

Chapter 4 - Creating Change: Instructional Strategies, Teacher Education, Teaching Science in Rural Aboriginal and Urban Multicultural Schools

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If schools are going to respond to the needs of Aboriginal students, then it is imperative that science teachers develop instructional strategies that take advantage of the different cultural perspectives that can exist in today's classroom. Education that legitimizes the cultural norms of only one culture within a pluralistic society robs students from other cultural backgrounds of their self-esteem and the potential of pursuing science related careers. Consequently, science teachers who are willing to take a multi-science approach are providing numerous opportunities for their students to learn that many cultures have contributed to science. Because no single culture has a monopoly on the generation of science knowledge, a single cultural approach to teaching science alienates some groups of students. Therefore, it becomes important for teachers to recognize the potential of students from different cultures to contribute to science because of their different ways of understanding and experiencing the world.

Teacher Perceptions

Canadian and American education institutions of learning have historically been dominated by western approaches, therefore the vast majority of teachers lack much of the necessary knowledge to provide effective culturally responsive education to Aboriginal youth. The most obvious, but also most lacking among teachers is an awareness and understanding of Indigenous cultures, histories, worldviews, language barriers, and current social, economic and political issues (Agbo, 2004; Aikenhead & Michell, 2011; Belezewski, 2009; Berger & Epp, 2005; Kanu, 2005, 2006; Snively & Williams, 2008). This is consistent with Aikenhead and Otsiji's (2000) exploration of the role of teacher-as-culture broker as complex. This complexity is a result of most curriculum developers and teachers being members of a colonizing culture and coming from rapidly changing modern urban societies with limited knowledge of Aboriginal traditions, knowledge systems, values, and culturally appropriate pedagogies (Hainnu et al., 2007).

Particularly distressing is that racist attitudes of dominant-culture groups pose a challenge to the inclusion of Indigenous Knowledge into the curriculum. Kanu's (2000) study of high school teachers' perception of integration showed that teachers themselves overwhelmingly identified racist, stereotypical images of Aboriginal peoples held by some non-Aboriginal teachers and students as a most difficult challenge. Teachers held such ideas as Aboriginal people are "living in the past," "are always getting something for free," and "we have nothing to learn from Aboriginal people" (Kanu, 2005, p. 60-62). All teachers cited these negative stereotypical images of Aboriginal people as the main reason why Aboriginal students tended to deny their Aboriginal ancestry and identity. In addition, Anne, one of the Aboriginal teachers in the study, spoke about what she called "the tyranny of time" and how "clock time controls everything in Western culture to the extent that people do not listen to their bodies or their emotional or spiritual needs" (Kanu, p. 62).

Clearly, there are a number of barriers to enabling Indigenous Science to co-exist in the science curriculum. Pre-service and practicing teachers have identified concerns about practicalities as well as concerns about attitudes and knowledge, as follows:

- My class periods are too short and there's no time.
- I don't know enough.
- This is a new way of teaching for me.
- I don't have relevant materials and resources for teaching about traditional science.
- My colleagues, parents, and/or principal aren't supportive.
- I don't have a connection to an Aboriginal community.
- I'd like to teach about Indigenous science, but I'm non-Native and I'm afraid to make mistakes. I don't want to get into trouble.
- Should teachers include IS in the school science curriculum when it includes spiritual teachings?

It is worth noting that this list includes perceived concerns over which teachers actually have control in their own classrooms. For example, teachers may feel that their lack of background in traditional knowledge is a significant barrier, they can however, control what they learn and teach. They have the option to enter the learning process with the students. While many remarked that the lack of more detailed science curricula was a significant barrier, others said the lack of curricula gave them a great deal of liberty in what they explored with their students (Hainnu, et al., 2007). Through opening oneself to the experiences of becoming knowledgeable about a different culture, teachers can begin to understand the different views of the world, and have increased respect for all students. Probably we need to respect the possibility that other traditions of understanding nature derive from complex human experience and generally recapitulate and incorporate illuminating an even more important insight.

A Nurturing Science Classroom for Aboriginal Students

When teaching in an Aboriginal community or in urban centres with classes of mixed ancestry, we must be aware that not all Aboriginal peoples are the same. This complexity has implications for how to create linkages between public schools and Aboriginal parents and communities. We must recognize that through a process of time and oppression, the residential schools forced assimilation and removals from traditional lands, resources, and wealth. Aboriginal communities have endured cataclysmic change and have taken a broad range of approaches to maintaining language, culture, traditions, and identity. There is also considerable diversity between communities and Nations. The Aboriginal children who come to our schools come from a wide-variety of backgrounds—coastal and interior, north and south, rural and urban, Christian, traditional Métis, Inuit and First Nations, and all possible blendings growing out of their unique histories and cultures. On the one hand, there are the few traditional groups who have, against enormous adversity, remained remarkably very close to the essence of their ancient and still viable life-ways; and on the other hand, there are those groups who have been completely assimilated within the larger Canadian society. Yet today, virtually all Aboriginal groups who retain any degree of self-identify are re-evaluating, acknowledging and celebrating their own traditional culture, and identifying themselves as First Nations, Métis, or Inuit. While most communities are struggling to reclaim past knowledge and identities, we must realize that Aboriginal people are not living in the past. As Bailey (2000) points out, “Aboriginal people are not returning

to a past era, but are, rather, reaffirming their knowing by using the old with the new, using both traditional and western modes of physical and mental healing” (p. 228).

