Journal of Environmental Studies and Sciences
DOI 10.1007/s13412-012-0088-6

The version here is the author's submitted final draft

TITLE: Building cultural bridges with Aboriginal learners and their 'classmates' for transformative environmental education.

AUTHOR: A. Hatcher

KEYWORDS:
Western_science; Indigenous_science; sustainability_ education; Two-Eyed_Seeing

ABSTRACT:

The educational gap between Aboriginal and non-Aboriginal Canadians is the most significant social policy challenge facing Canada (*Richards, 2008).* This gap is particularly evident in the science fields. Educational institutions are still regarded as mechanisms of colonization by many Aboriginal people. Their 'foreign' Eurocentric (or Western) culture reinforces the systematic barrier to success of Aboriginal students in the current educational system. It is time to develop a new kind of educational process, an ''*ecology of Indigenous education*'' (Cajete, 2009), to allow Aboriginal peoples to participate fully in academic science and to share their deep understandings about sustainable living. Significant advances in environmental education for all learners will follow if we can embrace the relationship with Mother Earth that allowed Aboriginal peoples to live in harmony with nature for so long before colonization.

> *"The exploration of traditional American Indian education and its projection into a contemporary context is much more than just an academic exercise. It illuminates the true nature of the ecological connection of human learning and helps to liberate the experience of being human and being related at all its levels." (Cajete, 2009)*

In Indigenous cultures, the development of respectful relationships among all participants must precede any effective learning. The development of this respect among all learners results from the successful incorporation of Indigenous culture into the classroom. Equal representation of knowledge from two cultural contexts is described by Mi'kmaw Elder Albert Marshall as "Two-Eyed Seeing" (Bartlett et al, this issue and Hatcher et al., 2009a). Two-Eyed Seeing is a mechanism to cross cultural borders, and has been very effective in the science classroom at many levels, as I will describe in this paper. With this guiding principle, Indigenous culture takes a place beside Western, not as an add-on to be brought out for multicultural 'festivals'.

The devastating impact of humans on Mother Earth can be seen as a result of the anthropocentric hierarchy which is evident in many Western Sciences. Mother Earth is calling for bridge-building between Western and Indigenous worldviews. This is a challenge for teachers because of the nature of Indigenous scientific knowledge. Eurocentric, or Western scientific knowledge is passed on as a package, using books, videos and multitudes of supports and props. Aboriginal, or Indigenous knowledge can be described as 'ways of knowing' and is acquired through a creative, participatory involvement with Mother Earth. There is an inherent trust in the learner and an intimate relationship between the learner and the 'knowledge', with an experienced guide to help. In this paper I will describe the basic premises behind a transition of the University science classroom to accommodate learning from two worldviews. This transition involves a move from inside to outside, both physically, spiritually and intellectually. It also involves an incorporation of ceremony, preparing the learner to listen and observe. Most importantly, a close engagement with the community and the cycles of Mother Earth must occur, reinforcing and expanding the engagement of the learner and the 'knowledge'.

Acknowledgements

I would like to acknowledge one of my Ph.D. supervisors (I had three), the late Dr. R.E. Johannes. Bob taught me that the most significant advances in Western Sciences were made by those who could cross standard disciplinary barriers. He also taught me that the people who really understood ecology were those who sustained themselves and their families by knowing the cycles of nature (Johannes, 1992). I also owe much to Mi'kmaq Elders Murdena and Albert Marshall for teaching me about Mi'kmaq science and to Dr. Cheryl Bartlett for helping me negotiate the common ground between Indigenous and Western science in a new field, called Integrative Science. The research for this article was supported by a contract to Dr. Hatcher from the Atlantic Provinces Community College Consortium, with the assistance and funding support of Health Canada through the Aboriginal Health and Human Resources Initiative.

Introduction

> *"If our collective future is to be one of harmony and wholeness, or if we are to even have a viable future to pass to our children's children, it is imperative that we actively envision and implement new ways of educating for ecological thinking and sustainability."* (Cajete, 2009)

It is time to honour Indigenous knowledge which is unfiltered through the Western lens. By doing this, we can leave a significant legacy for all of our children in our relationship with Mother Earth as well as make a step towards addressing the educational power imbalance of the past between the settlers with white privilege and those who are part of the land that the settlers colonized.

My journey within Western Sciences has taken me to several Universities in several countries and I have worked with many scientists as mentors and peers to gain several degrees and postdoctoral positions. It is from this solid footing in the Western Sciences of Biology, Zoology and Oceanography that I ventured to learn more about Indigenous Sciences and to try to build bridges between the two world views to benefit my students at Cape Breton University who were studying Integrative Science. I am a "committed non-Indigenous 'ally'" (Cajete, 2009) determined to ethically build science curricula honouring those Indigenous scientists who came before us. I am grateful for this opportunity to again place myself on the steep side of the learning curve and use all of my scientific knowledge for something a bit less selfish than the many research projects that I have worked on over the years.

It is time to develop a new kind of educational process, an ''ecology of Indigenous education'' (Cajete, 2009), to allow Indigenous peoples to participate fully in academic science and to share their deep understandings about sustainable living. Significant advances in environmental education for all learners will follow if we can embrace the relationship with Mother Earth that allowed Aboriginal peoples to live in harmony with nature for so long before colonization. In this essay, I will examine how inclusive, transformative science education can be approached under the guiding principle of Two-Eyed Seeing. Equal representation of knowledge from two cultural contexts is described by Mi'kmaw Elder Albert Marshall as "Two-Eyed Seeing" (Bartlett et al, this issue and Hatcher et al., 2009a). Two-Eyed Seeing is a mechanism to cross cultural borders, and has been very effective in the science classroom at many levels.

Background

The cultural underpinnings of modern science

Few people are aware of the human dimensions of Western Sciences, their operation within culture-laden presuppositions and paradigms (Aikenhead and Michell, 2011). Understanding the cultural underpinnings of modern sciences helps teachers bridge cultures for incorporation of Indigenous knowledge into science curricula. Science teachers who have taken the time to learn about a students' worldview are better able to construct bridges between that worldview and the worldview of Western Sciences. What is defined as 'science' is coloured by the worldview of the definer (Little Bear, L., 'Foreward' in Cajete, 2000). Worldview refers to *"the culturally dependent, implicit, fundamental organization of the mind. This implicit organization is composed of presuppositions that predispose one to feel, think and act in predictable patterns"*. (Cobern, 2000; p. 8). Today's scientists embrace paradigms which are shaped by science's origins and evolution, cradled in the social transformations in Europe. The empirical approach of Eurocentric or 'Western Sciences' (based on western thinking) arose in opposition to the authority of church and royalty, beginning with the Scientific Revolution of the 1600's. The term 'science' became applied to the Western approach with the birth of the BAAS (British Association for the Advancement of Science). Before this, 'science', which derived from the Latin 'scientia', simply meant knowledge (Aikenhead and Ogawa, 2007).

