Environmental Learning as a Unique Context for Science Education

Aprendizagem ambiental como um contexto único para a Educação em Ciências

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Abstract

Challenges faced by science and environmental educators in respect to the distinctions and interrelationships between these fields have been many over the past few decades. While some scholars note contradicting epistemologies and purposes in their critique of the nature of an environmental (science) education, this paper considers another perspective: through participatory methods it examines how environmental learning may form a unique and qualitatively different context for science education. The paper also highlights a collaborative inquiry into the practices of environmental learning as it is enacted in formal school curriculums in British Columbia, Canada. Our efforts involved critical document analysis of frameworks and resources from around the world. Focus groups and interviews conducted over a period of 16 months informed a collaborative writing process that included teachers, academics and government officials. The framework produced offers a conceptual view for environmental learning in all settings (including science) while providing several principles of teaching and learning to guide educators in designing activities for varied learning contexts. The framework provides a number of perspectives around which environmentally-focused lessons may be developed and demonstrates that environmental education should included scientific understandings but be broadened

to include other forms of knowledge including aesthetic appreciation, social responsibility and the development of an environmental ethic.

Keywords: environmental education, science education, place based education, sustainability, experiential learning.

Resumo

Os desafios enfrentados pelos educadores científicos e ambientais no que diz respeito às distinções e inter-relações entre esses campos têm sido muitas ao longo das últimas décadas. Enquanto alguns estudiosos notam epistemologias e propósitos contradizentes em sua crítica sobre a natureza da educação ambiental (em ciências), este trabalho considera outra perspectiva: através de métodos participativos, examina como a aprendizagem ambiental pode formar um contexto único e qualitativamente diferente para a educação científica. O artigo também destaca uma investigação colaborativa nas práticas de aprendizagem ambiental tal como aprovada nos currículos escolares formais em British Columbia, no Canadá. Nossos esforços incluíram uma análise crítica de documentos sobre modelos e recursos de todo o mundo. Grupos focais e entrevistas realizadas ao longo de um período de 16 meses compuseram um processo de escrita colaborativa que incluía professores, acadêmicos e funcionários do governo. O quadro produzido oferece uma visão conceitual para aprendizagem ambiental em todos os cenários (incluindo a ciência), enquanto fornece vários princípios de ensino e aprendizagem para orientar os educadores na elaboração de atividades para variados contextos de aprendizagem. O quadro fornece um número de perspectivas em torno das quais podem ser desenvolvidas aulas voltadas para o ambiente e demonstra que a educação ambiental deve incluir compreensões científicas, mas ser ampliada para incluir outras formas de conhecimento, incluindo a apreciação estética, a responsabilidade social e o desenvolvimento de uma ética ambiental.

Palavras-chave: educação ambiental, educação em ciências, educação baseada no lugar, sustentabilidade, aprendizagem experiencial.

Introduction

Challenges faced by science and environmental educators in respect to distinctions and interrelationships between these two fields are many (see BODZIN; KLEIN; WEAVER, 2010; SILVEIRA, 2001; VASCONCELLOS; LOUREIRO; QUIEROZ, 2010). Still, the teaching of environmental education (EE) has continued in science classrooms in one form or another for many years. Scholarly work in the field of EE often creates a paradox for science educators: separate professional organizations exist for the two fields, and relating the two knowledge bases, or receiving support from the science education community for work accomplished in the field of environmental / sustainability education are often significant challenges. Challenges evident for environmental educators include: changing definitions / streams of EE throughout history and the variety of forms for EE that exist in current day thinking (see SAUVÉ, 2005). These issues coupled with the multidisciplinary nature of EE and its marginalization in curriculum also contribute to the fragmented nature of this discourse.

This research began with the review of an earlier framework, *Environmental Concepts in the Classroom* (BRITISH COLUMBIA MINISTRY OF EDUCATION, 1995). The guide was originally developed to give support for an integrated approach towards environmental learning because so many subject areas touch on environmental topics or experiences. By emphasizing that the study of environment is not a unique subject area, it was hoped that students come to understand how their actions affect local *and* global environments (BRITISH COLUMBIA MINISTRY OF EDUCATION, 1995; 2007).

