculum. Adding an E to STS means that we need to create curriculum conjointly with learning conditions (environments) where ethics (including environmental ethics) can be explored critically. The challenge this orientation to learning poses for science education is to abandon the pretense of neutrality or a preferred abstract morality (Payne, 1999), to not ground our value systems exclusively in scientific/technical rationality (Bauman, 1993). Teachers teach morality at varying levels of consciousness so there is a need for them to know more about their own beliefs and pedagogical assumptions. Passive transfer of values is no more acceptable than passive transfer of knowledge. Rather social negotiation of values is the essence of environment in the curriculum.

Environmental education deepens the idea that science curricula should provide for experiences that are flexible, experiential and which students perceive to have personal/social meaning/value. Such experiences require instructional leadership which stresses student engagement, personal experiences, student reflection and action-oriented group work in natural settings as modes of learning. Values and beliefs are not taken out of the academic register but included as interpersonal dimensions of the learning process. Students learn the concepts and skills to handle moral issues both independently and cooperatively, as a social rather than an information form of learning. The implication is that teachers should be more aware of the moral education they provide. This involves the personal/pedagogical struggle
to uncover our taken-for-granted assumptions about teaching and learning which drive our pedagogical activities.

**Issues Beyond the STSE Science Curriculum: Epistemological and Educational Change**

It would seem that different mindsets were operating in the construction of a curriculum framework such as the Pan-Canadian science curriculum. If we choose to truly engage the debate about broadening and integrating the science curriculum, the political implications of the Pan-Canadian form of the STSE curriculum function at several levels. First, we require a debate about research which is deep enough to engage the character of educational knowledge and the pedagogic processes of selection and reconceptualization which are central to teachers and students (see Bernstein, 1996). For example, what kind of knowledge are we willing to accept as legitimate - scientific knowledge or a broader conception that includes social dimensions and moral knowledge (see McIntyre, 1990)?

Barlosky (1999) distinguishes three predominant and ultimately irreconcilable knowledge perspectives which ground epistemic assumptions. The dominant scientific perspective presumes that the progressive development and integration of knowledge will eventually bring certainty and coherence, the genealogical perspective replaces this hope with the call for creation of individual perspectives and the traditionalist perspective grounds knowledge within normative values and beliefs. MacIntyre (1990) sees these epistemological orientations, the empirical, interpretive, and the deductive, as complementary - a stance that helps clear away misunderstandings about the relationship between science knowledge, moral/ethic knowledge in the curriculum and ethical social action.

Each strand of knowledge simply does a different kind of work, the appropriateness of which is dependent upon context. This means that the mere accumulation of scientific knowledge will not resolve the tensions between the individual and the collective but that improved clarity between the cognitive and the interpretive (both equally legitimate ways of knowing) may accommodate better personal-social-environmental decisions at the level of practice and improving decisions about what counts in educational curriculum/policy decisions.

This returns us to Moore’s (2000) point that the acceptance of the social nature of knowledge does not imply an inevitable collapse into relativism. It is a certain ethical attitude, according to Reichenback (1999) to not always try to press the special and incommensurable into the modern schemes of one and only truth or one and only morality. From a curriculum perspective, selection of units or examples may be just as appropriate if they don’t stand for something more general, and decontextual. These epistemological issues applied to the core science curriculum, while worldviews apart, may be worth the debate given Bernstein’s (1999) rather pessimistic assessment of the cross-curricular alternative to these interdisciplinary struggles.

Second, environmental education represents a worldview which is ontologically distinct from science education, a philosophy that compels participation in socio-democratic action. According to
Kyburz-Graber (1999), environmental education for social change has to be considered as critical education which considers teaching as a project of research in action. The science teacher’s typical preoccupation with objective observation and quantification represents a scientifically determined philosophy of teaching and learning characterized by knowledge transmission which often excludes active independent learning. This philosophical difference is exemplified in the OECD-ENSI project which promotes a view of learning as going beyond the obvious acquisition of scientific information to include active deliberation and debate about issues relating to one’s own environment, a position widely supported in the environmental education literature (see, Fien, 1993; Morgensen, 1997; Robottom and Andrew, 1996; Wals and van der Leij, 1997).

As a distinct, ecophilosophical worldview, environmental education is about the construction of ethical awareness that includes critical understanding of one’s deep, perhaps contradictory and inconsistent, personal knowledge structures and beliefs, recognition of personal assumptions, predispositions and biases, cultural blinders, and ideological boundaries. Environmental education research has begun to focus, recently, on areas of personal reflection, significant life experience (Palmer, Suggate, Robottom, and Hart, 1999) ecological identity (Thomashow, 1995), social consciousness, and social responsibility (see Hutchison, 1998). These studies and many others are beginning the critical dialogue necessary to articulate multiple philosophies and pedagogies of environmental education.

What is emerging in this dialogue within environmental education, as a maturing area of research and practice, is the self critique and debate which marks a more mature and sophisticated dialogue about ways of knowing, ways of being and meaning in the struggle to conceptualize the social constructivist nature of environmental education as believable and credible. These debates about socially negotiated knowledge construction within newer journals such as Environmental Education Research and the Canadian Journal of Environmental Education are crucial to subsequent debates about curriculum and policy issues such as the rationale for the E in STS within the Pan-Canadian curriculum.

**Conclusion: The Politics of Change**

Environmental education is aimed at improving environmental quality. The major impediments are personal and social values which do not extend to include environmental values. The idea that personal/social values have a logical connection to environmental values implies that environmental action is more closely linked to ethics than to cognition, although the two are connected (Jonas, 1984). And because learning, as we now understand it, involves wider communicative and interpersonal competencies and skills, science education must be broadened to include political and ethical dimensions of learning far beyond the assumptions of technical and instrumental rationality (Lakomski, 1991; Preston, 1992). Environmental educators such as Payne (1999) argue that learning, as a form of embodied action, is intimately connected to personal and social experience and in turn, to active participation in community action and interaction, as well as social critique. Embodied action, rather than abstract reason, lies at the core of pragmatic social constructivism (Garrison, 1998).
Environmental educators have long argued that the modernist notions of schooling and curriculum, which are organized as subject matter disciplines, are inappropriate for learning about complicated, interdisciplinary social and environmental issues (Elliott, 1994; Posch, 1999; Robottom, 1987, 1988). Modern schools are informed, they say, by models of learning and change which reinforce and reproduce rather than challenge or reconstruct key features of institutional education (see Benedict, 1999). They represent a theory of social change that isolates teachers from the curriculum development process, thus from control over the thought and practice of policy. The result is not only a failure at implementation of innovation but a deeper failure to even engage in debate which may challenge taken-for-granted, entrenched concepts of knowledge (i.e., epistemology) and learning (Benedict, 1999; Robottom and Hart, 1993). Such teacher-deficit models of curriculum overlook the complexities of learning and of the change process itself.

In Beyond Science, Global Imperatives for Environmental Education, Palmer (1997) argues that environmental education should not be viewed as the “adopted child” of science education. In developing her argument she refers to the OECD-ENSI project where teachers adopted a research perspective which she describes as a community-based action orientation. My own inquiry into the environment-related thought and practice of Canadian teachers and McNamee’s (1997) examination of ecological caring together with Palmer’s research all point to the importance of voice in matters of ethics and environmental sensitivity. According to Thompson (1992, 1994) a different location or social position provides another mode of orienting the self in relation to the environment. This connection to internal as well as external environment resonates with Payne’s (1999) advocacy of a different ontological position against which we may evaluate the values inherent in both the current ideology of science education and the didactics of curriculum (see Westbury, Hopmann and Riquarts, 2000).

According to Orr (1994) now that we have the learning theories that join rational and moral dimensions we need teachers to participate in integrating new pedagogical ideas of environmental education with the conservative traditions of curriculum, policy, and education. Teachers need opportunities to share their theoretically informed reflections (as in experience-based theory) in order to provide insight into their pedagogical beliefs and assumptions. What are the criteria teachers use to make their curriculum decisions? How can we create conditions for teachers to discuss their theories in terms of cognitive as well as effective, aesthetic and personal understandings? How interested are teachers in finding out about their preoccupations and unconscious commitments? The only way to penetrate the ideology of teaching is to develop a discourse which reflects and honors, but also raises for critical discussion the credibility of strongly held, but rarely considered, views on teaching and learning that are the prerequisites to the right to influence their own curriculum. It is a central research issue that invites us to tune in to teachers’ voices and listen to what they have to tell us about what helps them to learn and also about what gets in the way of their learning and professional development (see also Olson et al., 1999).

Most science teachers in Canadian schools graduate from university with little more than surface declarative knowledge of their disciplines and few transferable skills (Ramsden, 1988) such as critical
thinking (Greenall-Gough and Robottom, 1993; Noordlink and Naidu, 1994), problem solving (Burgum and Bridge, 1997; Klein and Merritt, 1994; Spencer, 1992), decision making (Hall, 1976; Naish, 1986), or metacognitive (Flavell, 1976; Robinson, 1983). While these “skills” are more than cognitive, and involve some communicative and interpersonal competence, they lack the political and ethical dimensions so often needed in social critique. Professional development which includes personal, social, and environmental values can situate learning in a broader array of curriculum contexts where issues can be explored critically from ethical as well as scientific viewpoints. The challenge is to work toward science curricula which do not pretend neutrality nor abstract a preferred morality base that is unattainable (Payne, 1999) or to ground value positions solely in scientific/technical rationality (Bauman, 1993). Teaching invariably involves morals, thus moral sensitivity (and environmental sensitivity) can be extended performatively through the ethical actions of teachers and teacher educators. However, for this to occur professional development experiences must provide bridges between moral and scientific knowledge and ethic judgments. These connections remain problematic.