In this essay, I will outline the significant fundamental differences between Western and Indigenous Sciences. The crux of the differences relates to paradigms in Western Sciences which subscribe to the concept of Cartesian duality where material (physical) and non-material (metaphysical) worlds are non-interacting. The monist view (mind and matter intermingle) is more congruent with Indigenous Sciences. I will then explain some of the challenges in bringing Indigenous Sciences into the classroom. These include the legacy of consistent attempted assimilation of Indigenous culture by colonizing cultures. This legacy has made Indigenous peoples the subjects of study rather than active generators of knowledge and has perpetuated a climate dominated by racist attitudes. For transformative environmental education for all learners, we need to bring the Indigenous education model into the classroom with Western models using the principle of 'Two-Eyed Seeing', a form of cultural humility that will give us some tools for cultural border crossing.

Eurocentric or 'Western' sciences

The heterogenous knowledge systems that dominate in professional science communities are Eurocentric in nature (Aikenhead and Ogawa, 2007). Communication among these science communities is often hampered by discipline-specific metaphors and paradigms. Competitive behaviour among practising scientists is the norm, based on the need for career advancement and awards of limited grant funds to pursue research. Many of the principles of Western Science rely on a type of logic that requires objective, hierarchical thinking. The basic premise is that nature is 'knowable' and scientific knowledge is generalizable under these standard scientific paradigms (Aikenhead and Michell, 2011). Paradigms in most Western sciences subscribe to the concept of Cartesian duality where the material (physical) and non-material (metaphysical) worlds are distinct, independent and non-interacting (Aikenhead and Michell, 2011). However, monist (matter and mind intermingle) views underlie quantum theory (Duran, 2007), ecology (Turner et al., 2000) and sustainability science (Clark and Dickson 2003). The monist view is more congruent with aspects of Indigenous or Native Science.

Aboriginal or 'Indigenous' Sciences

The basic premise of Indigenous Sciences is knowing what nature is, not how it works. While Indigenous cultures around the world differ, their relationships with the natural world are similar and many generalizations can be made about Indigenous Sciences (Cajete, 2000). Battiste and Henderson (2000) summarize the structure of Indigenous ways of knowing: (1) knowledge of unseen powers in the ecosystem, (2) knowledge of the interconnectedness of all things, (3) knowledge of the perception of reality based on linguistic structure or ways of communicating, (4) knowledge that personal relationships bond people, communities and ecosystems, (5) knowledge that traditions teach specialized knowledge related to 'morals' and 'ethics' and (6) knowledge that extended kinship passes on social traditions and practices from one generation to the next.

Indigenous Sciences is a metaphor for a large range of 'coming to know' processes which result from human experiences in the natural world (Cajete, 2000). Knowledge is gained from the interaction of 'body, mind, soul and spirit with all aspects of nature'. Indigenous Sciences are underlain by the perception of multiple realities and that reality perceived by our five senses is but one of those (Cajete, 2000). Indigenous knowledge is more than the opposite of Western knowledge. Indigenous Sciences present a more holistic view of nature than do most Western Sciences. For a traditional Aboriginal learner, the compartmentalization and reductionism that underlies Western Sciences presents an

impediment to learning (Kawagley, 1995). This impediment is obvious with most learners in integrated science fields such as Ecology and Environmental Science. Within the Aboriginal worldview, concepts are based on reciprocal causality, as compared to the hierarchical thinking involved in many Western Sciences. With reciprocal causality, cause and effect cannot be isolated from other causes and effects with which they share a holistic relationship within a system.

In Aboriginal languages there is no word for 'science' or 'knowledge'. In the Yupiaq perspective, the closest meaning might be encompassed by the phrases: "trying to know', or 'a process of foreseeing and predicting the future' (Kawagley, 1995). Language is a currency of power. Because the Mi'kmaq (Mi'kmaki encompasses much of Atlantic Canada and northern Maine) believe that the Creator gave them their language to help them share knowledge and survive, they regard their language as sacred (CCM, 2007). '*Verb-based Indigenous languages allow for transcendence of boundaries, so there is no animate/inanimate dichotomy*' (Aikenhead and Ogawa, 2007). Everything is animate and has spirit (Little Bear, L., 'Foreward' in Cajete, 2000). Furthermore, Indigenous worldviews do not subscribe to the anthropocentric hierarchy of the Western worldview, but to searching for a more natural balance with all of creation on a more equal footing. Indigenous Sciences are underlain by the understanding that all physical bodies and minds are connected and expressions of a deeper spiritual essence. Human consciousness, which is part of the larger web, can thus be aware of the cosmic connections.

With the whole of creation composed of a web of interrelationships (in Mi'kmaq: ***Msit No'kmaq****; 'all my relations*' and in Lakota: ***Mitakuye oyasin*** *'we are all related'* (Cajete, 2000)), knowledge gained through these relationships implies a responsibility of the knowledge-keeper. This is a guiding principle in all Indigenous cultures (Cajete, 1986). 'Indigenous knowledge' can't be easily classified within a Western worldview. What we usually see in an attempted matching between the two worldviews is simply timelines which correspond. Complications arise when seeking translations between verb-based Indigenous languages and noun-based Western ones (Battiste and Henderson, 2000). Indigenous knowledge can't be reduced to categories such as 'science, art, religion or philosophy'. Indigenous ways of living in nature are strongly place-based and the goal of Indigenous Sciences is to become open to the natural world with all of one's senses, body and spirit (Cajete, 2000). Self-identities of Indigenous people are inextricably tied to their place in contrast to the common Eurocentric notion of land as a commodity. Place-based understandings of nature form the basis of Indigenous self-identity (Aikenhead and Ogawa, 2007). In the Indigenous worldview, the Earth is so sacred that it is often referred to as 'Mother', the source of life (Little Bear, L., 'Foreward' in Cajete, 2000). In science curricula suited to Indigenous perspectives, learning from 'place' is crucial (Michell et al, 2008). 'Place' is more than geography. It

encompasses environment, history and community; a shared understanding of how we live in our world respectfully and sustainably. Because Indigenous knowledge has largely relied on the oral tradition, it is firmly rooted in 'place'. The concept of places is captured by Edward Casey (in Feld and Basso, 1996; quoted in Michell, H. et al, 2008).:

> *"Rather than being one definite sort of thing- for example, physical, spiritual, cultural, social- a given place takes on the qualities of its' occupants, reflecting these qualities in its own constitution and description and expressing them in its occurrence as an event: Places not only are, they happen'.*

The sense of place is a challenging concept to bring into the science classroom because of the transition from an oral tradition to a Western, written one. Success requires that the teacher have a broad cultural and natural understanding of their larger 'classroom' beyond the school walls. Equally challenging is the transition of the concept from Indigenous languages to English (Battiste, 2002). I believe that many teachers have put it into the 'too hard' basket, being more comfortable with their packaged curriculum generated by education 'experts'. I feel that we have to begin the move toward understanding, realizing that it is a co-learning journey and that we need to reach a 'middle-ground'.

As a component of 'place', ceremonial practices are fundamental to Indigenous ways of living in nature because they provide a focus for intended actions and strengthen the will (Aikenhead and Michell, 2011; Vickers, 2007). These practices include smudging, sweat lodges, vision quests, the sacred pipe and Sundance ceremonies. Respect is born and matured through the sacred ceremonies in dialogue with the land (Vickers, 2007). Ceremonial practices are intimately related to the land and embedded in a culture which includes belonging to a clan and a family and knowing the language.

An intimate association with nature has led to a circular view of time in the Indigenous worldview (Hatcher et al, 2009a). With a long history of observation, the cycles of nature become an important method of time-keeping. For a science educator, it is important that learning opportunities (ie: labs, field trips) match the season. This is another aspect of the Aboriginal worldview that emphasizes that the journey is more important than the destination. '*Time is part of the constant flux but goes nowhere. Time*

just is.' (Little Bear, 2000 as cited in Aikenhead and Ogawa, 2007). When you are not rushing to the future, you value the time available in the present (Keane, 2007).

Strongly rooted in relationships, culture and 'place', Indigenous Sciences can inform a modern understanding of how humans fit in Mother Earth's web.

Challenges

Racism and White Privilege

Many people are unaware of the continuing impacts of racism in modern schools and universities. One of the most significant challenges for Aboriginal learners in the education system is racism. Many Indigenous worldviews are coloured by a history of racism and colonization (St. Denis, 2007). Attempted assimilation into the Western culture through measures such as residential schools has had a devastating impact on Aboriginal peoples. Michell et al (2008) reported that racism from educated people may be one of the biggest barriers to inclusion of Indigenous cultures into the education system. Because settler history is censored in textbooks and Aboriginal history and culture have been superficially treated, many people are unaware of the extent of colonization and attempted assimilation in the past. This has done little to foster respect for the history of Aboriginal people or to empower them with a sense of pride in their past. They have to be active participants in the knowledge, not objects of study! This is a major shift in thinking that is required at many institutes of higher learning.

For many people, particularly those in the majority, social identities are not obvious (Dlugos, 2006). Generally, people who belong to the majority group feel uncomfortable talking about racism. To develop a learning environment within which Aboriginal learners feel respected, racism issues need to be discussed rather than ignored (Battiste, 2002). Without being aware, racism can become a "normal way of seeing". It is possible to be critical of racism at the level of ideology but have "common sense racism" without even being aware of it (Bannerji, 1987).

All educators and learners have a racial identity, and in many countries it is the white European identity that dominates. It is a challenge to give "equal time" in the classroom to the Western and the Indigenous worldviews. The Eurocentric outlook often becomes dominant by difference (Fellows and Razack, 1998

as cited in St. Denis and Schick, 2003). This dominance occurs because of the lack of patience and understanding of those educated in the Eurocentric system with the different techniques and timelines underlying the Indigenous worldview. This lack of patience leads to the imposition of tools designed within the Eurocentric worldview to define Indigenous knowledge in its' own interests, from its' own perspective, ie: *dominant by difference*. Dei (2005) describes racism as "*about unequal power relations"* and how people relate to each other on the basis of defined social identities. This is evident in many education systems, where practices dominated by the privileges of "whiteness" are still prevalent despite all the educational rhetoric concerning multicultural pedagogy (Kincheloe & Steinberg, 1998).

A Colour-blind View

"*We are all the same under the skin"* is a common phrase which is meant to deny that racism exists. This colour-blind view may appear virtuous but it perpetuates ways in which minority groups are similar to the dominant white group, indicating that the different values of the non-dominant group are irrelevant. The values and norms of the majority white group become the 'yardstick'. Blindness to the influences of race in people's lives has a powerful negative effect on educational institutions in Eurocentric societies by keeping white people from learning about the role that their privilege plays in personal and institutional racism. If white teachers want to build an anti-racist, socially just and global curriculum, they need to acknowledge their power and privilege (Hickling-Hudson & Ahlquist, 2003).

> …*"Without addressing this part of the problem, well-meaning whites can remain bystanders who unconsciously and indirectly support racism through their own blindness and inaction." (Bell, 2002, p. 238)*

Denying racial identity (i.e., saying that we are all the same under the skin) trivializes the effects of power, and waters down the daily effects of White Privilege. The dominant racial identity (white) can thus be considered the norm against which others are judged (i.e., non-white) (Bhabha, 1994). This attitude can change if teachers become effective in cultural border crossing. A respectful recognition of the student's Aboriginal heritage will help de-fuse the destructive influence of racism.

> *"When the Mi'kmaq spirit is alive, racism does not affect you because you are comfortable in your own skin. You respond with tolerance and compassion, not aggression." (Albert Marshall Mi'kmaq Elder and Advisor, Unama'ki Institute of Natural Resources, Jan. 16, 2009)*

In many institutions, students often fail to establish a group cultural identity because the environment does not highlight their cultural distinctness. The group cultural identity is very important to many Aboriginal learners as a means to ensure engagement within the school community. If ethnicity and equality are to survive in the classroom it is crucial to celebrate cultural distinctness as part of the curriculum, not an add-on (Ogbu, 1982; Philips, 1983).