Since the original framework, there have been many developments in EE (see SAUVE, 2005). These were informed by International agreements, such as the Kyoto Protocol (1997), Johannesburg World Summit on Sustainable Development (2002), and the proclamation of the UN Decade of Education for Sustainable Development (2003). This is accompanied by new research on how people learn and on what constitutes a quality educational experience.

Why do we learn about environmental issues? In part, because there continues to be a concern about the state of the 'environment' broadly defined in the scientific discourse – yet we are confused by the complexities of other economic, ethical, political, and social issues related to the concept. The issues we face, both as individuals and within our broader society, are so pervasive and ingrained within our cultural ways of being that we can no longer look to science and technology alone to solve these problems (Bowers, 1998). As a consequence, environmental learning can and should include a sustained critique on dominant societal and industrial practices that often contribute to widespread and localized environmental problems (see SAMMEL; ZANDVLIET, 2003).

Hutchison (1998) describes three distinct approaches to the implementation of EE: a *supplemental* approach in which teachers are provided with curricular materials they may use in addition to regular teaching; an *infusionist* approach in which environmental themes are integrated into curricular topics, and an *intensive experience* approach in which students participate in short, outdoor immersive trips and experiences. In the *supplemental* approach curricular materials are self-contained and require limited knowledge or preparation on the part of the teacher. In an *infusionist approach*, the environment becomes the organizing concepts for an interdisciplinary curriculum, the premise being that all education is EE (ORR, 1994).

In our work, we build on the infusionist approach by conceptualizing environment as an organizing theme for interdisciplinary teaching. This stems from a belief that environmental learning is not a subject matter to be treated separately but is inter-connected with everything we do as human beings (BC MINISTRY OF EDUCATION, 2007). It is intended that an interdisciplinary approach to teaching supports students' understandings about how their actions impact the environment. Working to integrate environmental learning within all subject areas promotes this change in attitude by providing students with opportunities to experience and investigate relationships among individuals, societies, and natural surroundings. In addition, infused forms of EE provide students with opportunities to learn about the functioning of natural systems, to identify their beliefs and opinions, consider a range of views, and to make informed, choices for themselves, their families and communities.

Education, Environment and Sustainability

Developments among the fields of sustainability, environment and their relationship to education have continued apace over the past decades and these have impacted efforts at the international, national and local levels. Because of its openness, the content of EE has always developed with society (WANG, 2003). In response to this global debate about sustainability, the Canadian government developed a broad vision for environmental learning with its *Framework* for *Environmental Learning and a Sustainable Future in Canada*.The framework reported that a majority of Canadians felt that environmental learning should be inextricably linked to values and ethical ways of thinking (GOVERNMENT OF CANADA, 2002).

As stated, EE aims to integrate concepts and principles of the sciences and social sciences under a single interdisciplinary framework. In the ecological view, students may come to know and understand that all human environments, societies and cultures are deeply embedded and dependent on natural systems, both for their development and their continued survival. These *ecological* notions of EE are also congruent with the discourse around place-based education.

Place-based education has been described by Sobel (1993; 1996) and related ideas have been expanded on by others including critical pedagogy and rural education (GRUENEWALD, 2003), community contexts (HUTCHINSON, 2004), eco-literacy (ORR, 1992; 1994), ecological identity (THOMASHOW, 1996), and experiential learning (WOODHOUSE; KNAPP, 2000). Place-based learning connects theories of experiential learning, contextual learning, problem-based learning, constructivism, outdoor education, Indigenous education and EE. As BC is a diverse province, our ideas about environmental learning take seriously the notion of communities and their importance for the consultative process and for deep knowledge about local ecologies and learning (KNAPP, 2005).

Methodology

In our research, it is recognized that ideas about teaching can be described as both art and science. Environmental learning considers multiple models for teaching / learning, as well as teachers' pedagogical content knowledge to form a unique blend of interdisciplinary knowledge about learning contexts (PALMER, 1999). While guiding principles are helpful, they were only a starting point in our methodology.

In this effort, diverse voices and methods that constitute environmental learning across British Columbia were honoured while referencing international and national discourses that inform the broader field. The first part of our methodology involved a sequential analysis of frameworks across several jurisdictions using a comparative approach (ARNOVE; TORRES, 2003). The second involved community-based inquiry that has been termed *participatory action research* (GAVENTA, 1988; KEMMIS; MCTAGGART, 1994; SELENER, 1997).