The gap between the narratives of the Pan-Canadian curriculum and teachers is wide, partly because teachers’ expertise is little valued in the academic forum. Shifting the science curriculum of the future towards environment requires engagement in projects which call for extended interpretation of science and environment. These will only come from a strong sense of self for the teacher as well as facility across science and ethics and enhanced skills of communicative competence. The changes contemplated involve teachers who can be educated for instability (Kress, 2000), for a less predictable and generalizable curriculum delivered by teachers of individual creative agency, for which the guiding metaphor is not so much “design” as “caring.”

**Curricula, Paradigms and Problems: Environmental Education and the New Ontario Science Curriculum**

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This paper will address the educational assumptions underlying different environmental education paradigms and critique Ontario’s new science curriculum. In the past two years the Canadian province of Ontario has released a new high school science curriculum. This occurred in stages with the grades nine and ten document being implemented a year before the grade eleven and twelve curriculum. Under the assumption that these new curriculum may reflect underlying beliefs about the nature of science education in North American, this paper presents an exploration to the question of whether the educational foundations of these curricula are sufficient to meet environmental education’s goal of bring about individual and social change.
This begs the question of what is the foundation of environmental education? The proceedings of recent conferences suggest that the type of educational practices conducted in the name of environmental education remains essentially contested. There are many frameworks or definitions of environmental education and the concept of environmental education varies from nation to nation, state to state, province to province, school to school and teacher to teacher (Scott, 2000). These differing environmental education perspectives have the potential to challenge and expand interpretations and practices by providing new insights. This is apparent in environmental education research where Hart and Nolan (1999) state that even though this discipline may appear fragmented, researchers are connecting their work in ways that advance environmental education discourse. As such, differing environmental education perspectives must be continually reviewed and analysed so that each may draw on the strengths and reflect on the weaknesses of present beliefs. The existence of conflicting paradigms in environmental education may drive the process of change in much the same way as debates about the appropriateness of competing paradigms in science drives the process of scientific advancement.

**Education in, about and for the environment**

Teaching a seven-month course in socially critical environmental education in a preservice teacher program to mainly science teachers has encouraged me to explore pedagogical approaches that promote the visualization of different paradigms of science and environmental education. In the last two years of teaching this program, I have found my students demonstrated substantial changes in the way they envision the role of education in society and notions of what it means to be a teacher. This change has been evident in their discussions and how they interpret current curriculum documents to develop lessons and units based on the philosophies of socially critical environmental education. This curriculum interpretation is not representative of how most preservice science teachers translate the science curriculum as it centers on constructivist learning approaches, critiques of individual and cultural values and morals and has varying degrees of student suggested and generated action. Moreover, it is not how the curriculum is implemented in most Ontario schools. However, a framework I have found beneficial in generating preservice students' understanding and comfort in socially critical environmental education in both the theoretical and practical application of their pedagogy, is the philosophy of education in, about and for the environment. It is to this end I explore the underlying assumptions of this framework and use it as a baseline for critiquing Ontario’s new science curriculum.
Education in, about and for the environment has been a popular framework in Australia for interpreting environmental education. It distinguishes itself from other interpretations by highlighting student action as its defining component. Lucas (1979) originally proposed viewing environmental education as education about the environment, education for the (preservation of the) environment and education in the environment. This classification was an attempt to link contested forms of environmental education under a common agenda. Lucas suggested the ultimate goal of any educational program determines the type(s) of environmental education used. Environmental education currently represented in the dominant Australian literature has evolved from Lucas's original work. While education in and about the environment are similar to Lucas's original version, education for the environment has been greatly modified. The current Australian interpretation of education for the environment has a socially critical agenda that provides a new perspective to Lucas's original interpretation.

In many contexts, including my own, environmental education as represented by education in, about and for the environment, has been theoretically and practically advantageous. Starting from the student’s personal experiences, I introduce different perspectives of science and environmental education by providing this framework for students to deconstruct their own education. After students have reviewed the assumptions and ethics consciously or unconsciously associated with their educational experiences and their beliefs of what it is to be a student or a teacher, they are then introduced to educational theories embedded in education in, about and for the environment. These complex theories, such as critical pedagogy are explored and critiqued through narratives of lived experiences. In this way, education in, about and for the environment provides a common language for the subsequent investigation and critique of the lived experience of socially critical environmental education.

The terminology associated with this interpretation of socially critical environmental education is not commonly utilized in contemporary environmental education. This may be due to constructive criticisms that examine various limitations of education for the environment. For example, Jickling and Spork (1998) recognize this interpretation has been stimulating and productive but suggest uncritical use of this slogan may serve to limit the possibilities of environmental education and contribute to a sterile discourse. This will be addressed in more detail later in this paper. This critique may indeed be accurate, as education for the environment, along with all educational theories, needs to be continually critiqued. As such, much of the recent research in environmental education seems to have abandoned the notion of education in, about and for the environment as it is obviously absent in contemporary environmental education discourse. This is unfortunate, as I have found it presents a sound starting board for students to deconstruct their assumptions surrounding the teaching of science and environmental education and serves as a reasonable baseline for reviewing Ontario’s new science curriculum.

In this environmental education interpretation, education in the environment relates to direct experiences in the environment. Students observe the complexity and wonder of the natural and built world through personal experiences, thoughts or feelings and may become immersed in the values conflict of environmental issues (Fien, 1993).
This learner-centered approach aims to provide students with a sense of reality and appreciation towards the environment through direct contact, and also promotes practical skills. Education *in* the environment represents many of the philosophies of outdoor education programs. The objectives of outdoor education relate to student interaction with the natural environment, the identification and classification of organisms and skills such as data gathering, observation, sketching, photography, interviewing, using scientific equipment, aesthetic appreciation and group work.

There are criticisms of environmental education programs that just focus on education *in* the environment. Huckle (1986, p50) states that the technocentric-based education *in* the environment tends to “stress personal values, cooperation and new ethics but makes little mention of politics, conflict and power”. Fien (1993) agrees with Huckle, stating the majority of education *in* the environment fails to take into account the material or political base of society. Education *in* the environment may provide students with experiences of the natural or social environment, but, within this interpretation, it is only one aspect of environmental education, and should not be considered to be environmental education in its entirety. Education *in* the environment is most commonly used in conjunction with education *about* the environment (Fien, 1993).

Education *about* the environment is the most common form of environmental education (Fien, 1993; Sammel, 1997; Spork, 1992). This interpretation views education *about* the environment as just one of three aspects that make up environmental education. Education *about* the environment emphasizes the content aspect of the curriculum, including facts, concepts, environmental and social processes and patterns. Knowledge of the interactions between the human and natural environment is emphasized more than knowledge of the social or political environment in the majority of education *about* the environment. Linke (1980) and Robottom (1983) agree that education *about* the environment tends to focus on the natural or technological environment rather than the social environment. The emphasis placed on the natural environment to the exclusion of the social or individual environment may relate to the dominant association of the term “environment” with the natural environment. The word “environment” has been commonly linked to the physical and biological connections rather than the social or individual connections people have with the world around them (Sammel, 1997).
However, Fien (1993) believes that all interconnections between the social, natural and individual environments are essential for understanding and resolving environmental problems.

Education about the environment tends to be limited to science and geography curricula, rather than being cross-curricular (Fien, 1993). It also focuses on ecological concepts and technical solutions, rather than human causes and the changes in the social systems that must be addressed if real solutions are to be found. Education about the environment is less likely to take into account minority or gender issues (Di Chiro, 1987) and so may not provide a holistic view of these social problems or their solutions.

As with education in the environment, most education about the environment provides a technocentric view to environmental problems; that is, the view that most environmental problems can be addressed by scientifically proven techniques and resource management (Robottom 1987a). As Robottom (1987a, p104) states:

The technocentric world view promoted by education about the environment ignores the important qualitative dimension of the majority of environmental issues which involve “quality of life” or “social need” concerns - emotions, beliefs, aspirations, aesthetics and, perhaps most important of all, vested interests. It could be argued that a view of the resolution of environmental problems that stresses the role of technical rationality (i.e., the processes of an objective, applied science method) creates a false impression of the way these issues are resolved.

The technocentric or dominant worldview identifies nature as subservient to human needs and economic factors (Fien, 1993). This view has contributed to the current environmental crisis. Many environmentalists have argued that there is a need for a paradigm shift away from the technocentric worldview towards an ecocentric view that respects the natural, individual and social environments. Fien (1993) sees this ecocentric view as having:

- a high regard for nature; respect for the natural and social limits to growth;
- empathy with other species, other people and future generations; support for careful planning in order to minimize threats to nature and the quality of life; and
- a desire for change in the way most societies conduct their economic and political affairs (p.4).

There is a critical need for education about the environment to promote holistic awareness and understanding of environment issues. The promotion of the ecocentric paradigm is reflected in the socially critical approach to environmental education (Fien,
The socially critical educational paradigm is emphasized in the classification education for the environment.