Education models and the Two-Eyed Seeing classroom

In the Indigeous education model, knowledge is passed to another only when a relationship between the giver and receiver is formed and when the knowledge receiver is ready. This basic concept comes into play in the classroom where the development of relationships among participants must precede any effective learning. In the Aboriginal way of knowing, children learn by close observation and not by being verbally taught. They have to learn to be close observers of nature. Advice is given indirectly in the form of Legends and stories because there is a trust in the human consciousness and the ability of people to draw the conclusions that are best for them. Learners are allowed to make mistakes in order to learn, which can be a very effective education model. Learners who are able to make connections between new knowledge and previous understandings retain and understand information better than those who learn by rote (Novak, 2002 as cited by Kavanagh et. al., 2006). The main ethical educational rule in Indigenous Science is not to give direct advice or criticism.

Indigenous science is a way of knowing which is relevant to all aspects of Indigenous tradition (Cajete, 2000). It is contextual, a direct contrast to many Western Sciences. This is a formidable challenge for teachers in the current education system. In verb-based Indigenous languages, knowing is more about the journey than the destination. The challenge for the teacher is to help the student develop their ‘inner ear’ to hear the subtle voices of nature (Cajete, 2000). Education for Aboriginal students should help them connect with tribal consciousness and the traditions that animate their spiritual selves (Battiste, 2002).

The challenge is to empower the Aboriginal learner to see and interpret the world through his/her eyes, not the eyes of the “other” (after Sefa Dei, 1996). Inclusive education does not mean replacing one worldview (Eurocentric) with another (Aboriginal). This is the underpinning of the concept called Two-Eyed Seeing, brought forward by Mi’kmaw Elder Albert Marshall (Bartlett et al, this issue; Hatcher et al, 2009a). The educator is in the position to provide the tools to empower the Aboriginal learner through Two-Eyed Seeing, despite the dominant Eurocentric paradigm. Aboriginal students become more than

seekers of knowledge; they become active participants in it, a fundamental principle of the Aboriginal worldview.

> *"We are not aware that we act within conventional sets of rules ourselves. We assume instead that the way we behave, express ourselves, and interpret others is the way all people do it. All cultures operate within this myopia; it seems to me, not even suspecting that others may have developed very different rules." (Ross, 1992, page 5)*

Two-Eyed Seeing is a form of cultural humility, a pre-requisite for successful cultural border-crossing. Flexibility is the key to successful cultural border crossing (Aikenhead and Jegede, 1999). To successfully cross cultural borders is to shift from being one person in one context to being another person in a different context without losing self-identity. The cultural borders could be from the world of white middle class to that of an Aboriginal student who lives on a reserve or the world of an Afro-Canadian woman in a white male-dominated workplace. We can feel at ease in one world and not the other. Ease is due to several factors: being a fluent speaker, agreeing with the norms of that culture, being humanly bonded with people in that culture, or having a sense of shared history (Aikenhead and Jegede, 1999). The presence of only one factor can cause one to feel at ease. The concentration on the 'common ground' between Indigenous and Western ways of knowing means that one does not have to relinquish either position but can embrace elements of both (Brandt, 2007). Two-Eyed Seeing is similar to 'two-way learning' (Fleer, 1997) or 'both-ways education' (McTaggert, 1991). Cross-cultural science education is complex because of the differences in the nature of the two knowledge systems, as previously pointed out. Compatability of the two knowledge systems in terms of the development of curricula is contextual (Michell et al., 2008) and creating a balance between the two worldviews is 'the great challenge facing modern educators' (Battiste, 2000).

Spirituality as a component of the education model

Traditional Mi'kmaq believe that there are two worlds from which people can gain knowledge and wisdom, the physical and the spiritual. Dreams can link the two and Elders have the wisdom to interpret the dreams. It is the incorporation of ways of knowing from both worlds that makes Indigenous Sciences 'holistic'. Perhaps the removal of a 'mystical force' from Western Sciences causes a strict

reliance on rational faculties of humans which produces a culture that disrespects and uses nature rather than revering it (Kawagley, 1995). The perennial philosophy, which underlies all holistic curricula, states that all life is connected in an interdependent universe (Miller, 2007). Aldous Huxley (1970) defined the perennial philosophy as:" *the metaphysic that recognizes a divine reality substantial to the world of things and lives and minds; the psychology that finds in the soul something similar to, or even identical with, divine reality*." Inherent in the concept of the perennial philosophy is the understanding that the rational mind cannot fully grasp the wholeness of existence (Miller, 2007). Indigenous-based quests for knowledge and understanding are life-altering and transformative (Absolon, 2011).

> *" Spirituality is not simply worship of a higher being or holding certain ceremonies. The spirituality of a people is wrapped up in their language and their songs, their stories and their dances, in how they live and interact with each other, and who or what they honor." (CMM, 2007).*

This section about spirituality is from Chapter 5 in "Confederacy of Mainland Mi'kmaq, 2007, Kekina'muek, Learning about the Mi'kmaq of Nova Scotia, Woodland Publishing, Truro". Indigenous spirituality is a manifestation of deep connections to the land. It is not equivalent to Western religion (Cajete, 2000). In all Indigenous cultures, beliefs and practices about spirituality are passed down by the teachings of the Elders. In all cultures spirituality is practiced through rituals and ceremonies that show respect for and gratitude to a higher power. The Mi'kmaq believe that the Creator (Kisu'lk) made the universe. Because all things hold part of the Creator's spirit they must be respected. Because all things on Mother Earth are connected, nothing should be abused or exploited so that all creation can continue to work in harmony (CMM, 2007). Mother Earth provides food and materials for clothes and shelter and proper respect and gratitude must be shown for these gifts. In the classroom, this respect and gratitude can be emphasized when working outside by showing students how to minimize their impact on plants and animals, a solid foundation for sustainability.