Participatory Action Research

Scholars have generally described five approaches to participatory action research (PAR) including: (1) action research in organizations, (2) participatory research in community development, (3) action research in schools, (4) farmer participatory research, and (5) participatory evaluation (SELENER, 1997). Conceptually, PAR originates from critical and neo-Marxist perspectives and practices developed within the social sciences over three decades. Traditional scientific approaches and educational practice are sometimes seen as maintaining hierarchical roles for researchers/subjects and teachers/students. In contrast, PAR questions unequal power relationships inherent in these more traditionally-run institutions (eg education or science) and offers an approach to research that recognizes inequalities in our modern society.

The form of knowledge described herein as *participatory action research* enables a form of inquiry that places research capabilities into the hands of the "subjects" of the research, providing these individuals with the research tools with which they can generate knowledge for themselves. Knowledge created in this way is empowering, as it can be transformed by the participants into actions that are directly beneficial for their own community. A vital element of this type of research approach lies in its attempt to remove the distinction between researcher and subject, with scientists and community members walking up the research path together, encouraging all participants to share in the process of decision making and rewards of research (GAVENTA, 1988).

The use of PAR as a research paradigm has sometimes been contested with issues such as: Is the inquiry defensible as research? How crucial is participation and how is it expressed? Is the research about social improvement, or is it only about research efficiency with basic values unquestioned? Finally, what are the appropriate roles for researchers, research, and other social agents in the enhancement of the human condition? (KEMMIS; MCTAGGART, 1994). In our work, we address these issues by including a broad range of stakeholders in our community of inquiry – with government officials, pre-service and inservice teachers, school administrators, community members and university academics all working alongside each other to develop the ideas expressed in this work.

Consultative Methods

The focus and working groups conducted as part of this research occurred in a variety of communities around BC and as mentioned, included broad representation from various stakeholder groups including the Ministry of Education, schools, informal education organizations, First nations, university students and academics. The structure of these meetings were congruent with the PAR approach in that they were co-lead and co-organized by community members and participants – with researchers acting as resources (alongside teachers, administrators and officials) for the working part of the meetings. There were six working meetings held over a 6-month timeframe in communities around the province – ranging from a full to half-day format. Follow-up submissions were also required with further input and feedback solicited by email and telephone. These submissions continued for 10 months after each consultation as community members revised work started during the face-to face consultations.

Working Meetings and Focus Groups

For each consultation, participants were provided with the original government document: *Environmental Concepts in the Classroom* (BC MINISTRY OF EDUCATION, 1995) as well as a selection of readings/frameworks from other jurisdictions. Participants were organized into working groups tasked with re-visioning or re-purposing certain aspects of the original document (e.g. acting as quasi-editors). After each working session these groups reported back on their work to the whole community to have their ideas further scrutinized or enhanced. University researchers and graduate students acted as resource persons and record keepers during this engaging, community–based process of data collection. As a further enhancement to the process, community members made further presentations about their localized practices in environmental learning and encouraged to comment on how our joint project should be communicated to the wider teacher audience. These communications continued for up to 6 months after a face-to-face consultation – extending the content re-visioning process in each community.

Results

As noted, the consultative process and document analysis described in the previous section had the outcome of producing a revised framework for environmental learning that was adopted by the BC Ministry of Education and guided teaching and curriculum development in the interim. In short, the revisions to the original framework re-energized practices around environmental learning in the province and these ideas have are accessible to all teachers through a Ministry of Education website (www.bced.gov.bc.ca/greenschools). The results clearly delineate EE as conceptually broader than science education while also including important aspects of scientific literacy. What follows is a brief overview of the conceptual results of our knowledge and re-visioning process.

Environmental Learning Re-Visioned

In the completed framework, the following principles came together to integrate environmental learning by attempting to connect diverse subject areas, such as Science, with other disciplines such as Math, Social Studies and English. Facilitating environmental topics in the learning of all subjects, rather than isolating it, models for students to illustrate how the environment is connected to their daily lives and relationships within their communities. As a direct result of our efforts, the principles of environmental learning were organized into two related areas: first, the principle of: *experiential teaching and learning*; and second, a statement and description of some *organizing principles for environmental concepts*. This organization demonstrates the interdisciplinary nature of environmental learning, while showing a progression for the development of ideas leading students towards a deeper engagement with EE topics.