A problematic way in which teachers sometimes access Aboriginal histories, worldview and knowledge is through Aboriginal students who may have little experience with discussing the cross-cultural realities which they may have experienced; which can have both positive and negative ramifications (Groome, 1995; Butler, 2000). Many Aboriginal students are marginalized in the classroom and are rarely called upon. Thus, it can be quite shocking for some students to be placed in the position of pseudo-expert by teachers simply by their Aboriginality. For some students, being singled out for attention on this basis is unwelcome or shaming (Malcolm, 1998). Other students complain that they are seen as representative of all Aboriginal people, which calls upon them to contribute cultural knowledge, which they may not possess, and places them into positions to defend all views and action (Anderson et al., 1998; Butler, 2000). Thus, whilst some students may be able to provide information on the science knowledge of their culture, for others, the type of information sought such as language, medicinal, ecological knowledge or bush skills, is unknown. This is particularly true for those living in urban environments who have not experienced living on the land.

Careful observation and imitative play are tools of learning which are universal and not bound by culture. Pepper and Henry (1986) describe child-rearing practices in Native families:

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Much of the informal learning that takes place in Indian families is non-verbal in nature. The children learn the customs and skills of their society by sharing directly in the activities of others. In such situations, verbal instructions is neither offered nor required because the child’s close proximity to observable action makes instruction giving quite redundant. (p. 57)

Philips (1983) states, that the interaction systems in different cultures allocated use of the verbal and visual systems differently. What is of interest to science educators is that child-rearing practices emphasizing observation and experiential learning are consistent with good science practice. The discovery learning phase of inquiry science allows children unstructured time to explore a variety of hands-on activities without teacher guidance. Such connections have potential for integrating traditional teaching and learning styles into the science classroom.

We have been aware for quite some time of the importance of moving beyond making totem poles out of cereal boxes, making big houses out of Popsicle sticks, and igloos out of sugar cubes. We are aware that it is often inappropriate to make eye contact or expect hands to go up quickly. However, it takes work and experience to understand why so often one’s direct questions go unanswered or why students arrive late or are struggling so hard with an assignment. When students are absent from school, teachers should understand that Aboriginal students may be dealing with a death in the family, they may be grieving and they have family and community obligations that are deeply felt. For these reasons, schools require flexible and modular course planning.

When students have a sense of belonging in school they are engaged learners and participate in class and school activities. They do their homework, are prepared for their lessons, and participate in extra-curricular activities. Indigenous learners are no different from other learners. A major factor is learning in a nurturing classroom environment that is open and creates multiple opportunities for their voices to be heard and respected. A nurturing environment that fosters a sense of belonging involves teachers who are willing to learn about Indigenous culture, find the scarce resources to support their teaching and who are not afraid to include this knowledge in their classes (Willms, 2003; Steeves et al., 2010).

Instructional Approaches

Indigenous societies have rich and time-honoured ways of teaching their children and passing knowledge and wisdom from one generation to the next. These approaches include Elder guidance, apprenticeship, talking circles, storytelling, drawing, dancing, songs, ceremony, supervised practices, dreaming, and imagination (Cajete, 1994, 1999; MacIvor, 1995). As outlined by Aikenhead and Michell (2011, p. 137), these traditional methods typically follow a pattern:

- As much as possible, demonstrate what is to be learned while the students watch and listen. Allow time for the students to practice what they have learned.
- Involve a child in small tasks if possible.
- Allow time for a child to reflect on and practice what is to be learned.
- Provide an opportunity for a child to show what they have learned, but only when they feel ready.

This pattern harmonizes with the learning strengths of many Aboriginal students. Teachers should attempt to learn more about this pattern by watching and talking to Elders and knowledge keepers about how people in the community teach their children. The pattern is important to keep in mind in teaching contexts; however, it can have somewhat different implications for teaching in proximity to a small Aboriginal community and teaching in urban schools.