Education in and about the environment may provide awareness, knowledge and concern for the environment, but may not be sufficient to generate action (Hines, Hungerford & Tomera, 1986/87; Ramsey, Hungerford & Tomera, 1981; Robottom, 1987b). The development of citizenship skills and the willingness to act is an essential part of environmental education (Fien, 1993; Hines, et al., 1986/87; Huckle, 1993). Education for the environment is an action-based concept that promotes participatory skills. It generates an end product of civic participation, whether this is personal or community based participation. It involves critical thinking, evaluating, debating, being open to other points of view and clarifying personal views about theories and then using them to benefit the individual, social and natural environment (Fien, 1993).

Education for the environment provides a vehicle by which students can act constructively once environmental awareness, knowledge and concerns have been developed. Without the inclusion of student generated action, students may feel frustrated and helpless towards environmental challenges (Greenall, 1985; Huckle, 1993). The inclusion of socially critical education for the environment may be linked to the feeling of being responsible for the environment while encouraging an individual or group to realise they can make a difference.

This theoretical interpretation of education for the environment operates within a socially critical paradigm with an ecocentric worldview. The socially critical paradigm sees political action as paramount because political agendas and processes are intrinsic to the individual, social and natural environmental crisis societies are facing. This paradigm acknowledges that the dominant worldview creates societies that are structurally unequal in beliefs and values that relate to class, gender and race relations (Chapman, 1999; Fien, 1993). It also acknowledges that education can never be neutral as educational agendas usually seek to maintain and reproduce a particular social structure. Fien suggests that “education can never be totally neutral in its perspective as it reflects the current dominant worldview and this must be taken into account” (1993, p23).

Socially critical environmental education promotes changes in political, economic, social, cultural and ecological ideas and values that will lead to ecological
sustainability (Huckle, 1991, 1993). The socially critical paradigm also encourages the identification of any bias in order to promote “social justice, equality and democracy” (Fien, 1993). It seeks to achieve this through the thoughtful, ethically based, responsible and critical examination of social problems and active participation in developing a continually improving society (Stanley & Nelson, 1986). This orientation views schools as being shaped by societies and in turn shaping societies (Fien, 1993). In contrast, other paradigms stress information or values, but due to their unwillingness to deal with political issues, maintain the status quo, and so reproduce society's ideals and inherent problems.

Education for the environment encompasses the natural, social and individual environments and their interactions. It does not focus solely on the natural-human interactions, but sees all three environments as interconnecting. This interpretation of environmental education also focuses on a cross-curricular study of environmental issues and problems in the local community and deals with issues relating directly to students. It aims to provide opportunities for students to develop the concepts, procedural values and skills of political literacy so that they may learn how to participate actively in seeking solutions to the problems that concern them (Fien, 1993). Local concerns are then expanded to include national and international implications. Education for the environment reflects on past and present social beliefs so students can learn about political change and feel capable of altering governmental policy to advance ecological sustainability (Huckle, 1991; Jickling and Spork, 1998). Education for the environment searches for ecologically sustainable lifestyles that can alter present day environmental damage without jeopardizing the ecosystem or future generations (Fien, 1995).

Education for the environment has the potential to challenge the dominant social paradigm and prevailing structures and practices of schooling (Chapman, 1999; Elliot, 1995; Fien, 1993). However, education for the environment should not be viewed in isolation from education in and about the environment, but rather should be considered complementary to these other approaches. A general supposition in much of the literature is that environmental education should include all three approaches (Fien, 1995; Linke, 1980/81; Spork, 1990). As Linke (1980/81, p20) states “environmental education is all of these things: it is not, in its own right, any one of them”.
Realities of Environmental Education

In the United States environmental education has been a curricular buzzword since the 1960's. Childress (1978, p10) concluded that “most environmental education programs in the United States focused on knowledge and appreciation of the environment and its resources, rather than on helping students develop socially critical knowledge and skills to solve environmental problems”. Since this time there have not been significant changes in the delivery of environmental education in the United States or in other countries where the rhetoric-reality gap between education in, about and for the environment has been widely examined (Chapman, 1999; Elliot, 1995; Greenall, 1981a; Law & Baker 1997; Palmer, 1998; Sammel, 1997; Spork, 1992). Researchers have shown that in practice, education in and about the environment are emphasized more than education for the environment (Greenall, 1981a; Maher, 1982; Spork 1992). Greenall Gough (1990, p47) states that “education for the environment still seems to be uncommon”.

In an Ontario study of 600 teachers, Sammel (1997) found that teachers are most commonly incorporating the information and attitude components of environmental education in their programs and least commonly incorporating the values, morals or action components. This study explored Greenall’s (1981b, p292) belief that “an examination of environmental education in many parts of the world reveals few situations in which the hegemonic influences of mainstream educational beliefs and practices have not “diluted” education for the environment into more politically acceptable forms of education about and through (or in) the environment”. Greenall identifies a factor that may explain why education for the environment is not as common as education in and about the environment. This factor is based upon the description of socially critical education for the environment as being “counter-hegemonic”. Education for the environment is counter-hegemonic as it encourages students to challenge the social, political, economic and educational influences that allow present socially unjust and ecologically unsustainable societies to continue (Chapman, 1999; Elliot, 1995; Fien, 1995; Greenall, 1981a), rather than accepting the statuesque.
Many environmental educators consider the ultimate goal of environmental education to be action (Chapman, 1999; Fien, 1995; Greenall Gough, 1990; Huckle, 1993; Jordan, Hungerford & Tomera, 1986; Robottom, 1987a; UNESCO, 1977; UNESCO-UNEP, 1978). In education for the environment, the action component is emphasized along with values analysis, investigating viewpoints, critical thinking and problem solving, but it tends to be the “action” component that is omitted from educational programs (Greenall, 1981a). The action that may be generated by socially critical education for the environment may appear to be “radical” and so may deter teachers from incorporating it into their programs.

Greenall Gough (1990, p44) believes that the timidity of many teachers is understandable as many “education for the environment” actions could be “politically sensitive”. Therefore, the “acceptable” and “safe” education in and about the environment aspects of environmental education are more common. Maher (1986) believes this relates to a climate of censorship and control over teachers, for it encourages teachers to impose self-censorship on “politically sensitive” material. Other possible explanations why teachers exclude education for the environment may be linked to their perceptions of the role of educational systems. Stevenson (1987, p73) explains that historically schools were not intended to develop “critical thinkers, social inquirers and problem solvers, or active participants in environmental and political (or even educational) decision making. Put simply, their intended function was not to promote social change or reconstruction”. The traditional function of schooling was to perpetuate the existing order of society by reproducing mainstream beliefs, norms and values. The contradictory purposes of the present educational system, based on this traditional function, and education for the environment may inhibit the implementation of education for the environment.

Other problems in implementing education for the environment have been identified, these include a lack of curriculum support, rigid timetabling, specific assessment procedures and fragmented subject areas (Chapman, 1999; Law & Baker, 1997; Sammel, 1997; Stevenson, 1987). Even though Stevenson (1987, p75) believes that this may be more of a concern for secondary schools than primary, he feels that this may account for the perceived lack of time for environmental education in the classroom.
Furthermore, Maher (1986) believes that effective education for the environment requires a flexible administration and a revised responsibility structure, and this may not occur in present educational systems.

The lack of education for the environment in environmental education programs may also reflect a lack of professional preparation and knowledge. Sia, Hungerford and Tomera (1985/86) emphasize that teachers must be confident and knowledgeable in carrying out environmental education action in order for them to encourage students to do the same. Spork (1992, p163) addresses the seriousness of this factor by stating that “lack of professional preparation and development of teachers may have much to do with the discrepancy between theory and practice”.

Finally, educational curricula may play a major role in the discrepancy between the theoretical emphasis on the desirability of all three aspects of environmental education and the practical focus on education in and about the environment. As the foundation of educational curricula stems from society’s reproduction of the dominant social beliefs and values, the counter-hegemonic nature of socially critical education for the environment may inhibit its inclusion into formal curriculum guidelines. Maher (1986, p23) believes that this censorship is the education system's attempt “to secure its value system from challenges”. The lack of education for the environment within the curriculum may be reflected in teaching practices, as teachers may not have any knowledge of, or support for education for the environment. Therefore, as it is not formally included in the curriculum, teachers may not be willing to implement it. Additionally, some teachers may believe that education for the environment may not be appropriate for their curriculum area or the age level they teach (Pike & Selby, 1988).

Even though education for the environment encourages the identification of and critical reflection on underlying values and assumptions, it has been accused of not applying this characteristic to its own perspective (Jickling & Spork, 1998; Fien, 1993; Gough, 1987; Sammel, 1997).

A critique of education for the environment

In relation to present environmental educational ideologies, no other perspective emphasises action to transform the social problems that create or maintain environmental
crises. However, education for the environment should not be seen as being the ultimate in environmental education, as there are valid criticisms of this perspective.

Four major criticisms of education for the environment are:

1. Jickling & Spork (1998) believe this term has become a slogan and is insufficiently problematized. They state it has become an operational doctrine where the only valid practices of environmental education are those that include education for the environment. This term has moved from a descriptive to an analytic meaning demanding more critical attention than other forms of environmental education.

2. Fien (1993) claims that education for the environment is anthropocentric. The emphasis on human needs and wants is contradictory to some philosophies of ecocentric environmental education, which regard humans as being integrated with nature. The division made between “the natural environment and humans” reinforces the belief that humans are removed or above the natural environment and other species. Gough states education for the environment as “being somewhat patronizing and anthropocentric (who are we to say what is 'good for' the environment, and which environment is 'the environment', anyway?), and that this slogan maintains the sorts of distinctions that tend to work against a deeply ecological world view” (Gough, 1987, p50). He proposes that education with the environment reflects the philosophies of the ecocentric paradigm better as it implies that “learning is not a transfer of something by someone to someone, but it is a relationship...the relationship is considered to be reciprocal” (Gough, 1987, p49).