Intuitive Education

Figure 1: Medicine wheel

Holistic curriculum needs to connect intuition and linear thinking (Miller, 2007). Intuition is direct knowing, which is linked to creativity, while linear thinking progresses through sequential steps. What Miller (2007) called 'intuition' describes the sensory inputs for knowledge acquisition that may come into play in the teachings of the medicine wheel (Fig. 1). Miller (2007) described four types of intuition: physical, emotional, mental and spiritual. The following are examples of each. Muscle tension is a common response to stress (physical intuition) (West direction of medicine wheel). Emotional intuition

comes into play when we pick up vibrations (vibes) from other people (South direction of medicine wheel). Mental intuition is often image-rich and described as insight (the 'Ah! Ha!' moment) (North direction of medicine wheel). Spiritual intuition is a personal resonance with Mother Earth and her cycles (East on medicine wheel).

Intuition can be incorporated into the classroom through the use of visualization. For example, visualizing yourself as a white blood cell can be part of a science and a creative writing class. Metaphors, or making a connection between words that are not normally connected, are also a useful way to bring intuition into the classroom. The use of metaphors forces students to imagine connections and see patterns among ideas and subjects (Miller, 2007). The recognition and processing of patterns is the basis of scientific inquiry within all world views.

Theme-based inquiry and instruction: lifeways

Within the Indigenous worldview, education mirrors 'theme-based' curriculum in the Eurocentric world view. Traditional peoples teach their 'lifeways' continually in a variety of ways ranging from cradle songs to ritual offerings in symbolic places (Mills, 1990). Indigenous pedagogies involved a respectful transmission of knowledge through various means such as language and storytelling (Battiste and Henderson, 2000, Miller, 1996). Indigenous knowledge systems were not formally regimented or institutionalized. This is the basis for the 'Holistic, lifelong learning models' developed by First Nations across Canada in collaboration with the Canadian Council for Learning (http://www.ccl-cca.ca/CCL/Reports/RedefiningSuccessInAboriginalLearning/RedefiningSuccessModelsFirstNations.htm). Learning in the Aboriginal context is 'as much a spiritual, social and cultural process as it is a cognitive one" which can't be separated from the "*larger cultural and social matrix from which it is defined*" (Michell et al, 2008).

Modern theme-based curriculum is multidisciplinary and well-integrated across disciplinary boundaries. Themes weave together subjects and experiences that are found in the students' lives and provide opportunities to develop instruction using many of the students' multiple intelligences (Armstrong, 2000). A trans-disciplinary science theme unit using several of the students' multiple intelligences may be based on many subjects such as: 'Birds' (Hatcher and Bartlett, 2009a), 'Traditional medicines' (Hatcher and Bartlett, 2009b) or 'Traditional legends' (Hatcher et al, 2009b).

Inquiry-based learning within themes

Inquiry or problem-based learning can be imbedded in a theme-based curriculum. In problem-based learning, the problem becomes a contextual basis for learning rooted in the learner's experience (Kain, 2003). The basic structure of inquiry is in three steps: What do we know? What do we need to know? How can we find out? (Kain, 2003). This approach is one can span both Western and Indigenous Sciences, based on the principles of 'learn by doing' and 'learning in meaningful contexts'.

Problem-based learning focuses on the process of inquiry (Kain, 2003). The problem-solving approach to learning develops attitudes in learners which resonate with the philosophy of Indigenous Sciences. Specifically, learners become successful collaborative learners, knowledge is relevant and applied and connected to prior learning, and learners become self-directed, assuming responsibility for their own learning.

Holistic Sciences curriculum

The word 'Holistic' comes from the Greek 'holon' which refers to a universe that is made up of integrated wholes which are more than the sum of their parts (Miller, 2007). Holistic curriculum is based on the principles of connection, balance and inclusion and it attempts to align science education with the fundamental processes of nature. In the classroom, a healthy balance must be reached between individual and group learning, content and process, knowledge and imagination, ration and intuition, quantitative and qualitative assessment. Balance is achieved through lessons which use several of the multiple intelligences. Linear thinking can be balanced with intuition, using metaphors, visualization techniques and Indigenous Sciences pedagogy such as the Medicine Wheel (Lane et al, 1984). The body and mind can be connected through movement and dance. Academic disciplines and Indigenous Sciences can be connected in many ways, such as through the visual arts. Self and community can be connected through inquiry-based curriculum and a concentration of learning activities in communities outside the classroom. Self and Mother Earth can be connected by helping the learners re-establish themselves as part of nature rather than separate from it. This often involves a re-adjustment of the senses and a fine-tuning of the powers of observation. Ego and soul can be mindfully connected as deep connections to other humans and to all life develop (Miller, 2007). In the context of holistic education in science, these connections develop with the establishment of stronger community connections, connections to the learners' ancestors and connections to previous learners through the 'culture of the classroom'.

Transformational learning pedagogy

In transformational learning, the learner and curriculum are seen as connected and the aim of the transformational orientation is development of the whole person. The concept of personal perspective transformation was introduced by Mezirow (cited in Cranton, 2006) in an attempt to explain how a change in perspective, as a result of a significant event or occurrence, could lead to a transformation of that individual, which he referred to as perspective transformation (Cranton 2006, p. 21). Perspective transformation is the process of becoming aware of how existing assumptions affect the way we perceive and understand the world, how these assumptions can be altered to allow for a change in perspective, and how this change can lead to new understandings. In transformational learning, individuals create meaning structures for their experiences through the frames of reference created by their values, beliefs, and assumptions. In this way, the learner can learn to see through the other's eye without subsuming his/her cultural identity.

Creating the 'culture of the classroom'

Integral to a holistic education model is creating a community within a classroom and between the class and the community outside the school. A 'psychologically safe' environment is created within the school by a teacher who is present and mindful to the students (Miller, 2007) and/or to carefully-engineered student-friendly surroundings as found in the Montessori classroom, explained in more detail later in this essay. Communities within a classroom often develop through a cooperative learning strategy where students feel responsible for other students' learning as well as their own.

The school classroom should be a sanctuary where 'people feel affirmed' (Secretan, 1996 as cited in Miller, 2007). The environment should be one of respect and caring where people feel 'validated as human beings' (Miller, 2007). Creating a classroom which is a sanctuary can be accomplished in part by following these steps (after Miller, 2007):

1. The educational institution needs to acknowledge the traditional inhabitants of the land on which the institution stands. Aboriginal students are not just another 'ethnic' group.
2. Make space for Elders and knowledge holders from students' communities both in the classroom and in the curriculum on an equal footing with Western Science investigations.