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When out on the land, Aboriginal students are taught to observe in multi-sensory ways and to cultivate their memory to recall important environmental information. This multi-sensory approach provides more input channels for information to be stored and recalled, and is consistent with good science and environmental education teaching methods. In the classroom, make available a variety of visual and sensory experiences (photos, tools, equipment, rocks, shells, pinecones). Provide students with hands-on inquiry based activities such as: playing and learning with snow and ice, heat and temperature, water, sand, soap, shadows, simple machines, magnets, electricity, and so on. Plan learning experiences inside and outside the classroom. Implement field trips whenever possible. This could include short trips to a nearby pond, field, forest, seashore or sacred site. Allow sufficient time for students to enjoy the beauty and peacefulness of the natural world; and to experience the interconnections of all life.

Hands-on community-based projects increase student engagement if the project involves culturally related environmental issues (Bowers, 2001; Orr, 2004; Sutherland & Henning, 2009). On southern Vancouver Island, BC, Wright (2010), engaged high school students of both Aboriginal and non-Aboriginal ancestry in the conservation and restoration of a sacred but abandoned SNITCEL (Place of the Blue Grouse). Native eelgrass (*Zostera marina*), an environmentally important plant once abundant in local nearshore marine environments, was seriously diminished by development and pollution. Students helped to monitor a newly restored eelgrass meadow. A sister project conducted by Eijck & Roth (2013), engaged Brad, an adult member of the Tsawout First Nations community, in a hands-on internship program that involved restoration of native terrestrial plants on the backshore of the eelgrass restoration site. Brad brought to the project a perspective of native plants used for tools, medicine

and food by local First Nations communities that proved helpful for the practice of nature conservation, such as invasive plant removal and replanting of native species. In addition, Brad learned scientific protocols for monitoring levels of toxic pollutants in samples of nearshore marine sediments and invertebrates, and presented these findings to the academic community and to the public. A primary aim of both programs was to provide participants with experiences that could lead to feelings of empowerment and consideration of science related careers.

Young persons in Aboriginal communities, as well as many attending urban schools, have many rich experiences for the teacher to draw on. Many begin helping their parents and grandparents as soon as they are physically capable. By the age of 5 or 6, they may be gardening, picking berries, gathering clams and mussels, fishing from a line on a beach, setting crab traps, and cooking, smoking, drying and canning foods. Many will know a lot about Indigenous spiritual stories, medicinal herbs, and will have participated in ceremonial traditional songs and dances. Many will have experience drawing traditional figures, weaving baskets, making jewelry, designing and sewing button blankets, and carving animal figures and masks. By the age of 10 or 12, some will have had their own motor boat and know a lot about navigation, carpentry, and mechanics. Many will have experiences with fish hatcheries, commercial fishing, sonar and computers, processing fish, and running a family business. Teachers could develop science lessons around what students experience and talk about in the Aboriginal community (Snively, 1995).

Additionally, the following considerations may be helpful:

- No one textbook can comprise a viable science program for culturally different students. Textbooks should be reviewed for the purpose of removing offensive and racially stereotyped content. A variety of materials and resources should be used.
- Oral traditions must be respected and viewed by teachers as a distinctive intellectual tradition, not simply as myths and legends. The oral narratives and heritage of the Indigenous community should become part of the school science experience.
- Teachers should adapt written and spoken languages to avoid disadvantage to those with language difficulties, where possible provide bilingual science instruction. We should pay attention to the language of science education, and provide more opportunities for students to use language to explore and develop understandings—using analogies, models, metaphors, songs, role-plays, and stories.
- The history of colonization and how language has been used to legitimate economic and cultural imperialism should be acknowledged.
- We should acknowledge that issues of history, morality, justice, equality, freedom, and even spirituality are inseparable from the proper discussion of science and technology.
- Classes can gather and discuss data to show that there are many interpretations of the same phenomena, for example, different cultural notions of the concepts of heat and temperature, snow, classification (Phylum), and life cycles.
- Instruction should provide a high percentage of unstructured play activities, and “discovery” and “hands-on inquiry” learning that provides for the intake of sensory experiences and experiential learning.
- Throughout the unit, instruction should move from the concrete to ideas that are more abstract.

- Use science experiences to promote numeracy skill development as well as observation, predicting, collecting and analyzing data.
- Teachers should provide repeated opportunity and the time necessary for students to complete tasks.
- References can be made to current events and to present-day, home and community, real-life situations, and issues applicable to all children.
- Teachers should design curriculum materials and lessons that use exemplars from a variety of cultures and countries, so providing a “multicultural view” of science and technology.
- Teaching strategies should emphasize solving science and technology problems, environmental problems, resource issues, and sustainable societies’ problems. Instruction should identify local approaches for achieving sustainability. This will increase the meaningfulness of school and be consistent with traditional beliefs in working for the good of the whole group and community rather than of the individuals.
- Teachers can locate traditional stories and/or write stories around a science topic or resource issues related to a particular home place and engage students in opportunities to identify and articulate their own ideas and beliefs with others in small group situations.
- Promote scientific attitudes of curiosity and problem solving, thoughtful consideration of questions and challenges.