3. The emphasis that education for the environment places on political change may not stress the importance of individual change. Education for the environment highlights structural causes of environment problems and encourages political change due to the immediate impact they may have on improving the sustainable nature of that community.

4. Education for the environment highlights tensions between different social perspectives. This conflict directly reflects the differing perceptions of the roles of schools in society. The educational ideology of education for the environment believes schools have the potential to transform societies, while the dominant paradigm utilizes schools for social reproduction. This tension emphasizes that schools are not neutral institutions, but have political agendas in that they:

   encourage or do not encourage persons to develop and use their critical capacities to examine the prevailing political, social and cultural arrangements and the part their own acts...play in sustaining or changing these arrangements (Berlak & Berlak, 1981, p253).
This critique of education for the environment highlights the many problems associated with generating change within a system that is not set up for, or supportive of change. Fien (1993) believes that “critical education for the environment is ... challenged by many aspects of the way education and schooling are structured to support the Dominant Social Paradigm...and that teachers who try may...meet much opposition from those whose status and identity derive from prevailing definitions of society and education” (p47).

Education for the environment should not be a static concept, but should be continually reviewed and revised to address these criticisms. As the foundation of socially critical environmental education is based upon the deliberation of underlying beliefs and practices, these criticisms may hopefully challenge education for the environment to apply its own philosophy and critically reflect and refine both its rhetoric and practices so as to continually evolve.

**Ontario’s New Science Curriculum and Environmental Education**

The past two years have seen a new secondary science curriculum introduced in Ontario. The first to be implemented was the grades 9 and 10 curriculum while the grade 11 and 12 document was launched a year later. These documents vary from the old curriculum in many ways. The old curriculum, released in 1987, focused on students gaining scientific knowledge and understanding “cause-and-effect relationships that govern the structure and behaviour of natural phenomena” (Ministry of Education 1989, p.6). The new curriculum focuses more on understanding the impact science has on the lives of Canadians in order to generate scientific literacy (Ministry of Education, 2000). These differing philosophies are reflected in how they approach environmental issues. In the old curriculum, environmental issues were taught in a separate course called environmental science that focused on scientific facts and concepts. The new curriculum has eliminated environmental science as a separate subject. In these new curriculum documents, environmental issues are integrated into every science course through a section called science, technology, society and the environment which focuses heavily on the positive aspects of technology and how it affects the everyday life of the student rather than the exploring environmental issues.
What the old curriculum suggested be taught under environmental science reflected facts about the natural environment and for the most part, this information can still be found in the same neutralized form in the geography curricula. Therefore, environmental information presented in both the old and the curriculum is at best representative of education *in* and *about* the environment. The environmental issues in the new curriculum focus less on scientific facts but rather explore the dominant economic and scientific opinions of environmental problems and solutions. The science, technology, society and the environment section of every science subject is intended to be one of three core elements the students must master before passing any science courses. It is by far the smallest element of the three.

The three core elements of the new science curriculum are intended to set a new foundation for learning and teaching in Ontario. The curriculum states its basic aim is to ensure scientific literacy for every student and attempts to achieve this by promoting the three elements of:

1. basic scientific concepts;
2. developing skills, strategies and habits of mind required for scientific literacy; and
3. relating science to technology, society and the environment.


The learning specified in the grades 9-12 science curriculums somewhat supports education *in, about and for* the environment in it aim to highlight the interconnections between the natural, political, economic and social environments. Furthermore, the document states it seeks to introduce a “values” dimension into the curriculum and encourage the extension of learning into the community. However, the “values” aspects are severely constrained within the “politically appropriate” agenda.

The new science curriculum suggests the school system should be preparing students with life skills rather than specific work skills, which is an improvement on the previous science curriculum. The new curriculum is based both in the social and natural science disciplines, with emphasis upon practical, social and expressive knowledge. The
educational foundations of this curriculum reflect Fien’s (1993) description of liberal teaching programs:

These programs often have a problem or issues focus which seek to add relevance to the curriculum. They also advocate inquiry-based learning in order to develop students’ higher order thinking and problem solving skills. These are worthwhile educational developments. However, the environmental ideology behind this approach to education is technocentric. It promotes a view of environmental problems as issues to which successful accommodation can be made through resource auditing, impact assessment, and improved, scientifically proven management practices (p.41).

Inquiry-based learning and the development of higher order thinking and problems solving skills are important ways of the addressing environmental problems that already exist. However, the information presented in the curriculum does not address deeply rooted social assumptions that maintain personal or social lifestyle conditions that may lead to new social and environmental problems. The curriculum therefore, may prepare students to evaluate the need for social reform and to act to the best of their abilities, using their talents in a socially responsible way, but it does so within politically acceptable agendas. This curriculum does not appear to appreciate that school values, curriculum and practices are political and reflect the dominant patterns of power, justice and control (both overtly and hidden) in society. It presents learners with a range of opinions and facts and provides them with critical skills to analyse information and form their own ideas. These facts are given without addressing the underlying values and biases of the dominant worldview and so this paradigm fails to compare the strengths and weaknesses of different value bases. This neutralized form of education does not address fundamental political or lifestyle changes necessary for promoting social justice or ecological sustainability.

The goals of the science, technology, society and the environment aspects of the curriculum are at best reflective of education in and about the environment, as they aim to provide knowledge, understanding, respect, esteem and responsibility, but they do not encourage the investigation of the underlying social or political agendas or biases of the teacher, school or society. Therefore, knowledge outlined in the curriculum is presented as value and bias free information. It is an education which accepts technocratic and
managerial values and, insofar as it uncritically accepts existing social structures and hierarchies, may perpetuate elitism, injustice, class and gender inequalities and “business as usual” approach to economic growth and the resultant environmental degradation. The science curriculum emphasizes objective fact that is viewed as external to the individual and imposed on the individual. Curriculum knowledge is never questioned or analysed; it is something to be managed or mastered. This curriculum was developed by experts and reflects the values and beliefs of the dominant worldview. It does not address issues about the nature of truth, the difference between reality and appearances, knowledge and opinion and the inequitable distribution of power. Huckle states that schools in this paradigm “reproduce workers and citizens with skills, beliefs, and values appropriate to the existing order” (Huckle, 1991, p56).

The socially critical orientation of education in, about and for the environment varies greatly from this educational paradigm because it examines value-laden issues. In comparison, this curriculum remains neutral and does not identify political biases. My main criticism of the new science curriculum is its inability to meet aims such as calling “for students to deal with the impact of science on society and the environment” (Ministry of Education 2000, p4), while still maintaining and reproducing current social structures.

Even if these new science curriculum documents had an environmental education focus, the technocentric foundation would not allow for the extensive social critique and subsequent individual or social action necessary for attempting to challenge existing social structures. It is the reorientation of social structures towards ecocentric perspectives that is the underlying goal of socially critical education for the environment and this ultimately can not be achieved by Ontario’s new high school science curriculum.

**Conclusion**

In this paper I have examined educational assumptions underlying different environmental education paradigms. I explored and critiqued the philosophies of socially critical education in, about and for the environment. With this as a foundation, I have juxtaposed and critiqued Ontario’s new science curriculum. It is my belief that the educational paradigm underlying this new science curriculum is inadequate to meet environmental education’s goal of bring about significant, fundamental individual and social change. As such, issues of social and environment justice will be insufficiently addressed in even the
best case scenario of the implementation of the new science curriculum. It is my hope that the new curriculum represents a stepping stone towards an environmental education Mecca, rather than the proverbial Sinai.
Towards a holistic view of environmental education

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Background and rationale

The current round of reforms in science education were initiated by the publication of 'Science for All Americans' and further reinforced by many writers and reports such as the National Science Education Standards (National Research Council, 1996). Interests in such educational reforms have emerged virtually simultaneously around the globe creating the possibility for widespread and co-ordinated reform. In the U.S., this reform has focused on four major goals: science for all, teaching for understanding and application of science knowledge and processes, inclusion of a broader view of science in the curriculum, and "less is better" in terms of the breadth of the science curriculum. In many ways, these reforms highlight the importance of a social context for both the pedagogy and the (negotiated) content of science education, while providing an ideal context for the greater inclusion of environmental concepts in the curriculum.

Comparatively, attempts to develop meaningful subject matter for the study of environmental education have gone hand in hand with a quest for new forms of learning. In recent years, arguments in support of environmental education have increasingly referred to the idea that social themes are an excellent medium for 'new learning processes.' Particularly when forms of active learning, situated learning and collaborative learning are used (Ten Dam, Vernooij and Volman, 2000). Many works have been published describing the need for an inclusion of social and cultural (values) in the pedagogy of environmental education (Abraham, Lacey and Williams, 1990; Bowers, 1993; 1997; Lacey and Williams, 1987; 1990; Thomashow, 1995). Further, many practical resources are also available which describe the effective integration of environmental science within this social perspective (eg. Elstgeest, 1990; Hart, 1997; OECD 1995; Wass, 1990).