Teaching and Learning Principles

Educators across the province acknowledged first that *direct experience* with a

concept, followed by opportunities for student observation, reflection and negotiation, presented the richest form of learning. Experiential learning in the environment (see KOLB, 1984; LUCKMAN, 1996**)** is an important and vital way to learn. These opportunities help provide students with a deeper understanding of natural systems and the impact humans have on those systems. Direct experience also allows students to challenge other cultural perspectives regarding environmental problems and examine them critically.

Our communities acknowledged that for direct experience to be relevant, the development of critical and reflective capacities is paramount. When students are given adequate time to reflect on learning, they evaluate their experience against the experiences of others. Central in this is allowing students to negotiate among multiple perspectives or ideas about environmental problems. *Negotiation* involves actively seeking out differences in opinions and looking for common ideas or themes around specific issues. A view of teaching and learning that incorporates the direct experience, critical reflection and negotiation as a foundation for the learning process is summarized (below) as the experiential learning cycle.
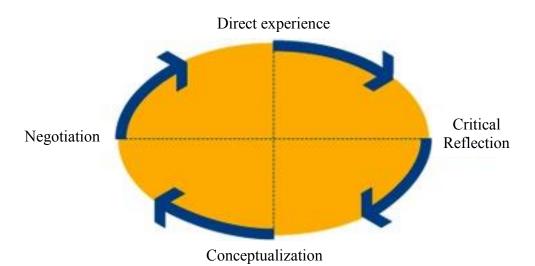

Figure 1: The Experiential Learning Cycle.

Methodology typical to a learning cycle approach includes: choosing a concept to be taught, and having students explain their experiences and evaluate their ideas against others' conclusions, as well as with their own direct experiences. In this model, knowledge is not viewed as stable, but instead *conditional* as our developing knowledge grows from exposure and experience. In the model, teachers emphasize thinking, understanding and self-managed learning for students (see Shapiro, 1994).

Principles for Conceptualizing Environment

Another outcome of the consultation was that a restatement, description and summary of organizing principles for *conceptualizing environmental learning*. These principles essentially give teachers a set of lenses with which to critically view curriculum. Through a consideration of these principles, teachers, understand that experiential programs must examine the complexity of natural systems and that human interaction with these systems must be considered using not only scientific

inquiry but a range of other methods. Participants understood that holistic forms of environmental learning help students to develop a sense of respect and appreciation for the natural world and that an *aesthetic appreciation*, along with a scientific understanding of nature, encourages students to learn and act to protect and sustain the environment. Consultation also developed the idea that we need to facilitate students' deep understanding of what constitutes *responsible action* toward the environment and to help students to act responsibly it in their personal lives. Finally, participants understood that these actions can be influenced by belief systems and personal limitations (physical and cultural) student actions can take many forms. Teachers should encourage students to make decisions based on an understanding of the issues, as well as their personal values, and with the (sometimes conflicting) values of others.

Working groups synthesized these ideas into four discrete themes. The principles for organizing and conceptualizing environmental education now include: a consideration of *complexity* (or complex systems); *aesthetics* (or aesthetic appreciation); *responsibility* (responsible action and consequences of action); and the practice of *environmental ethics*.

Figure 2: The Mnemonic and Metaphor of CARE (Complexity, Aesthetics, Responsibility, Ethics)

The mnemonic and metaphor of CARE (Complexity, Aesthetics, Responsibility and Ethics) was developed and can be used to describe the various forms environmental knowledge can take. To the working groups, CARE demonstrates the interdisciplinary nature of environmental concepts, while also showing a progression of the development of ideas that can lead towards deep engagement with environmental learning in all of its forms. Inherent in this was the notion that EE was a broad, overarching concept that could effectively provide a unique context for science education. This paper now continues with a discussion of the emergent principles and a consideration of how each of these types of knowledge contribute to the conceptualization of environmental topics in curriculum.