Approaches to Assessment

The way assessment is designed and carried out can be a challenge for Indigenous learners. Assessments in schools are designed to be competitive and stratifying in the way students strive for marks, usually timed and require a single “right” response. Barnhardt and Kawagley (2005) found the Eurocentric approach to testing to be very limited. “Such an approach does not address whether that person is actually capable of putting that knowledge into practice” whereas traditional knowledge is “tested in a real world context” (p. 11).

Written examinations are a major component of conventional school science culture during the middle and high school years, and represent a form of assessment foreign to students who have not been explicitly taught how to approach an exam. Consider that when science achievement exams are required, offer to students practice exams over several weeks, exams organized into smaller parts, as well as open-book exams; and give students ample time to finish.

As much as possible teachers should make every effort to use a variety of practical assessment techniques. Rubrics or checklists are helpful because they spell out what is expected. Self-evaluative questions and student journals can also be very helpful. Continuous feedback is critical to learning and for students to understand what is required and to feel supported and encouraged.

Knowledge and skills are not assessed in isolation from their purpose and application. In addition to assessing the students’ understanding of key concepts, assess students on the science processes; their ability to observe,

describe observations, predict outcomes, collect information, and evaluate outcomes of a project. For example, assess the students' ability to observe the details of a plant or animal, predict when specific animals will migrate through an area or estimate and map populations of organisms in a given area.

Give students opportunities for independent studies in which they identify a science-related topic or issue that is important and motivational such as: interviewing an Elder and/or scientist, making a film, conducting a questionnaire or poll. Research how their ancestors and community members observe how plants and animals thrive on the land so that they would not be over harvested.

In the Indigenous worldview, the purpose of learning must be to be helpful to the self, family, community, the ancestors and descendants, and the environment. Service learning engages students in projects such as removing invasive plant species from a forest, re-introducing indigenous plants or animals, cleaning up a salmon stream, or picking berries and making jam for an Elder. Assessment should take into account the goals of the project, knowledge of science associated with the project, the plan and timeline, organization of necessary materials and equipment, use of mathematics when appropriate, presentation of the project to class and possibly beyond, and indicators of success—how will we know if the project was successful. For group work, consider assessing the contributions of each student to the group project. The Alberta document *Learning Strategies for Aboriginal Students* (2005) provides insights for helping students design independent studies and conduct successful service learning projects.

The following list is derived from a judge's rubric for a First Nations and Métis traditional science fair. It illustrates community-based notions of assessment that inspire effective teaching practices, in contrast to conventional notions of assessment that can inhibit effective teaching and learning. For example, did a student

- indicate a sense that a journey was taken to become wiser?
- demonstrate harmony with nature and other values of the local Indigenous community?
- benefit the community in some way?
- embrace physical, mental, emotional, and spiritual aspects in their in-depth understanding?
- indicate that relationships were formed or strengthened, that responsibilities were taken on, and that protocols were properly followed? (FSIN, 2009)

As well, indicators of success might include

- increased knowledge of flora and fauna of an area.
- increased knowledge of the geology of an area.
- increased knowledge of the medicinal uses of plants, and the properties of plants that aid in healing.
- increased knowledge of the history and cultural significance of an area.
- ability to access the impact of specific technologies on the environment.
- ability to predict impacts on future generations.

Collect as much assessment evidence as feasible over a reporting period. At the end of the grading period, make an assessment based on knowledge of science along with a range of assessment techniques. Assessment strategies should be holistic, frequently anecdotal, and part of the on-going learning process. As much as possible, assessment should be positive. Several chapters in this book describe traditional forms of assessment: chapters 13, 14, and 15.

Teaching in an Aboriginal Community

When teaching in an Aboriginal community every attempt must be made to extend the world of learning beyond the school walls and bring the world of the Aboriginal child into the classroom (Battiste, 2000a, 2000b; Cajete, 1994, 1999; Edwards, 2004; Snively, 1995; Aikenhead & Michell, 2011). These attempts draw on concrete and real situations as a basis for science learning and allow movement away from learning out of context. In this regard, it is important for the teacher to find out what is going on in the Aboriginal community, to seek help from Indigenous scholars, teachers, teacher aides, and to encourage students to seek counsel from their Elders.

Beyond reaching out to the community yourself, students can be involved as student researchers and become involved in gathering and documenting local knowledge. This can be as basic as having students work with tape recorders, cell phones, or iPods to gather information from such sources as their families, Elders, or cultural groups. Plan medicinal herb walks, bark gathering or berry picking walks with an Elder or knowledge keeper to connect students with the land. With the help of Elders and other resource persons, plan a holistic Indigenous Science camp at an ancestral or culturally significant location. Such community-based projects will help alleviate alienation that is common to those who cannot participate fully in the typical science classroom.