To some, the terms 'environmental' and 'science education' are very similar. However, though they share some perspectives and often cover the similar subject matter, it is important to realize they have arisen from distinct conceptual frameworks and often take radically different approaches. A goal of this paper is to begin to clarify issues and to raise questions regarding the relations that exist (or don't exist) between the two pursuits. Currently, there is a great deal of confusion regarding the nature of these relationships. For example, within many colleges of education, environmental education has become yet another area of specialized study and has further been identified as a 'branch' of science education. Bowers (1999) states that:

"The effect of this categorization is that the other areas of teacher education and graduate education continue to ignore the connections between the values and ideas they promote and the cultural behaviours now overwhelming the viability of natural systems. In addition, the association of environmental education with the sciences helps to perpetuate the modern myth that science and technology provide the most effective means of restoring the environment." (p. 161).

Despite the importance placed on values related in Bower's message, science and environmental education are indeed related (covering similar subject matter) and have much to contribute to each other in
terms of offering different perspectives on the "pedagogy of understanding" and in creating a somewhat broader role for science in the curriculum. Therefore, inclusion of a greater numbers of environmental concepts in science classes could be seen as advancing the goals of the current reform effort related to science (and environmental science) education. Further, a strengthening of the scientific perspective in 'environmental education' might also be useful in if we are to effectively bridge the gap between public discourse and discourse within the scientific community. In order to promote an understanding of scientific and environmental issues in the wider community, we must continue to adopt socially relevant strategies that will make these scientific issues more readily accessible to the public. This idea was expressed succinctly by McBean and Hengeveld (2000):

In contrast, to the fundamental role of logical thinking in scientific learning, society in general, accumulates and processes knowledge through experience, perception and intuition. Thus new information and facts are best understood and assimilated if these are placed within the context of the existing knowledge and past experience of the individual or community. (p.5)

To accomplish this goal, science educators must better understand the multiple perspectives inherent in the conceptual framework which informs the pedagogy of environmental education. These viewpoints are those that are also commonplace in the wider community and form the true context for learning about environmental issues.

**Perspectives on Environmental Education**

An interdisciplinary approach is central to the conceptual framework for environmental education. The environment concerns a social theme that by definition must span several disciplines. Real world problems are rarely simplified, and rarely fit neatly into one discipline (Ten Dam, Vernooij and Volman, 2000). From the perspective of the reform movement, and for new models for teaching and learning, the environment forms an authentic context in which learning processes can be situated, thus making the learning content more meaningful to students. In turn, this facilitates deep understanding of the subject matter: a key component of the reform effort in science education.

However, in many jurisdictions, environmental education, if included at all in the curriculum, has long been marginalized. Considered one more subject to be added to the already dense curriculum, environmental issues can be reduced to the transmission of a body of knowledge or facts related to nature study. Sometimes described as the scientific approach to environmental literacy, this approach plays a significant role in the teaching of environmental concepts. Golley (1998) in the foreword to his book *A Primer for Environmental Literacy* asks the question, "What does a scientific approach to environmental literacy mean? While he acknowledges that science can at times seem anti-environmental, especially when its discoveries are developed with no understanding of social or environmental needs. He goes on to describe the manner in which science contributes to environmental literacy as follows:

Science is the study of the material world, the world of matter, trees animals, rocks and soil. But is much more than a listing of the materials one encounters on a walk through a meadow. The scientist searches for patterns of relationship between natural objects and processes ... the
observation of patterns in nature and assessment of their consistency lead the scientist to generalizations." (p xi)

In addition to this scientific perspective on the study of the environment, some K-12 'environmental education' programs also include field studies and interdisciplinary curricula along with practical guidance on how to address environmental problems in their communities (Williams and Taylor, 1999). This attempt to provide a broader understanding of the relationship between the self and environment is difficult as there exists a great deal of variability in the value systems which groups bring to bare on issues related to the study of 'environment.'

An example of another perspective on environmental education was described in the controversial book Facts not Fear (Sanera and Shaw, 1999). In the foreword to this book, Patrick Moore (a co-founder of Green Peace) criticizes the environmental movement as giving "a whole new meaning to the idea of teaching our children about the birds and the bees." Moore relates that the subject matter has expanded to include "everything under the sun" and that "our children cannot separate fact from fiction" in a highly charged political debate. He asks "how can we help our children reach informed and balanced opinions on the multitude of issues and ideas that are collectively called environmentalism?" The irony in this statement is evident in that the perspective given through much of the book places a high value on economic considerations and (when taken alone) the book itself represents a very unbalanced view of environmental issues. The following quote is typical of statements made in the book:

Real environmental education (should) be far different. It would teach children critical thinking skills. It would inform students of science as it really is: an ongoing search for truth ... Students would also learn that protecting the environment is more complicated than "good guys" battling "bad guys." Controlling pollution can be costly and can slow economic growth. Slower growth can reduce people's interest in further environmental protection and their ability to bring it about (p.26).

While the above quote might be viewed by some as distinctly "anti-environmental" the quote makes an important point about the fundamental social and political connections between economic "progress" and ecological or environmental issues. It also makes a claim that economic or scientific values hold greater worth than other perspectives. While it is true that a purely value based approach to environmental education is probably not what we are looking for in the teaching of environmental issues, a purely scientific approach is also not without it's detractors.

An outspoken critic of the scientific perspective, Deloria, in his book Red Earth, White Lies: Native Americans and the Myth of Scientific Fact gives a depressing description on what the scientific perspective has meant for Native American culture and the environment. He sees the scientific perspective as culturally and socially limiting and believes that science is disdainful of more the traditional forms of knowledge held in native communities. His activism comes across as thinly veiled scorn in the following quote:
We are taught to visualize the scientist as a cheerful fellow clad in a white smock working in a spotless lab, and asking the insightful questions that will eventually reach us at K-mart in the form of improved vitamins, new kinds of audiotapes, and labour saving devices. On reaching the end of this experiment, which has featured a set of daring questions which he is forcing Mother Nature to surrender, our scientist publishes his results (p. 42).

Deloria also make another important point in that he describes the scientific viewpoint (without consideration of socio-cultural perspectives) is not presenting the whole picture on environmental issues. The scientific perspective when taken alone is seen as limiting the types of learning that can happen and that other social or emotional forms of learning are somehow viewed as less important than classic "knowledge based" outcomes. Whitehead also made this same point over half a century ago in the following quote (Whitehead, cited in Deloria, 1995).

When the routine is perfect, understanding can be eliminated, except such minor flashes of intelligence as are required to deal with familiar accidents, such as a flood, a prolonged drought, or an epidemic of influenza. A system will be the product of intelligence. But when the adequate routine is established, intelligence vanishes, and the system is maintained by a coordination of conditioned reflexes. (p.232).

Science educators today would know probably agree with Whitehead in the notion that we need to discard the old scientific reductionist models in favour of more authentic and socially negotiated approaches to the teaching and learning of environmental science. However, Deloria also argued that the lack of a crafted social or emotional component in the teaching and learning of environmental issues is the greatest deficit in the scientific perspective.

The separation of intellect and emotion (in science) can often be described as a contrast between the "ultimate in reduction" or "generalized abstraction" of concepts and (the moment of) "particular instances" (Krapfel, 1999). We may encounter in the same dimension the possibility for moving in one of two directions (the cognitive or emotional domains). However with environmental issues, Krapfel notes that a new characteristic can be emphasized: "... the perfect fusion of intellectual understanding with aesthetic emotion. It is in this fusion which creates the love of learning that drives scientists ever onwards ... " (p. 56). Awareness of this dimension is important because curriculum frameworks for environmental education often have an affective component (an emotional response to the natural world) and a separate intellectual content component (an intellectual response to the world).

In considering social and emotional competencies, they are often described as the ability to understand, manage, and express the social and emotional aspects of one's life in ways that enable the successful management of life tasks such as learning, forming relationships, solving everyday problems, and adapting to the complex demands of growth and development. They include self-awareness, control of impulsivity, working cooperatively, and caring about oneself and others (Cohen 1999). Social and emotional learning is the process through which children and adults develop the skills, attitudes, and values necessary to acquire their social and emotional competence. Knowledge of ourselves and others as well as
the capacity to use this knowledge to solve problems creatively provides an essential foundation for both academic learning and the capacity to become an active, constructive citizen (Cohen, 1999).

Since the publication of Howard Gardner's Multiple Intelligences in the Classroom in 1994, a great deal of attention has been paid to the notion of other forms of intellectual capacity and learning such as social and emotional capacities. Daniel Goleman in his 1995 book *Emotional Intelligence*, provided much evidence for social and emotional intelligence as the complex and multifaceted ability to be effective in all the critical domains of life, including school (cited in Cohen 1999). Goleman also stated the key point simply: "It's a different way of being smart." Cohen also points out that the multiple intelligences are socially based and interrelated:

"It's difficult to think of linguistics, musical, and interpersonal intelligence out of the context of social and cooperative activity, and the other four forms of intelligence are likewise principally social in normal practice." (p.3)

Of additional interest is that our knowledge of these capacities is expanding. In 1999 an eighth intelligence was added to Gardiner's original list of seven intelligences: the Naturalist (Thomas, 2000). The core of this intelligence includes a capacity to discriminate or classify different kinds of fauna and flora or natural formations such as mountains or clouds. Gardner added it to the theory after concluding that it met the same criteria for an intelligence as the original seven. Currently, a ninth intelligence; Existential is under consideration. Gardiner also notes that children can have several "proclivities" or inclinations towards the various types of learning which would include, Linguistic, Logical-Mathematical, Spatial, Bodily-Kinesthetic, Musical, Interpersonal, Intrapersonal forms in addition to the Naturalist form.