3. Recognize the importance of the non-verbal and the messages that contain so much information. For example, a smile to a student can make her feel welcome.
4. Pay attention to the aesthetic environment of the school and classroom, a principle crucial to the development of a Montessori classroom.
    a. Display art from previous classes; pictures of students and communities; culturally-appealing pictures
    b. Display healthy plants
    c. Provide comfortable seating in a circle for discussions
    d. Create space and time for students to share food and drink.
5. Tell stories about the school and weave stories about present and past students and teachers into the fabric of the present. This 'mythology' generates a shared history or sense of meaning.
6. Use celebrations and rituals to give students a sense of connection to their community and of the changing of the seasons.
    a. These are part of the normal classroom activity, not add-ons for special days.
    b. Invite family and community members whenever possible.
7. Value trust and authenticity and make sure that what we say is what we do (ie: live by our own rules). Secretan (1996) as cited by Miller (2007) says that telling the truth is a significant part of cultivating soul in the classroom.
8. Encourage a nourishing voice where people can speak freely, without fear.
9. Make sure that the classroom is welcoming to students' families and community members

Talking and learning circles

Community can be created in any classroom by following the Indigenous practice of forming talking circles. Students may arrange seats in a circle and pass the feather or stick (to indicate connectedness to the land) to indicate who has the floor. The circle can be used to share stories or as a mechanism of problem solving. The circle symbolizes completeness.
"When you put your knowledge in a circle, it's not yours anymore, it's shared by everyone." (Douglas Cardinal, architect (Regina Leader Post, November 28, 1995)).

In a Talking Circle, each participant has equal status and the same opportunity to speak. Students in a Talking Circle can learn to listen to the views of others. Students who are shy will often speak in a talking

circle because it is safe. What is said within a talking circle is not spoken of outside. Participation in talking circles helps to connect with and understand classmates.

The circle is a powerful symbol in Indigenous Science because: " *Everything the power of the world does is in a circle. The sky is round, and I have heard that the earth is round like a ball, and so are all the stars. The wind, in its greatest power, whirls. Birds make their nests in circles, for theirs is the same religion as ours…the life of a (person) is a circle from childhood to childhood, and it is in everything where power moves"* (Black Elk & Neihardt, J.G., 1979)

Montessori philosophy of teaching and the Two-Eyed Seeing guiding principle

Montessori education is a good example of a holistic model, a balance of teaching and assessment strategies and a vision of the learner as a whole person (Miller, 2007).The Montessori approach to learning is based on the premise that the 'learner' has sensitive periods when he or she is open for a particular type of understanding and that if the understanding is not gained in the particular sensitive period it will be more difficult to gain. Montessori's original work concentrated on young children but many of her concepts apply to learners at all levels. The 'sensitive period' theory is an extension of the work by the Dutch horticulturist, Hugo DeVries and it was later developed further by the ethologist, Konrad Lorenz (Lillard, 2005). This concept of 'sensitive periods' during human development relates to the Indigenous worldview where knowledge is passed to another only when the knowledge receiver is ready. In Mi'kmaq teachings, in the circle of life, gifts from the Creator are given at certain periods during a person's development. A child is born with the first gift, love. At seven year intervals, the gifts of honesty, humility, respect, truth, patience are given in sequence in the developing person. With each gift comes a greater understanding and a greater capacity to learn, grow and develop, reminiscent of the concept of 'sensitive periods'. The last gift is wisdom which is underlain and supported by the other six. Only when a person has all seven gifts and the gifts are evident to others can they become an Elder.

Many of the precepts of Montessori education (Lillard, 2005) resonate strongly with the principles of Two-Eyed Seeing in the classroom environment. These common-ground principles are:

1. movement and cognition are closely related
2. effective learning is underlain by the learner's sense of control over their lives
3. contextual learning is more effective, richer and deeper than learning about abstract concepts
4. collaborative learning is very effective

The Montessori approach is to immerse the student in a well-engineered environment where tools are appropriate for their size and stage and there is a basic respect shown for the individual. The individual controls his/her own learning under the guidance of a director, rather than the common hierarchical concept of teacher and pupil. This is co-learning, a foundational principle of Two-Eyed Seeing education. A co-learning approach reinforces the learner's sense of self control over his/her education. In the Montessori and the Integrative Science classroom, learners exercise more choice in the direction, intensity and duration of their particular study than in the traditional classroom. This reinforces the sense of self control of the learners' own education and thoroughly engages him/her in the learning process.
"*to teach details is to bring confusion; to establish the relationship between things is to bring knowledge*" (Montessori, M., 1948/1976)

Contextual learning is effective, and in the Montessori classroom this is accomplished by bringing in personal interests to the classroom and by introducing resources that students are attracted to. In Integrative Science (the Two-Eyed Seeing science classroom) the emphasis is on developing a conversation with Mother Earth which involves an active participation in and awareness of natural cycles and processes and the role of the student. Cultural context of materials and lessons is fundamental. Lessons are constantly reinforced when students become active observers outside the classroom. Rewards in both learning models are internal. External rewards such as gold stars and grades have no place in the Montessori classroom. Similarly, in the Indigenous worldview learners are rewarded when they grasp significant, interesting concepts. This is quite independent from the achievement of high marks from an external authority.

The Montessori education model is based on making connections across disciplines and integrating, leading to what Dr. Montessori called '*Cosmic Education'*. She believed that it was a way to show the student how everything in the universe is interrelated and interdependent. Every component, even the tiniest atom, has a part to play in the maintenance of the harmony of the whole (Lillard, 2005). Dr. Montessori noted that learners are not satisfied with a collection of facts, and it is important to let the student discover that "*everything in the universe is interrelated*" (Montessori, 1948/1976).This resonates with the spiritual understanding of Indigenous people, '*we are all related'* ((in Mi'kmaq: ***Msit No'kmaq****; 'all my relations'* and in Lakota: ***Mitakuye oyasin*** *'we are all related'* (Cajete, 2000)). Collaborative, or co-learning provides context and value because the learning has immediate connections beyond oneself (Lillard, 2005).

Transformative education and the 'Healing' journey

Transformative education is needed to empower this generation of Environmental scientists and practitioners. Transformative environmental education serves a dual purpose. All learners can benefit from the holistic relationship with Mother Earth embodied in the Indigenous worldview. In addition, equal representation of Western and Indigenous Sciences acknowledges that the educational process can be one of unequal power relationships and that learners should be active creators of knowledge rather than passive recipients (Royal Commission on Aboriginal Peoples, 1991). The teacher is a facilitator who can guide the educational process without dominating, as is the case in a Montessori classroom. Transformative education is contextual. It ties the personal experiences of the student into a larger world of learning and understanding. This educational process is participatory and may take various forms such as experiential learning, research projects, and oral histories. Knowledge is shared among all participants and there is no competitive ranking of performance (Royal Commission on Aboriginal Peoples (1991)).