When teaching in an Aboriginal community, your task as a teacher will be more successful if you adhere to the following guidelines:

- Invite Elders, parents, and local resource persons. Come to a mutual agreement of the purpose of the activity if taking a trip.
- Ask permission to use certain stories, songs, dances, etc. If there is any uncertainty, refrain from using the materials until you have the permission to incorporate them into your teaching.
- It is critical that teachers acknowledge his or her limited understanding of Aboriginal songs, stories, ceremonies, etc., and articulate this to the students. This avoids unintended misinformation of Aboriginal teachings. Orally reference the materials and the family/band/tribe/nation from which it came. This follows proper protocol and if not practiced is analogous to plagiarism.
- Ask permission to take photographs, videos or notes at ceremonies in or out of the big house/long house. Most songs, dances, and ceremonies are owned by families and recording this information is often prohibited.
- Find out and follow local protocols when asking Elders to come into the classroom.
- Acknowledge the traditional territories upon which the school, ceremony or fieldtrip activity is taking place. This respecting and acknowledging of Indigenous history and territory follows proper protocol.

Family support is often the deciding factor in student success or failure, as is with any child. By building on existing Indigenous curriculum materials and inviting parents and Elders to the classroom, the teacher is communicating an attitude of respect and shared teachings. In Indigenous cultures, grandparents (especially culturally knowledgeable grandparents) are held in high esteem as they contribute to the community by passing on knowledge, skills and wisdom.

Bring Elders and knowledgeable grandparents into the classroom to share personal knowledge when studying subjects like nutrition, plants, ecology, medicine, harvesting techniques, sustainable resource traditions, use of modern fishing techniques, the residential schools, and local cultural history. Aboriginal students must be given every opportunity to feel a sense of belonging and understanding in the two-worldviews that dominate their lives. As well, all students can benefit from the knowledge and wisdom of Elders and cultural knowledge holders.

When Teaching in Large Urban Schools

While many of the teaching strategies described are appropriate for small or average sized schools, there are additional ways to make a large multicultural urban school more culturally sensitive. Some of the negative aspects of size can be the impersonal and bureaucratic conditions that go along with large-scale factory-like institutions. These large schools can be broken down into several smaller learning communities, or schools within schools (Barnhardt, 2006). Students and teachers can form clusters that can function as a cohesive unit with a support system based on personalized relationships. Classes can be organized in a block format, where longer periods of time are made available for extended field trips and intensive projects without interfering with other classes.

The potential problem of cultural differences can be made into an asset in an urban school where the student population is a rich cultural mix. Many students of Aboriginal ancestry attend urban schools, and these students may or may not have close ties to a strong traditional place-based culture. The interests, knowledge, and strengths of each student can be recognized and rewarded through cultural demonstrations, group projects, language comparisons, and the inclusion of cultural songs, dances and customs. Over time, students in large urban schools can learn to celebrate cultural differences, and identify cultural difference as a strength rather than a threat.

In the higher grades, whether teaching in rural or urban communities, it is important to convey a sense of occupational purpose for their science learning. Provide opportunities for students to research and if possible, interview by e-mail, phone or in person, Indigenous scientists, biologists, engineers, technicians, architects, health specialists, fisheries and forestry professionals, environmental managers and technicians. Have students create posters, reports, and biographical collages of Indigenous scientists and their science-related work.

Connecting With Aboriginal Communities

There are many layers of shared understandings in any community, and especially in a small cultural community. For an outsider to begin to understand those deeper layers takes a considerable openness of mind and a great deal of effort and reflection. While the nearest library can be a helpful introduction to a new community, Barnhardt (2006) contends, “The fewer prior conceptions and the less cultural baggage that you carry into the situation, the more likely that you will be able to avoid jumping into superficial conclusions leaving you free to learn what it takes to make a constructive entry into the local flow of life” (2006, p. 2). The most important consideration is keeping an open mind and a good heart, reserving judgment and accepting people on their own terms. Remember the old saying, “first impressions count.”

In 1972, when the students of a community-based teacher education program in Mount Currie, BC, interviewed prospective instructors for the Lil'watul, they were looking for specific qualities. Wanost'sa7 Lorna Williams, who was involved with the decision-making process, outlines the qualities they were looking for:

- An openness toward people who are different from them, a willingness to learn, and understand, a sense that our ways would be respected and not be unsettling. We looked for instances where they might have lived in or travelled to places where they were a minority and had to learn to live with cultural or linguistic differences. How did they respond to the experience? What did they take away from the experience? What were their views about Indigenous people? It wasn't necessary for them to have extensive or intense knowledge about us; we could teach them about ourselves if they were open. Sometimes if a person came who had studied about First Nations, they thought they knew everything and stopped listening.
- We were interested in their thinking about colonization and imperialism. If they hadn't been aware of it, how willing were they to learn? At the time this was something we were learning, and exploring how colonization affected our lives and learning. We knew that as teachers we needed to break the pattern of the devaluation of our way of life.
- We were interested in their level of passion for the subject that they were coming to teach. We wanted to see the light in their eyes and bodies when they talked about the course they were going to offer. We wanted to feel the excitement in our bodies and to see the possibilities for our learning. When we asked for changes to the content or their approach we could see how flexible they were and how they too could see new possibilities for the course. We looked at what we were learning in each course, not just for ourselves but how it would impact our students and community. We were building a school for our community's future and we needed the tools and knowledge to bring two worldviews together.
- How able were they to communicate their ideas to us and to help us be understood so that there was mutual understanding? For many of us our English was limited, so how well could the candidate explain their ideas to us without making us feel stupid. It wasn't our intellectual limitation that kept us from understanding, it was our limited English and our limited experience with the Western world. Whether communicating legal, scientific or educational concepts it was the jargon that limited understanding. It is patience, knowledge, kindness, and willingness to find alternative ways to explain the concepts in the content readings that made the learning and teaching effective.

As opportunities arise, get involved, attend or find out about community events as early as possible. When appropriate, visit local Elders and other cultural bearers, and try to become familiar with aspects of the language. Showing enough interest in the local language to pick up even a few words or phrases will go a long way toward building your credibility in the community. Always assume the role of both teacher and learner.

Thoughts about Spirituality in the Science Classroom

From an Aboriginal perspective, understandings of spirituality are fundamentally interconnected with understanding of Indigenous Science (Cajete, 1999; Little Bear, 2000, 2009). Gregory Cajete (2000) suggests that divisions do not exist between science and spirituality, and states: “every act, element, plant, animal, and natural process is considered to have a moving spirit with which humans continually communicate” (p. 69). Teachers need to understand that religion and spirituality are different. There is no Traditional Ecological Knowledge (TEK or TEKW Traditional Ecological Knowledge and Wisdom) in the bible; and there are no TEK or TEKW spiritual missionaries.

It becomes essential for teachers of Aboriginal children to understand that serving their people is a paramount purpose of Indigenous education. Its purpose is not individual advantage or status. Aboriginal children are taught from childhood to contribute to the greater good, to be useful, help one another, pay attention to Mother Earth, and pray. This view of education is in marked contrast to the “me-first” attitude that is often found in most public schools and universities (Cajete, 1994, 1999; Kawagley, 1990, 1995; Kawagley & Norris-Tull, 1998).

To participate in school science, many Indigenous students are expected to set aside their Indigenous ways of knowing nature. Knowledge in Eurocentric science expresses an *intellectual tradition* of thinking, while Indigenous knowledge expresses a *wisdom tradition* of thinking, living and being. Broadly speaking, an intellectual tradition emphasizes individual cognition, while a wisdom tradition emphasis group-oriented ways of being as practiced by living in harmony with Mother Earth for the purpose of survival. Thus, practical wisdom tends to resonate with wisdom-in-action (Aikenhead & Elliott, 2010; Aikenhead & Michell, 2011).

A reverence for life and an affinity of the interconnections of all beings are integral components of Aboriginal worldview (Canada Council on Learning, 2007a, 2009). Essentially, spirituality is about day-to-day living—how we relate to one another and with the planet. Spirituality is also about how we learn. The Canada Council on Learning (2007a) document *Redefining How Success is Measured in First Nations, Inuit, and Metis Learning* includes the following:

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For the Metis people, learning is understood as a process of discovering the skills, knowledge and wisdom needed to live in harmony with Creator and creation, a way of being that is expressed as the ‘Sacred Act of Living a Good Life’ (p. 20).

Many Aboriginal peoples share the concept of a learning spirit. Vizina (2008) states, as quoted in the updated Canada Council on Learning (2009) document, *The State of Aboriginal Learning in Canada: A Holistic Approach to Measuring Success*:

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Acknowledgement of the spirit world and acceptance of spiritual gifts, such as dreams and visions, are a natural part of traditional life for Aboriginal people. Spiritual experiences are integral to each person’s learning journey and are honored through ceremony and relationships with the community’s spiritual leaders (p. 29).

Thus, to make knowing possible, the individual turns inward to connect with the energy inside oneself and in all of creation. Spiritual experiences are equated with knowledge creation and is manifested through ceremony, vision quests and dreams.