**Towards a Holistic View**

To many, a third way has arisen out of the confusion of perspectives that is environmental education today. Termed 'ecological education' it marries many of the perspectives described in this paper under one framework. Ecological education connotes an emphasis on the inescapable 'embeddedness' of human beings in natural systems. Rather than seeing nature as other - a set of phenomena capable of being manipulated like parts of a machine - the practice of ecological education requires viewing human beings as one part of the natural world and human cultures as an outgrowth of interactions between our species and particular places (Smith and Williams, 1999). Such an approach negates issues of 'right and wrong' and allows individuals or groups to consider multiple perspectives on an issue or problem.

As a point of example, In British Columbia, the multidisciplinary nature of environmental education has been described in a holistic manner which resists integration into either the science or social studies curricula. *Environmental Concepts in the Classroom* (Ministry of Education, 1995), describes how teaching about the environment is a complex undertaking involving a consideration of scientific, economic, ethical and political perspectives. It describes how educating students about the environment provides students with opportunities to learn about the functioning of natural systems, to identify their beliefs and issues, to consider a range of views and ultimately to make informed and responsible choices.
Smith and Williams (1999) list the dominant principles which inform the work of environmental educators subscribing to this type of ecological framework including:

1. development of personal affinity with the earth through practical experience and an ethic of care;
2. grounding learning in a sense of place by investigating surrounding natural communities;
3. induction of students into community experience - countering the press towards individualism;
4. acquisition of practical skills needed to regenerate human and natural environments;
5. introduction to occupational alternatives that contribute to the preservation of local cultures;
6. preparation for work as activists able to negotiate structures/policies supporting social justice;
7. critique of cultural assumptions upon which modern industrial civilization has been built.

In bridging the theory and practice of environmental education six principles central to our pedagogy are enacted in the B.C. guidelines, those of: direct experience; responsible action; complex systems; consequences of actions; aesthetic appreciation and environmental ethic (Ministry of Education, 1995).

Direct experience with the environment is a central platform to the guidelines as they provide students with a deeper understanding of natural systems and human impacts on those systems. Responsible action is considered integral to, and a consequence of environmental education. In B.C., environmental education addresses the study of complex systems in two ways: it examines the complexity and interrelatedness of natural systems and; it looks at human-created systems, both those that our built or part of the social fabric. Also, students learn how human decisions and actions have environmental consequences, that environmental awareness enables students to develop an aesthetic appreciation of the environment. Finally, the study of the environment can enable students to develop an environmental ethic.

Finally, by describing and complementing the distinctive conceptual frameworks in science and environmental education and their converging socio-constructivist pedagogies, it is proposed that educators can begin to address a number of important goals (general and scientific) pertaining to environmental issues in the broader curriculum. A holistic view of environmental education would include the following basic components:

1. development of a theoretical rationale and conceptual structure for environmental education (including a clarification of goals, values and beliefs) in students;
2. inclusion of environmental topics in diverse curricula which can include the social and natural sciences, the humanities and the arts;
3. a consideration of diverse instructional strategies including: experiential learning, sensory awareness, creative drama, role-playing, simulation, critical thinking, concept mapping, etc;
4. development of science processes including: observing, inferring, predicting, classifying, measuring and recording, controlling variables, building models, interpreting data;
5. fully considering environmental systems concepts such as product life cycles, food cycles, waste water treatment, air quality, land use planning, role of parks/reserves, etc.

In conclusion, the overall goal of environmental education is to reconnect disparate individuals and groups with the natural and technological environments which sustain them in the emerging post-industrial society. These connections may be remade in a number of dimensions including the physical, cognitive and spiritual (emotional) domains. Environmental and science education education together can also connect disparate views through negotiated activities which may include laboratory or research work, discussion on local or global environmental issues and through student lead research and guided inquiry. Wherever possible these should occur in "natural" settings however these are defined. Throughout a "course in environmental education" school age students should consider multiple values-based views about environmental education (including the scientific view) and should obtain valuable socio-developmental skills and cognitive attributes through exposure to real-world problems.

Perspectives on Environmental Education- Related Research in Science Education

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Introduction

This work takes as its starting point papers submitted to a special edition of the International Journal of Science Education. The papers were invited and edited by Justin Dillon and William Scott (University of Bath, UK). The aim of the special edition was to critically examine:

1. The relationship between science and environmental education in terms of ontology, epistemology, pedagogy and policy;
2. The role teachers of science might have in teaching EE with respect to the issues raised in 1;

The special edition seeks to draw contributions from across the world and from different perspectives. This paper picks out key issues in the (forthcoming) manuscripts, in an attempt to identify the critical issues that characterize the interfaces between science education and environmental education at the turn of the century.

Some key questions about future directions for environmental education can be identified from some of the titles of the articles:
Question 1: What might learning look like?

- Park Visitors’ Understandings, Values and Beliefs Related to Their Experience at Midway Geyser Basin, Yellowstone National Park, USA
- The science and values that young people draw upon to make decisions about biological conservation issues
- Knowledge producers or knowledge consumers? Argumentation and decision making about environmental management.

Question 2: What might teaching look like?

- Controversial environmental issues: a case study for the professional development of science teachers
- Making Biodiversity Meaningful through Environmental Education

Question 3: What might the curriculum look like?

- Mutualism: Toward a new agenda for environmental and science education
- Thinking/acting locally/globally: Western science and environmental education in a global knowledge economy
- Environment in the Science Curriculum: The Politics of Change in the Pan-Canadian Science Curriculum Development Process

These questions might form research agenda as well as a taxonomy of some current thinking.

Key Questions

Question 1: What might learning look like?

Brody (forthcoming) in a study of learning in an informal context (and I would wish to discuss what is implicit in the preceding phrase) argues that:

Modern, evolving theories of learning require that we continue to address the existing personal conceptions that people bring to educative events as well as the shared understandings of people created within the unique experiences related to the natural environment. Informal education programs must take into consideration the personal existing conceptions of people, their socially constructed meanings.

Such thinking about learning fits in well with some current discourses of science education. Talk of the social construction of knowledge and of building on existing conceptions fits well with much of what is discussed in NARST’s journals and conferences. However, is that a good thing? Research in science education has focused more on the cognitive dimension than on affective dimension. We do not really know much about how people learn. Is there a danger that in appealing to a constructivist discourse of learning that we will neglect other aspects of learning that may be more relevant to environmental education than they are to science education?

Brody makes the interesting point that unusual natural environments provide ‘Contexts for science and environmental education … [that] help support effective learning through the inclusion of social and
cultural contexts and unique subject matter’. It seems to me that that environmental education can offer science education a range of perspectives on knowledge and situated learning that assist those in the science education movement who wish to challenge existing orthodoxies. Through its multi-disciplinary origins and traditions, environmental education offers a conceptual richness that challenges some current thinking in science education.

The environmental dimension of EE also challenges some of the orthodoxies of the new science education paradigm. For example, Carlsen argues that ‘Inquiry-oriented science teaching often focuses on subject matter that is conceptually alien to students [whereas] … [I]nvestigations of the local environment … can bridge the familiar and the novel, as long as an appropriate model of inquiry is utilized’. This is a seductive argument but is it one that stands up to much scrutiny? What is the subject-matter that students can learn from the local environment? In what way is the local environment actually relevant to students? And how is that relevance different to the relevance of forces, electricity, acids, proteins, bacteria and genetics? Surely most subject matter can be made relevant? What does the environment have to offer that is so special to science education? It may be, as Brody intimates, that it is novelty of the environment that produces some of the biggest challenges to the learners’ existing conceptions. Maybe we should focus on how learners deal with the sheer complexity and splendour of the environment as well as looking to use the local environment as a vehicle for developing understanding of the more mundane aspects of the science curriculum.

Environmental education offers an opportunity to introduce not only novel science subject matter but also novel and useful social and cognitive skills. As Brody argues environmental and science educators are challenged to ‘respond to new intellectual and moral dimensions of education as they apply to people and the environment’. Environmental education provides an opportunity to bring in modern and challenging social and scientific issues into the classroom that is currently denied by the packed and sterile science curricula of many countries around the world.

Picking up this idea, particularly in terms of a fundamental biological concept, Van Weelie and Wals (forthcoming) point out that the ‘challenge for environmental educators is to enable the learning to attach personal meaning to biodiversity by embedding it in a very specific context in which the learner is or becomes psychologically and physically involved’. Environmental education offers science education contexts which might increase involvement and motivation.

It is not just students who are faced with learning about the new challenges facing society. How is the public to be educated about issues such as ‘bioprospecting, the threats of biopiracy and the value of newly discovered biotechnology resources’ (Brody, forthcoming)?

But what we know from research in science education is that many scientific concepts are difficult. Grace and Ratcliffe (forthcoming) point to ‘a study by Lewis and Wood-Robinson (1997) for example, showed that almost half of British 15-16 year olds (from a sample of 700), who had already studied genetics, were still unaware that all living things contain genetic information’. Teachers, they
argue, ‘are aware of the topic’s perceived difficulty and consequently often place it at the end of the school curriculum’. Grace and Ratcliffe argue that:

Teaching genetics prior to considering conservation issues and explicitly indicating the appropriateness of drawing upon genetics, ecology and the other essential concepts may be a useful foundation for conservation education’. So environmental education research might challenge the existing orthodoxy of topic sequencing.