To achieve an Indigenous context for education, educators must be committed to holistic teaching and learning processes. Cajete (1994) described the transformational nature of Indigenous education which emphasizes the Indigenous understandings that: learning happens of its own accord in prepared students, learners and learning situations are all unique, learning is lifelong and collaborative between learner and teacher (human or otherwise) and effective learning occurs within a context of a greater whole. Similarly, according to Michell et al (2008), these themes describe effective school practices for Indigenous science education: holistic knowledge and spirituality, indigenous knowledge of local populations, student engagement, strong community and parent relationships and effective teacher education and pedagogy. These changes represent a step in the healing journey of Aboriginal communities and culture, recovery from colonization and systematic racism experienced over many generations.

Conclusion

Cultural modes of perception and understanding are deeply embedded and self-perpetuating. Indigenous Sciences are deep and subtle wisdom which Mother Earth needs. It is difficult to practice Indigenous Sciences within Western ontological assumptions and experiences. The Western / Indigenous Sciences dichotomy is a construct which arises from the Western practice of viewing knowledge as static, unchanging and singular. Using the guiding principle of Two-Eyed Seeing, education melds the Indigenous Sciences sense of the whole with the Western Sciences sense of the parts. Knowledge is considered as dynamic and heterogenous and a constructive process. All students can '*walk in two*

worlds with one spirit' (Kushman and Barnhardt, 2001), an ability that means success in the Aboriginal world view.

"Can human civilization influence global climate?" was an interesting topic during my early University years. I have seen this change to a lively debate on "How fast?" fuelled by billions of dollars to tighten our estimates. We seem to be disconnected from our Mother Earth, applying band-aid approaches to problems which require major surgery. Perhaps this major surgery involves a shift within ourselves, reconnecting with our support system in a meaningful way to re-develop a sustainable course for the future. This essay explores an approach to transformative environmental science education which will provide a way to learn from those who lived sustainably on this land. This learning encompasses much more than content. The Two-Eyed Seeing approach also provides a way to open the door of the foreign culture of the academic science classroom to Aboriginal students, taking a step to help with the healing journey from generations of colonization and cultural genocide.

Literature cited:

Absolon, K.E. (Minogiizhigokwe), 2011. Kaandossiwin; How we come to know. *Fernwood publishing, Halifax (N.S.), 175 pp.*

Aikenhead, G.S., Jegede, O.J., 1999. Cross-cultural science education : a cognitive explanation of a cultural phenomenon. *Jour. Of Res. In Science Teaching, 36(2); pp: 269-287.*

Aikenhead, G. and Michell, H., 2011. Bridging cultures: Indigenous and Scientific Ways of Knowing Nature. *Pearson (Canada), Toronto. 196 pp.*

Aikenhead, G.S. and Ogawa, M., 2007. Indigenous knowledge and science revisited. *Cult. Stud. Of Sci. Educ. 2:539-620*

Armstrong, T., 2000. Multiple Intelligences in the Classroom. *Association for supervision and Curriculum Development, Alexandria, Virginia USA, 154 pp.*

Bannerji, H., 1987. Introducing racism: notes towards and anti-racist feminism. *Resources for Feminist Research, 16(1): 10-13.*

Bartlett, C., Marshall, M. and Marshall, A. (in press). Two-Eyed Seeing and other Lessons Learned within a co-learning journey of bringing together indigenous and mainstream knowledges and ways of knowing***…….this issue***

Battiste, M. & Henderson, S.Y., 2000. Protecting indigenous knowledge and heritage: a global challenge. *Purich Publishing, Saskatoon (Sask.)*

Battiste, M., 2002. Indigenous knowledge and pedagogy in First Nations Education: A literature review with recommendations. *Prepared for the National Working group on Education and the Minister of Indian Affairs, Indian and Northern Affairs Canada (INAC). Ottawa: Ontario*

Bell, L A. (2002). Sincere Fictions: The Pedagogical Challenges of Preparing White Teachers for Multicultural Classrooms. *Equity & Excellence in Education, 35(3):236–244.*

Bhabha, H.K., 1994. The location of culture, London, Routledge, *as cited in: St. Denis, V. & Schick, C., 2003. What makes anti-racist pedagogy in teacher education difficult? Three popular ideological assumptions. The Alberta Journal of Educational Research. 59 (1), pp. 55-69.*

Black Elk & Neihardt, J.G., 1979. Black Elk Speaks: Being the life story of a holy man of the Oglala Sioux. *Lincoln: University of Nebraska Press.*

Brandt, C.B., 2007. Epistemology and temporal/spatial orders in science education: a response to Aikenhead & Igawa's: Indigenous knowledge and science revisited*. Cultural studies of science education, 2: DOI 10.1007/s11422-007-9067-8.*

Cajete, G., 1994. Look to the mountain: an ecology of Indigenous education. *Kivaki Press, 243 pp.*

Cajete, G., 2000. Native science: natural laws of independence. *Clearlight Publishers, Santa Fe, New Mexico., 339 pp.*

Cajete, G., 2009. Contemporary indigenous education: a nature-centred American Indian philosophy for the 21st century world. *Futures 42: 1126-1132.*

Clark, W.C. & Dickson, N.M., 2003. Sustainability science: the emerging research program. *Proceedings of the National Academy of Sciences of the United States of America*, 100(14), 8049-8061.