There is concern amongst some teachers and school administrators about altering scientific course curricula to make it more meaningful for Aboriginal students, and that the inclusion of Aboriginal examples, and in particular the spiritual dimension, will dilute or diminish the quality and standards of science education. By teachers introducing IS, they are not introducing religion (as understood by mainstream Canadian society) into the classroom. Herman Michell, a Woodlands Cree and Director of the Northern Teacher Education Program, Northern Professional Access College in Saskatchewan, notes that it is important that all Aboriginal students complete all the standard course requirements. Michell states, (as cited in Mullens, 2001), “When they [the Aboriginal students] get a degree here, it’s the same degree as the guy sitting next to them. If you get a different degree for Native students, it could very well carry a stigma” (p. 10). And, as Jette, founder of the Native Access to Engineering Program at Concordia University, points out, “the seeds must be planted early. Unless students obtain the basics of mathematics and science in elementary school it is almost impossible to pursue it [science] at the post-secondary level” (Mullens, 2001, p. 10). It becomes critical to understand that while the Aboriginal people of Canada have long advocated learning that affirms their own ways of knowing, they also desire an education that can equip them with the knowledge and skills they need to participate in society. They simply do not want to be assimilated and lose their culture in the process.

Teacher Education Programs

In preparing our science methods for the challenging task of teaching elementary and secondary science in schools (based on Western institutional, cultural and science standards), we know that many university and science education professors continue to contribute to the cultural genocide of Aboriginal people, through their singular way of viewing the world. To counter this possibility, Bailey (2000) builds an argument for examining our institutions based on the following concerns:

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- how we frame and name our own racism—to come to feel comfortable talking about our own biases and prejudicial thoughts, actions, and attitudes, as a necessary first step to action;
- how we disadvantage Aboriginal students in our universities, for whom success may require some form of personal amputation; and,
- how we, as teacher educators, can begin to model through our own culturally sensitive action, and through teaching, ways of becoming culturally sensitive classroom teachers. (p. 229)

In an attempt to examine our own institution, the Faculty of Education, University of Victoria, declared in its University Strategic Plan a strong will to address the under-representation of teachers with an Aboriginal ancestry in our schools, as well as an urgent need for pedagogical strategies that help Aboriginal children complete their school education (Faculty of Education, 2002). In our teacher education faculty, most of our classes on campus have some Aboriginal students.

It is possible that there are Aboriginal students in every school in the province, rural or urban, and teachers need to know how to teach this population that the school system has consistently failed. To that end, the University of Victoria created a course on Indigenous Education mandatory for all teacher education students. The course covers five areas: Indigenous knowledge and learning; information on Inuit, Métis, and First Nations peoples; their languages, cultures, and land base; the effects of colonization in education and decolonizing efforts; and the history and current policies and practices in schools that affect decision-making and pedagogical practice.

In addition, the undergraduate environmental education courses and Graduate Program in Environmental Education include many examples of IS, and in particular TEK. The aim of the graduate program is to draw people from diverse backgrounds together in learning about the forest and ocean environments, respecting the cultures of Indigenous people, and educating future citizens to make wise decisions regarding long-term sustainable communities and environments. Many respected Chiefs and Elders are regarded as professors and invited to speak to the students. Because the work of Elders is always grounded in their own spirituality, it has a different dimension to it—Elders speak from the heart and without a sense of competition. By bringing Elders, storytellers, scientists and other resource persons into the classroom and engaging them in field experiences, we invite all participants (both Aboriginal and non-Aboriginal graduate students) to work together in attempting to resolve environmental problems using both Western Science and Indigenous Science knowledge and experience. From the participants' experiences, the program provided a unique interdisciplinary starting point for developing research and curriculum efforts (Snively, 2006).

The idea of spirituality informing our work in universities is increasingly a topic of scholarly work (Bailey, 2000; Kanu, 2005; Little Bear, 2009; Snively, 2006). Often, the notion of spirituality remains unclear, with the terms “religion” and “spirituality” becoming fused. Whether we refer to Creator or God, the sense of a higher power has a significant impact on how people see their world and their actions within it. Unfortunately, in our Eurocentric culture many of us have lost the sense of spirituality, of oneness with the universe.

Starting Points and Information Sources

The questions raised by pre-service and in-service teachers provide a starting point for creating a more relevant science education for all children. Here are some possible considerations for teachers:

- Arrange for special speakers of various cultures;
- Develop lesson plans and teaching units around science themes of interest to children of specific home places and cultural origins;
- Develop lesson plans that address multi-sciences, traditional science, culture, and the changing nature of science;
- Develop questioning strategies that encourage active listening and the identification of personal beliefs about science concepts and the relationship between culture and science traditions;
- Observe children in multicultural classrooms;
- Interview teachers of multicultural students;
- Co-plan an Indigenous Science learning centre, science fair or Indigenous Science Camp.