Discussion -- Conceptualizing 'Environment' in the BC Curriculum

Assertion one: Environmental Education considers Complexity

The principle of complexity as an organizing theme for environmental topics was a relatively uncontested idea in this work and is well supported in the academic literature (see for example CAPRA, 1996; GONZALEZ-GAUDIANO, 2001; DELGRADE DIAZ, 2002). Participants in the consultations agreed that environmental learning could

address the study of complex systems in two ways. First, it examines complexity and interrelatedness of natural systems (from a scientific perspective), but also how humans interact with and affect those systems. It looks at human-created systems, both those that are built and those that are part of our social fabric. For example, when students investigate the water cycle, a food web, or photosynthesis, they are studying a natural system (using scientific methods). However, when they investigate government and politics, economics and the evolution of societies, or highway and sewage systems, they are studying human-created systems. These investigations help students understand the complexity of systems and the links between them that are not scientific 'in nature'.

Participants in the consultations concurred that knowledge from a broad range of scientific disciplines contributes to a well-rounded understanding of environmental issues. However, they also stressed that there must be awareness that knowledge is not static and that these theories can change. Knowledge from the sciences, economics, politics, law, and sociology were also viewed as equally vital to the study of complex systems and human interactions. Through also studying cultural systems and global issues, students may begin to see the relationships between the environment and human rights, justice, race and gender equity. Other cultures in the world present diverse perspectives on ways of valuing and relating to natural and human-created environments. In developing a thorough understanding of these systems, students examine the origins and impact of their present worldview and analyze the implications of new information and changing societal values.

Assertion two: Environmental Education considers Aesthetics

The principle of aesthetics as an organizing theme for environmental topics was a fairly widely held idea in the consultations and many participants believed this to be the most evocative principle with which to capture students interest in the environment. This principle significantly extends the epistemology of environmental education beyond a consideration of only the scientific perspective. Aesthetic appreciation can span a number of areas of practice including: art education (BLANDY; HOFFMAN, 1993; CARPENTER; TAVIN, 2010); ecological art (SONG, 2009); architecture (UPITIS, 2007); and music (TURNER; FREEDMAN, 2004). In short, aesthetics deals with beauty, artistic expression, and our physiological responses to these. Participants concurred that environmental learning helps students to develop an aesthetic sense of respect and appreciation for the natural world through study, physical challenges, and other experiences in nature. An aesthetic appreciation, along with other understandings of nature, encourages students to learn and act to protect and sustain the environment, and contributes to self-awareness and personal fulfillment. Further, participants acknowledged that outdoor studies and activities in physical/outdoor education helps develop in students an aesthetic appreciation. Aesthetics also was regarded as having an internalized component related to what we personally value in nature.

Participants concurred that aesthetic values may also explore explicit value shifts, such as those found when examining a natural setting for the development of a park or a residential development. The idea that nature has fundamental worth from an aesthetic point of view is one example of a value shift. Different types of value shifts are also possible in environmental aesthetics and environmental criticism in the arts;

however, these often concentrate on cultural expressions of interactions with nature. Finally, aesthetic experiences were seen by educators as providing insight / enrichment to human interaction with the environment by allowing students to: develop understandings of aesthetic qualities that exist in the environment; develop skills and sensitivity to the application of aesthetic criteria; and develop the ability to formulate, apply, and communicate personal aesthetic criteria for assessing environmental issues.

Assertion three: Environmental Education considers Responsibility

The notion of responsibility is also discussed extensively in EE literature (see PALMBERG; KURU, 2000; LEWIS; MANSFIELD; BAUDAINS, 2008; SHORT, 2010). However, the principle of responsibility as an organizing theme for environmental learning was somewhat contested during our consultations as groups explored the relationship between two related principles explored in the original framework: the *consequences of action*; and second, what constitutes *responsible action*. A consensus eventually emerged in our work that determined that the two concepts were closely related, but differed mainly in the temporal dimension. As such the two concepts were combined into the larger principle of *responsibility*.

Participants related that studies about environmental responsibility provided opportunities for students to explore the environmental *consequences of actions* or decisions made at personal, community, societal, and global levels. Studies in geography, history, technology, or other disciplines help students to develop awareness of diverse cultural perceptions and interpretations. Further, participants concurred that through the study of human impacts on the environment, students could explore and develop positive approaches to long-range environmental concerns. Exploring and addressing global issues, such as militarism and war, inequitable distribution of wealth and resources, food production, and transportation are essential to establishing a sustainable society. Finally, a focus on decisions or actions in other cultures was seen as contributing to questions about how to live more sustainably. In the more immediate sense, *responsible action* was seen by participants as being a consequence of, environmental learning. Participants clarified that in light of what we know about past decisions on environmental issues, it is vital for students to decide what constitutes responsible action, and begin to practice it.