Grace and Ratcliffe, in research that looked at how children examined an ecological situation involving competition between two species, raise another interesting point when they write that:

Values and scientific ideas are closely connected in the human mind. During discussions there were a number of pupil comments which could have multiple interpretations. For example, when a pupil argues that ‘puffins should be moved to a safer place where rabbits don’t live’, is this a ‘scientific’ or a ‘value’ statement? Competition between organisms is a scientific concept; competition between animals and humans is a values issue, depending on one’s biocentric-anthropocentric viewpoint.

Environmental education challenges not only the notion that science education should be value free but the notion that it is possible to identify whether utterances can be speared into ‘scientific statement’ or ‘value statement’. This is important because, as they argue, ‘Biological conservation is often taught as a value-free scientific discipline, and this may impede learning’.

Grace and Ratcliffe conclude by stating that their study showed that:

scientific concepts and values are both used by pupils in deciding about conservation issues, but more weight appears to be given to values, particularly as the discussion proceeds.

This poses a quandary to science educators who believe in the primacy of scientific thinking in working through some environmental issues, such as risk assessment and management.

Rather alarmingly, Grace and Ratcliffe point out that:

Pupils can fully engage in decision-making about conservation issues, but their use of values and scientific concepts is context-dependent, indicating a need for them to discuss a range of conservation scenarios in order to maximise their understanding of the complexities involved.

Environmental education does not usually occupy enough curriculum time to allow all the current issues to be contextualised and discussed. Should science education give up some of its curriculum time to environmental education on the grounds that EE is likely to provide richer and more efficacious learning situations?

Question 2: What might teaching look like?

Separating learning and teaching in this paper may not be wise. The points made by Van Weelie and Wals (forthcoming) show that the separation might impede discussion rather than enhance it.

Contextualising the concept of biodiversity does not in and by itself guarantee that it will become a suitable topic for environmental education. When developing an environmental education program we
also have to relate an analysis of the meaning of biodiversity … and the determination of an educational perspective to appropriate learning goals. Four pedagogical arguments for learning about biodiversity surfaced in the study: the emotional argument, the ecological argument, the ethical argument and the political argument.

Van Weelie and Wals examine the ‘ill-defined nature of biodiversity’ which ‘appears to be a useful feature from the perspective of environmental education’. According to them:

Biodiversity is renewing the discourse on nature conservation issues by bringing together different groups in society that are searching for a common language to discuss nature conservation issues in relation to sustainability issues. The resulting debate allows the socio-scientific dispute character of 'science-in-the-making' to surface (Bingle and Gaskell, 1994). Participation in such a dispute is an excellent opportunity to learn about a highly relevant, controversial, emotionally charged and debatable topic at the crossroads of science, technology and society (Bybee, 1991; Fensham, 1988; Latour and Woolgar, 1979). The socio-scientific dispute, with its underlying normative claims, which characterises biodiversity, provides a tremendous challenge for educators. Learners are confronted with many such concepts in everyday life. In the domain of environmental education, but also of contemporary biology education, one can think of concepts such as; sustainable use, sustainability, sustainable development and even nature conservation. Recognising the different political, symbolic and scientific uses of such concepts and making a critical assessment of their strengths and weaknesses, and of their knowledge and value claims in different contexts, could be an important learning goal of environmental education.

The implications for teachers here are immense. Not only do teachers need to understand the variety of meanings attached to such terms as ‘sustainable use, sustainability, sustainable development’ – a challenge in itself – but they need to be able to help students to develop an understanding of the ‘different political, symbolic and scientific uses of such concepts’ and encourage students to make ‘a critical assessment of their strengths and weaknesses’. What science education research offers to environmental education is an understanding of teachers’ opinions and knowledge.

Gayford (forthcoming) rightly points out that the:

Inclusion of controversial issues, such as global climate change within the school science curriculum presents several different challenges to teachers. Firstly the controversial nature of the topic, secondly it does not relate well to the normal sequencing and division of topics within most science courses and thirdly there are important non-scientific aspects to possible solutions to the problem.

Through discussions with teachers in focus groups, Gayford found that ‘science teachers preferred to maintain the integrity of their subject rather than be involved in extensive inter-disciplinary teaching’. Expanding on that point, Gayford writes that:

The teachers had a clear understanding that whilst they may have personal views about the environment and the ethical issues involved their responsibility was not to promote these at the expense of other objectives but instead to create a learning experience for students that allowed them to explore and
develop their own value system in a rational way. Within this view of education science education was seen to make a unique contribution. Particularly important here is the view of the nature of science and the problem of uncertainty.

Unlike some of the other authors in the special edition, Gayford asserts that:

emphasis within science education programmes could be more profitably focused on a range of more broadly based science abilities, rather than particularly concentrating on conceptual understanding.

So, should teachers focus on ‘broadly based science abilities’, as Gayford suggests or on ‘recognising the different political, symbolic and scientific uses of such concepts and making a critical assessment of their strengths and weaknesses’ as Van Weelie and Wals argue?

**Question 3: What might the curriculum look like?**

Governments continue to struggle to find a place and a purpose for environmental education, whereas science education is in a stronger position in most parts of the world. van Weelie and Wals key research question in their study (forthcoming) was posed by the Dutch government: ‘What are basic criteria, guidelines, principles and constraints when developing the theme of biodiversity from an environmental education perspective?’

However, Annette Gough points out that in her experience, ‘environmental education continues to be a priority for environment ministries but not education ministries’. Gough argues, on pragmatic grounds that there is a need for a ‘new, mutually beneficial relationship between’ science education and environmental education:

Science education needs environmental education to reassert itself in the curriculum by making science seem appropriate to a wider range of students and making it more culturally and socially relevant. Environmental education needs science education to underpin the achievement of its objectives and to provide it with a legitimate space in the curriculum to meet its goals because they are very unlikely to be achieved from the margins.

Gough argues for a ‘science education that [is] a reconstructed form which incorporates a more mutualistic relationship’ with environmental education. However, Gough points out that current versions of environmental education are far from adequate.

A new environmental science education will need to take account of:

1. critiques of traditional science education from feminist, postcolonialist and anti-racist perspectives (see, for example, Brickhouse 1994, Gough 1998, Harding 1993, 1998),
2. critiques of traditional science education from cultural and constructivist perspectives (see, for example, Aikenhead and Jegede 1998 and Bencze 2000 respectively),
3. declining interest of students in studying science at school (Dekkers & De Laeter 1997),
4. frequent calls for increasing the scientific literacy of the general public (Jenkins 1992, 1994, Shahn 1988, Willis 1990),

5. discussions of the role of science in environmental discourse (Hajer 1995), and

6. research which explores differences between the youth of today and previous generations (Gough 1999).

Gough (forthcoming) argues for a focus on the local context for environmental education but for reasons other than those mentioned by Carlsen earlier. Gough argues that the ‘local context … provides the opportunity for generation of local knowledge informing and empowering action’ adding that ‘privileging local knowledge also helps to destabilise notions of the universal status of scientific knowledge’.

Gough points out that ‘such a proposal might be threatening to those who practice traditional science education’, however her rationale is clearly spelled out:

as the numbers of disinterested students in class increase and the total numbers of students studying science decline, the alarm bells should be triggered that change is needed in science education practices. Adopting an environmental education approach may be just what science education needs. However, the task is to convince those who control the school curriculum and those who teach science in classrooms that science education needs to change.

Noel Gough attacks one of the most well known rallying calls of the environmental education movement – ‘Act Local, Think Global’. Gough takes the position that ‘the contribution of Western science to understanding and resolving environmental problems may be enhanced by seeing it as one among many local knowledge traditions’, something guaranteed to raise the hackles of some science educators.

The production of a ‘global knowledge economy’ in/for environmental education can then be understood as creating transnational ‘spaces’ in which local knowledge traditions can be performed together, rather than as creating a ‘common market’ in which representations of local knowledge must be translated into (or exchanged for) the terms of a universal discourse.

This view might be seen to challenge the view of Zandvliet who argues for a holistic view of environmental education and proposes a ‘multidisciplinary approach that is applicable to all subjects and grade levels’. Taking what some would call the modernist view, Zandvliet argues that:

it is imperative to explore a variety of different conceptual frameworks, societal perspectives, and personal values relating to "environment." The goal of environmental education being to reconnect disparate individuals and groups with the natural and technological environments which sustain them in the emerging post-industrial society."

Taking a more teacher-focused approach, Hart (forthcoming) argues that ‘Environmental educators have long argued that the modernist notions of schooling and curriculum, which are organized as subject matter disciplines, are inappropriate for learning about complicated, interdisciplinary social and environmental issues …’. According to Hart, ‘Modern schools … represent a theory of social change that isolates teachers from the curriculum development process, thus from control over the thought and practice of policy’. 
Hart asks a series of challenging questions:

1. What are the criteria teachers use to make their curriculum decisions?

2. How can we create conditions for teachers to discuss their theories in terms of cognitive as well as effective, aesthetic and personal understandings?

3. How interested are teachers in finding out about their preoccupations and unconscious commitments?

But these are questions that we can surely ask of all teachers and not just those involved in environmental or science education. Hart argues that:

Professional development which includes personal, social, and environmental values can situate learning in a broader array of curriculum contexts where issues can be explored critically from ethical as well as scientific viewpoints. The challenge is to work toward science curricula which do not pretend neutrality nor abstract a preferred morality base that is unattainable (Payne, 1999) or to ground value positions solely in scientific/technical rationality (Bauman, 1993). Teaching invariably involves morals, thus moral sensitivity (and environmental sensitivity) can be extended performatively through the ethical actions of teachers and teacher educators. However, for this to occur professional development experiences must provide bridges between moral and scientific knowledge and ethic judgments. These connections remain problematic.