Topics for Integrating Indigenous Science into the Classroom

The following are possible topics for integrating Indigenous Science activities, textbooks, and resource materials:

- medicines and medical procedures
- edible plants
- edible seaweeds and marine animals, harvesting and preparation
- knowledge of food preparation
- animal behaviour, life cycles, habitats, distribution, animal migration
- tides, ocean currents
- lake and river dynamics
- forest relationships
- knowledge of tanning hides, making moccasins, mittens, and parkas
- knowledge of wood products: cedar bark clothing, baskets, ropes, and twine
- knowledge of tools and machines, wedge, lever, maul, incline plane, fulcrum, and wheel
- traditional fish harvesting, Nisga'a fish wheel, weir, halibut hook, gillnet, halibut hook
- knowledge of weather and seasonal changes
- classification of plants and animals, classification of environments
- ecological knowledge, environmental change over time, climate change
- erosion and relocation
- sustainability practices
- enhancement practices, salmon and trout enhancement, clam bed enhancement, estuarine root gardens
- snow and ice, igloo, snow shoes, snow goggles, sled, toboggan
- wilderness survival, shelters, making fire
- use of controlled burning to enrich soil, enhance wild food crops, control insects, control forest understorey
- metallurgy
- astronomy, knowledge of constellations, movement of sun and moon
- navigation across oceans following constellations
- agriculture, knowledge of soil types, propagation of corn, pumpkins, potatoes
- geology, knowledge of soil types, knowledge of rocks (sandstone, flint, obsidian, jade, copper)
- nautical design, dugout canoe, birch bark canoe, whaling canoe, sturgeon canoe
- architecture (heat and temperature control), cedar log big house, teepee, igloo

For a more complete description of curriculum connections, see Appendix A.

Information Sources

Sometimes, collecting information on Indigenous Science is fairly easy such as when information is readily available in a book or film, or when an Elder can be used as a resource person. It can be more complicated when the information concerns specific local knowledge, is culturally sensitive or when the knowledge has been lost or distorted.

Gathering local Indigenous Science examples takes time, creativity, and effort. Primary teachers will need to identify materials and resource persons, but at the intermediate and secondary levels, teachers can also engage students in collecting information. The following are possible sources:

- informal interviews, talking circles, participant observations
- resource people from the local community
- students as researchers
- biographies of Elders
- field trips, camping trips
- books, legends, taped songs and stories
- maps, photographs, sketches, time lines
- internet, YouTube, Facebook, blogs, social media
- films, documentaries, National Film Board of Canada
- historical archives, archeological and anthropological archives
- tribal and band offices, (land claims research)
- school district Aboriginal education office, ministries of education (Aboriginal Programs)
- Traditional Ecological Knowledge (TEK) researchers (biologists, geologists, climatologists, ethnobotanists, etc.), TEK journal articles
- universities (Faculties of Education, Indigenous Governance, Linguistics)
- Appendices A, B, C, and D of *Knowing Home*.

Accessibility to the digital world varies in every community, and changes are made rapidly. It becomes worthwhile to find out what is available in the school community.

Responsibilities of Government

The responsibility of ministries of education and territorial governments is to include a meaningful degree of Indigenous Science explicitly in the science curriculum through collaboration with Indigenous Elders and knowledge holders. Ministry documents should include information on Indigenous Science, resources, and teaching strategies that facilitate responsible cross-cultural science education. It is the responsibility of school boards and government to create and fund workshops and alert teachers to opportunities to become engaged. Without administrators' interest and leadership, and without adequate funding, teachers feel unsupported.

Conclusion

One of the encouraging notes in these times is that in spite of all manner of historic and contemporary violence and oppression, both the Indigenous Knowledge stories and the people still thrive in many parts of Canada and throughout the world. It is given to us who work at universities and in the school system to create programs and spaces for the stories of Aboriginal practitioners to be told to both Aboriginal and non-Aboriginal students.

The rightful inclusion of Indigenous Science in school science will not be accomplished overnight. In spite of formidable forces, there are isolated pockets within the educational establishment across Canada where much progress has been made. While many educational institutions include in their educational philosophies idealistic statements about Indigenous Science, what is prescribed in ministry documents is all too often not reflected in science classrooms. Clearly, the resolution lies in people who are motivated to explore ways of respectfully accessing and building connections with Indigenous learners, their families, and communities. What is important is the need to recognize the value, indeed the usefulness of Indigenous ideas about the world in which we live, and how we should live in it. There are good reasons to stop arguing about the authenticity of Indigenous Science and recognize the importance of the knowledge and wisdom that it contains and reflects. While education is a major part of the problem, it can also be a major part of the solution.

DISCUSSION POINTS

In a small group of 3 to 5 persons, discuss the following:

- Tell a story that you observed or were engaged in that is an example of culturally sensitive science related teaching. Or culturally insensitive science teaching.
- Respond to the statement: “I’d like to include Indigenous Science in my school classroom, but I’m non-Native and I’m afraid to make mistakes. I don’t want to get into trouble.”

Things to do:

- Visit the Aboriginal Resource Centre in a School District to review their curriculum resources. If possible, find out what programs exist in the district that relate to Indigenous Science.
- Visit a classroom or event that engages students in topics related to Indigenous Science.

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