Assertion Four: Environmental Education considers Ethics

The principle of ethics as an organizing theme for environmental learning was the most widely held idea in the breadth of our consultations and many participants believed this to be the overarching principle for the work of environmental educators (see JICKLING, 2004; BOWERS, 2009). Participants also saw the principle of environmental ethics as one closely related to that of *responsibility*. Focus groups concurred that the practice of supporting students to take action would ultimately require an examination of values and that environmental learning also provided opportunities for students to question cultural assumptions that often lead to social conflict and environmental crises. Participants concurred that this 'questioning' process created new visions and possibilities, but stressed that students need to examine how issues are the result of our value systems.

Participants concurred that students should be encouraged to make decisions based on an understanding of the issues, as well as their values and the values of community members. Knowledge of critical thinking tools, such as perspective analysis, argument analysis, and message deconstruction provided a means to assist with the decision-making process and other disciplines. In our consultations, it became evident that the development of an environmental ethic in students is perhaps the culminating goal for environmental learning in all of its forms and that this requires an understanding of all of the previous forms of environmental concepts described in our work (complexity, aesthetics and responsibility). Understanding the complexity of daily interactions, while also recognizing the aesthetics of their environment, helps students take active responsibility in creating change. When this happens, an environmental ethic can become part of the moral fiber of their (ecological) identities (THOMASHOW, 1996).

Conclusions

In this work, the diverse voices and methods that inform environmental learning are honoured through the use of participatory action research. This inquiry enabled a study that placed research capabilities into the hands of our "educator-subjects" - providing them with research tools with which they could generate knowledge for themselves. The focus and working groups included broad representation from stakeholder groups including the BC Ministry of Education, schools, informal education organizations, First nations, university students and academics. The knowledge we created in this way was empowering and is being transformed by these participants into actions that directly benefit their own community and the practices of environmental learning in and around classrooms of this province.

This document resulting from our extensive "working group" consultations describes how EE is a way of understanding environments, and how humans participate in and influence these environments. In using the term 'environmental learning', we refer to a range of approaches to environmental issues, including environmental education, ecological education and education for sustainable development. All of these forms aim to integrate concepts and principles of the sciences and social sciences under a single interdisciplinary framework. In the ecological view, students may come to know and understand more deeply that all human environments, societies, or cultures are all deeply dependent on natural systems, both for their development and, ultimately, their survival. In this framework, we present numerous principles for organizing teaching practices related to environmental concepts.

Finally, the results of our study communicates important principles for environmental learning that include forms of scientific literacy. These principles are organized into two areas: first, the widely supported principles for the teaching and learning of *direct experience*, *critical reflection* and *negotiation* are related and described in the form of an experiential learning cycle; and second, organizing principles for environmental concepts are summarized and described. These principles also demonstrate the interdisciplinary nature of environmental concepts, while showing a progression in the development of ideas that lead towards deeper engagement with learning in all of its forms. Students are assisted by the organizers of *complexity*, *aesthetics*, *responsibility* and *ethics* to guide their developing ideas about the environment as they appear in

mandated curriculum. Further, this paper demonstrates how EE should NOT be conceived simply as a form of science education but instead describes in detail, how certain forms of EE can form a unique and rich context for an alternative (ecological) view for science education. In the ecological model, science learning outcomes are imbedded in a broad and rich tapestry of interdisciplinarity and do not dominate.

Lastly, the process described in this paper ultimately produced a revised framework for environmental learning adopted by the BC Ministry of Education and has guided teaching, curriculum and resource development in this province. This outcome demonstrates clearly how educational research when it is participatory and action oriented in nature, can inform educational policy. Our work has re-energized teacher practices around environmental learning in BC. We hope that the resulting policy document continues to be useful to teachers as they incorporate environmental themes into teaching / learning across the broad spectrum of curriculum as we embark on another process of curriculum revision.

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