CMM (Confederacy of Mainland Mi'kmaq), 2007, Kekina'muek, Learning about the Mi'kmaq of Nova Scotia, *Woodland Publishing, Truro*

Cobern, W.W., 2000. Everyday thoughts about nature. Boston, MA: Kluwer Academic. *(As cited in Aikenhead, G. and Michell, H., 2011)*

Cranton, P., 2006. Understanding and Promoting Transformative Learning (2nd ed*.). San Francisco: Jossey - Bass Publishers*

Dei, G.S., 2005. The Intersections of Race, Class, and Gender in the Anti-Racism Discourse. In: *Zalwilski, V. & Levine-Rasky, C. (Eds.) Inequality in Canada – A Reader on the Intersections of Gender, Race, and Class. (pp.17-35). Toronto: Oxford University Press.*

Dlugos, P., 2006. "Beyond Food": Creating Opportunities for Intercultural Communication with Students and Local Residents. *Diversity Digest, Vol. 9, No. 2, accessed online on June 6, 2009 at:* http://www.diversityweb.org/Digest/vol9no2/dlugos.cfm

Duran, P.H., 2007. On the cosmic order of modern physics and the conceptual world of the American Indian. *World Futures 63: 1-27.*

Fleer, M., 1997. Science, technology and culture: supporting multiple world views in curriculum design. *Australian Science Teacher's Journal, 43(3), 13-18.*

Hatcher, A. & Bartlett, C., 2009a. MSIT: Transdisciplinary, Cross-cultural science; an Integrative science unit on birds for high school students. *Green Teacher Issue 86 (Fall, 2009), pages 7-9.*

Hatcher, A., Bartlett, C., 2009b. Traditional medicines- how much is enough? *Green Teacher Issue 86 (Fall, 2009), pages 11-13.*

Hatcher, A., Bartlett, C, Marshall, A. & Marshall, M., 2009a. Two-Eyed Seeing in the Classroom Environment: Concepts, Approaches, and Challenges. *Can. Jour. Of Sci., Math. & Tech. Educ., 9(3), 141–153.*

Hatcher, A., Kavanagh, S., Bartlett, C., Marshall, M., 2009b. Traditional legends: meanings on many levels. *Green Teacher Issue 86 (Fall, 2009), pages 14-17.*

Hickling-Hudson, A. & Ahlquist , R., 2003. Contesting the curriculum in the schooling of indigenous children in Australia and the USA: from Eurocentrism to culturally powerful pedagogies. *Comparative Education Review, Vol 47, No. 1, 2003, pp. 64-89.*

Huxley, A., 1970. Brave New World, *The Dramatic Publishing C., NY*

Johannes, R.E., 1992. Words of the lagoon: fishing and marine lore in the Palau district of Micronesia. *Univ. of California Press, 320 pp.*

Kain, D.L., 2003. Problem-based learning for teachers, Grades 6-12., *Pearson, Boston., 240 pp.*

Kawagley, A.O., 1995. A Yupiaq worldview: A pathway to Ecology and Spirit. *Waveland Press. Illinois, 166 pp.*

Keane, M., 2007. Science education and worldview. *Cult. Stud. Of Sci. Educ. DOI 10.1007/s11422-007-9086-5*

Kincheloe, J. & Steinberg, S., 1998. 'Addressing the Crisis of Whiteness. Reconfiguring White Identity in a Pedagogy of Whiteness'. *In J. Kincheloe, S. Steinberg, N. Rodriguez and R.Chennault (Eds.) White Reign: Deploying Whiteness in America, New York, St. Martin's Press, p. 3 – 30.*

Kushman, J. & Barnhardt, R., 2001. Reforming education from the inside-out: a study of community engagement and educational reform in rural Alaska. Journal of research in rural education, 13.

Lane, P. jr., Bopp, J., Bopp, M., Brown, L and Elders, 1984. The Sacred Tree., *Lotus Press, WI, 82 pp.*

Lillard, A.S., 2005. Montessori: the science behind the genius. *Oxford Univ. Press, USA, 424 pp.*

McTaggert, R., 1991. Western institutional impediments to Australian Aboriginal education. *Jour. Of Curriculum Studies, 23: 297-325.*

Michell, H., Vizina, Y., Augustus, C., Sawyer, J., 2008. Learning Indigenous science from place; final report (CCL); 158 pp.
http://www.ccl-cca.ca/pdfs/FundedResearch/Michell-FinalReport-14Nov2008-AbL2006.pdf

Miller, J., 1996. Shinkwauk's vision: a history of native residential schools. *Toronto: University of Toronto Press.*

Miller, J.P., 2007. The Holistic Curriculum. University of Toronto Press, Toronto, 216 pp.

Mills, S., 1990. In Praise of Nature. Covelo, CA; *Island Press.*

Novak, J.D., 2002. Meaningful learning: the essential factor for conceptual change in limited or inappropriate propositional hierarchies leading to empowerment of learners. Learning 548-571. as cited in: Kavanagh, S., Bartlett, C., Marshall, M., 2006. Imagination in the natural sciences: pattern recognition, transformation and expression. Paper presented at the 4th International Conference on Imagination and Education, Vancouver. Available online at:
http://www.ierg.net/confs/viewpaper.php?id=141&cf=1

Ogbu, J. U. , 1982. Cultural discontinuities and schooling. Anthropology and Education Quarterly,13, 290–307.

Philips, S. U. , 1983. The invisible culture: Communication in classroom and community on the Warm Springs Indian Reservation. New York: Longman.

Richards, J., 2008. Closing the Aboriginal/ non-Aboriginal education gaps. C.D. Howe Institute Backgrounder, No. 116, Oct., 2008).Royal Commission on Aboriginal Peoples (1991), Vol. 3 (Chap. 5) retrieved from:
(http://www.ainc-inac.gc.ca/ch/rcap/sg/si45_e.html) on June 11, 2008.

Ross, R., 1992. Dancing with a ghost; exploring Indian Reality. *Reed Books, Markham, Ont., 195 pp.*

Sefa Dei, G. J., 1996. The role of Afrocentricity in the Inclusive Curriculum in Canadian Schools. *Can. Jour. Of Educ. 21 (2): 170-186.*

St. Denis, V., 2007. Aboriginal education and anti-racist education: building alliances across cultural and racial identity. *Can. Jour. Of Educ. 30(4): 1068-1092.*

St. Denis, V. & Schick, C., 2003. What makes anti-raist pedagogy in teacher education difficult? Three popular ideological assumptions. *The Alberta Journal of Educational Research. 59 (1), pp. 55-69.*

Turner, N.J., Ignace, M.B., & Ignace, R., 2000. Traditional ecological knowledge and wisdom of Aboriginal peoples in British Columbia. *Ecological Applications 10: 1275-1287.*

Vickers, P., 2007. Ayaawx: in the path of our ancestors. *Cultural Studies of Science Education, 2, DOI 10.1007/s11422-007-9067-8.*