So, another possible avenue for research would be to examine how teacher professional development can lead to the building up of connections between teachers’ ‘moral and scientific knowledge and ethic judgments’.

Concluding Remarks

In this paper for the NARST panel, I have rather peremptorily hacked around with the views of a range of colleagues in order to build the first step in what might be a coherent argument. For the time being, I would appreciate comments on this paper and would ask that the paper not be quoted until after the NARST conference when a better version will be available.

Conclusions

Yvonne Meichtry, Northern Kentucky University

The purpose of this symposium was to inform and raise questions relevant to the relations which exist between environmental education (EE) and science education (SE). Specific themes which emerged through the voices of the authors included the epistemology of EE and SE, curriculum development and implementation considerations and practices, and the blending of effective pedagogy. The information and ideas presented about these themes provide insights into the distinctions and interrelationships between the fields of EE and SE. The authors also defined issues and raised questions related to the theoretical and practical considerations inherent to our combined roles as environmental educators and science educators.
Epistemology

Discussions related to the epistemology of EE and SE included the challenges of defining the epistemology of SE and EE, the differences and similarities between the epistemologies of EE and SE, and the potential for the epistemology of one field to inform the other. The epistemology of EE was characterized as:

1. multi-disciplinary in nature, crossing subject area boundaries in traditional school subjects and including the social, political, economic, personal, cultural, ethical, and moral dimensions of learning;
2. inclusive of learning content-identifying and considering a range of beliefs and values about issues-and acting through the process of making informed decisions; and
3. embedded in social constructivism.

Challenges faced by environmental educators in an attempt to define the field are summarized as follows:

1. There are a variety of EE conceptual frameworks that exist. Even in the current time period, during which national guidelines (NAAEE, 1999) which are based on international efforts (UNESCO, 1978) have been developed for K-12 and preservice teacher preparation, we find that the concept of EE varies across countries, states, localities, and among teachers.
2. The emphasis on teaching in and about the environment has changed throughout history. Throughout history, the stages of teaching about the environment, in chronological order, have been nature education, conservation education, outdoor education, and environmental education. Although current day EE is inclusive of the emphases in each of the previous eras, due to a more narrow focus of each of the previous eras, a more narrow view of what EE is still exists today.
3. The nature of EE is multi-dimensional. As pointed out in this paper, the environment is about real world problems and real world problems do not fit neatly into one discipline. The authors agree that an interdisciplinary approach is inherent to EE. It is the multidisciplinary nature of EE, however, that has caused a fragmented and inconsistent approach to this field and created a situation in which EE has been marginalized in school and university curriculum.

As pointed out in this paper, EE is ontologically different from SE because it compels students to participate in socio-democratic action. EE takes a view of learning that goes beyond acquiring knowledge to include active deliberation about issues relating to one’s own environment. The authors agree that the inclusion of the social, political, moral, ethical, attitude and values, and personal dimensions of EE in SE will require a reconceptualization of SE.

This reconceptualization was described as a broadening of SE and is seen as one way that EE can inform SE. Other ways that EE can inform SE include, 1) the fostering of an examination of ways that science affects the environment, 2) adding the social-constructivist dimension to examine the effects of science on society and of society on science, and 3) fostering the development of the personal and social competence of students.

In turn, there were views about ways in which SE can inform EE, which included: 1) deepening the learning of ecological concepts and 2) the teaching and use of scientific inquiry processes used in the search for knowledge about how the natural world functions.
Questions posed by the authors on the topic of epistemology included: 1) Does EE set a good example for SE in respect to the inclusion of the role of values, decision-making, and taking action? 2) What can science educators learn from EE about science, the nature of science, and scientific inquiry?

**Curriculum Development and Implementation**

The curricular ideologies which have dominated SE for decades, as Hart points out, are undergoing significant changes and challenges. The new reform-based premises of science are based on the goal of developing a scientifically literate citizenry (AAAS, 1993). This goal reflects a shift toward the inclusion of social contexts in science teaching and provides the ideal context for a greater inclusion of environmental concepts in the curriculum. The new curricula discussed in this paper, *Science, Technology, Society, and the Environment* (STSE) and *Science, Mathematics, Technology, and the Environment* (SMTE), reflect the current trend of reform-based curricula to integrate teaching about society, technology, science, and the environment.

While the authors recognize that these curricula are an improvement of traditional science curricula, they provide insights about their limitations as well. One major area of concern expressed was the biased perception that evolves due to the integrated theme of society, science, technology, and the environment. The premise of the concern about these curricular associations is that they may develop the perception that science and technology promote the most effective way of restoring the environment.

The degree to which the intended curriculum is actually implemented by teachers was another concern posed. Factors identified in this paper that have the potential to influence the degree to which the “intended” curriculum gets implemented by teachers include the teachers’ construed meaning about the value of change, their personal ties with the natural environment, their cultural and moral values, and the degree of educational training they have had in regard to the newly integrated dimensions of EE with the science curriculum.

Questions related to curriculum issues include: 1) What factors influence the differences between the “intended” and “enacted” curriculum? 2) What is the true ability of the new science curricula to adequately meet EE’s goal of bringing about fundamental individual and social change? 3) What are effective ways to broaden the SE curriculum through the inclusion of EE? What goes? What stays? What is newly created? 4) What are ways we can create curricular associations between the dimensions of EE and SE in a balanced way, without sacrificing the integrity of either field?

**Pedagogy**

Connections between the teaching pedagogies associated with EE and SE were referred to by the authors in a number of contexts. Specific teaching strategies, well supported in the literature for the teaching of both EE and SE, are experiential learning, sensory awareness activities, role-play, values-clarification, student engagement, personalized instruction, group work, student reflection, use of the natural environment as a context for learning, learner-centered teaching, addressing the multiple
intelligences, and providing experiences which students perceive to have personal and social meaning. Teaching pedagogy discussed in some detail by the authors included the importance of including attitudinal and values development strategies, the use of the environment as a learning context, and the use of scientific inquiry teaching methods.

The consideration of pedagogical methods to address the attitudes, beliefs, and values of students was explicitly addressed by the authors as a core pedagogy used in EE that is lacking in SE. The reform goal to develop scientific literacy does include the study and development of scientific values in the context of social structure. How explicitly this is evident in existing curricula and in teacher-developed curriculum, however, is questionable.

Using the environment as an authentic context for learning was another pedagogy promoted by the authors. Providing students with direct experiences in the environment was seen as a way to address the aims of both EE and SE; by developing an awareness and appreciation for the environment, while providing the context for students to develop such scientific skills as questioning, data gathering, and use of equipment. Using a local setting that is familiar to students as a means to facilitate the assimilation of new learning was another learning benefit identified. That the use of the natural environment helps to make the learning of content more meaningful, facilitating a deeper understanding of the subject matter and that it provides a social context for learning, promoting a sense of purpose through exposure to authentic problems were other advantages discussed.

Using the natural environment as an educational setting also lends itself to the integration of other areas of learning such as the visual arts, language arts, and social studies. Evidence gathered from 40 schools in a national study conducted by the State Education and Environment Roundtable indicated that students learn more effectively within an environment-based context than within a traditional educational framework (Lieberman & Hoody, 1998). Results from this study showed that students had better performance on standardized measures of academic achievement in reading, writing, math, science, and social studies; reduced discipline and classroom management problems; increased engagement and enthusiasm for learning; and a greater pride and ownership in accomplishments.

The use of scientific inquiry teaching methods is another pedagogy that has strong support in the teaching of science and EE. Specific teaching approaches supported by the authors include the engagement of students in inquiry, the development of science process skills, and providing experiences which are truly discovery-based, as in authentic science – meaning that students and teachers do not know what the results will be in their own environment.

**Concluding Thoughts**

Hart cites Bonnett and Elliot (1999) as stating explicitly that it would be difficult to identify an issue of greater importance for humankind than its relationship with its environment. I would ask that each of us contemplate this statement. I would next ask that we identify our own beliefs and values in regard to the statement. Finally, I would ask that we define for ourselves how our own beliefs and values have the
potential to impact the decisions we make about our teaching and programs, the degree to which we are involved in the policy arena, and the choices reflected by our own scholarly work. Through this set of reflections and in keeping with the spirit of this symposium to create an opening for dialogue, I would encourage each of us to answer the following set of questions:

1. What are my goals in relationship to EE and science education?
2. How can NARST help me to accomplish these goals?
3. Who can I work with at my home base to help me accomplish these goals?

Other questions posed by the authors of this paper that we can ask ourselves as science teacher educators and/or environmental educators, include the following:

Do the current practices of Colleges of Education that designate EE as a specialized area of study or that identify EE as a “branch” of SE, reflect the true epistemology of EE discussed in this paper?

1. What do we as teacher educators or as nonformal educators use as a source of guidance in our decisions and practice?
3. How do we ensure that teachers receive the training and encouragement to use the new reform-based curricula as their primary science program?
4. What is the relation between current trends in EE and SE research?
5. What are the researchable questions we can ask to develop a knowledge base about the broadening of SE to include the social and moral dimensions of EE?

The authors hope the information, ideas, and questions presented in this symposium will promote dialogue and continuing discussions within the NARST community. Feedback is welcome and encouraged. It is also the hope of the authors that the momentum generated within NARST during this past year will continue to create a venue for interested participants to discuss their interests in EE and to develop relevant support networks.

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References in Conclusions:


