

Learning Indigenous Science from Place

**Research Study Examining Indigenous-Based
Science Perspectives in Saskatchewan First Nations
and Métis Community Contexts**

November 2008



LEARNING INDIGENOUS SCIENCE FROM PLACE

a collaborative effort of



©2008
Michell, Dr. Herman, Yvonne Vizina,
Camie Augustus and Jason Sawyer

ISBN: 978-0-9810855-0-0

We can be contacted through:

Aboriginal Education Research Centre
Room 1212, College of Education
University of Saskatchewan
28 Campus Drive
Saskatoon, SK S7N 0X1 Canada
Tel: (306) 966-1360 Fax: (306) 966-1363
E-Mail: aerc@usask.ca

Cover Photo ©Yvonne Vizina

TABLE OF CONTENTS

1. Introduction	6
1.1 Project Background.....	9
Indigenous Knowledge in the School Science Curriculum Committee	9
Committee Principles.....	9
Committee Partners and Stakeholders.....	9
1.2 Project Description.....	11
Research Questions	11
Goals of the Study.....	12
Benefits of the Study.....	12
1.3 Aboriginal Identity	12
2. Literature review.....	15
2.1 Historical Overview of Aboriginal Education in Canada	15
Traditional Education in Aboriginal Contexts	15
Education under Colonialism	17
Aboriginal Control of Education.....	18
The Royal Commission on Aboriginal Peoples Report.....	19
Contemporary Challenges.....	21
2.2 Historical Overview of Saskatchewan Learning Policy.....	22
A History of Saskatchewan Learning Action Plans, 1981 to Present	22
2.3 The Concept of Indigenous Science	26
Place as an Aspect of Learning Indigenous Science	26
2.4 The Concept of Indigenous Science Education	30
Indigenous Knowledge, Worldviews, and Epistemologies	30
Defining Science and Indigenous Science	33
Comparing Indigenous Science and Western Science	34
Integrating Indigenous Science and Western Science in Education	35
Environmental Movements and Science Education	37
2.5 Promising Practices: A Summary of the literature.....	44
A Summary of Common Themes in the Literature	48
Holistic Knowledge and Spirituality	48

Indigenous Knowledge of Local Populations	48
Student Engagement through Technology and Mentoring	49
Strong Community and Parent Relationships.....	50
Effective Teacher Education and Pedagogy	50
Conclusion.....	52
3. Research Methodology and Methods.....	53
3.1 Community-Based Action Research Approach	53
3.2 Methods Used.....	53
3.3 Research Site.....	53
3.4 Research Participants.....	54
3.5 Snowball Sampling Method	54
3.6 Interviews.....	54
3.7 Convention for Citations	55
3.8 Ethical Considerations.....	55
3.9 The Ethics of Conducting Research in Aboriginal Communities	56
Intellectual Property Rights and Indigenous Heritage	57
4. Data Analysis	60
4.1 Holistic Lifelong Learning Models	60
First Nations Holistic Lifelong Learning Model	61
Métis Holistic Lifelong Learning Model	61
5. Research findings	62
5.1 Learning Indigenous Science from Place: First Nations Perspectives.....	62
5.2 Learning Indigenous Science from Place: A Métis Perspective.....	90
5.3 Learning Indigenous Science from Place: Pre-Service Teacher Perspectives	108
5.4 Learning Indigenous Science from Place: Teacher Perspectives	113
5.5 Discussion of Findings	117
5.6 Summary of Research Findings and Conclusions.....	118
5.7 Research Questions	121
6. RECOMMENDATIONS.....	131
6.1 A Holistic Paradigm	131

6.2 Strategies to Enhance Indigenous Science in Curriculum	133
6.3 Recommendations for Further Research	134
Bibliography	135
Appendices.....	147
Appendix 1: First Nations Holistic Lifelong Learning Model	148
Appendix 2: Métis Holistic Lifelong Learning Model	149
Appendix 3: Indigenous Science and Western Science: Similarities and Differences	150
Appendix 4: Promising Practices Database.....	154

1. INTRODUCTION

Indigenous science is a concept unfamiliar to most Canadian education systems. It is a study of natural systems that contributes to a holistic view of the environment and the role of human beings within that environment. The holistic nature of Indigenous science encompasses intellectual, physical, affective and spiritual domains of learning. Practical applications of Indigenous knowledge are balanced with deeply respectful spiritual practices leading to informed decision-making that is in the best interest of self, others and the world around us. In undertaking this research, the project team considered the need to voice Aboriginal community wishes to incorporate cultural teachings within mainstream or other school curricula, but there was also a consideration of the need to help school systems prepare students for career choices within scientific disciplines.

Canadian society, provincial education systems, and local communities face a critical issue in relation to under-representation of Aboriginal¹ Peoples in scientific-related careers. Students unable to achieve success in school science at the K-12 level, mean low participation rates in Canada's booming economic and resource management sectors. For Aboriginal Peoples, this reflects a historic and contemporary problem of equity and social justice with the dismissal of Aboriginal cultural knowledge within school curriculum. Societal demands for sustainable development supports having a variety of scientific professionals steeped within land-based cultural foundations and equipped with the latest scientific knowledge and skills to resolve environmental challenges facing Canada and the rest of the world. Student success in school science must address the idea of learning Indigenous science in relation to Place as well as generalized science curriculum currently available to public, separate and band schools.

In 2007, a group of Aboriginal and non-Aboriginal scholars, teachers, administrators, and institutional representatives embarked on the creation of a project entitled *Learning Indigenous Science from Place*. The overall goal of the project was to investigate the inclusion of First Nations and Métis perspectives in the Saskatchewan school science curriculum as a way to improve the achievement levels of Aboriginal students. The Canadian Council of Learning provided major funding support with in-kind support from project team members. The research commenced under the joint leadership of First Nations University of Canada and the Aboriginal Education Research Centre, University of Saskatchewan. The following pages represent a final report of this research project.

As a group, we knew the results of the work would have continuity and serve as a starting base to couch further studies and action plans from the foundation of local First Nations and Métis communities. The project team utilized a community-based action research approach wherein information and activities is shared in an open, accountable, and transparent way. The approach was focused on knowledge gathering for the purpose of taking action in addressing pressing community issues (Stringer, 1999). The research model provided a process and avenue through which community members could collectively clarify problems and formulate new visions for the future, implement and test meaningful solutions and thereby generate new knowledge. Our major intent in using the approach was to provide space for the perspectives of Aboriginal Peoples who have been previously marginalized from opportunities to envision, develop, and operate policies, programs, and services concealed by the products of other research processes. We are indebted to the Elders, teachers, pre-service teachers, university professors,

¹ We use the term 'Aboriginal' in this final report to refer specifically to First Nations and Métis communities that are the focus of the study. The term 'Aboriginal' is used in the Canadian constitution to refer to First Nations, Métis, and Inuit people of Canada. In addition, we use the term 'Indigenous' to refer to Original peoples worldwide that are connected to place.

and traditional land users who took part in the study and who so graciously shared their words of wisdom with the project team.

The intended outcome of using the action research approach is community change using practical solutions generated through the research process that will assist in the development of new programs or modifications to existing policies, school science curriculum, and support services for teachers. The model enables localized, pragmatic strategies to research, investigating particular issues and problems in particular communities, at varying times in the lives of individuals and groups. The purpose in this project was to provide participants with new understandings of issues they defined as being significant and the means for taking corrective action. The research process allowed people affected by the way in which school science is developed and delivered to have their voices heard and to be actively involved in research activities. The research results have the potential to provide a means for people in both professional and occupational roles to reformulate policies and practices to enable them to provide programs and services that are effective for Aboriginal learners.

According to the research literature uncovered during the course of this project, recognizing *science as a cultural construction* opens the doorway for coming to understand there are multiple science perspectives in which Western science is only one among thousands of Indigenous Knowledge systems (Aikenhead, 2006a). Science is not value neutral, but rather, is tied to and defined by social and cultural norms. School science in Canada has been typically defined exclusively by Euro-centric Western models, worldview, and epistemology, and has thus rejected diverse Indigenous Knowledge systems. Incorporating Aboriginal perspectives in school science is not only imperative to generating interest and relevance for Aboriginal students; it will also broaden all people's worldview and understanding of our interconnected relationship with the earth and environment. From this worldview, Indigenous epistemologies although diverse, consider knowledge as action and wisdom with elements of spirituality and empiricism – a holistic approach that seeks harmony with nature for survival (Aikenhead & Huntley, 1999). Hence, incorporating Aboriginal perspectives in school science has the potential to resolve social, cultural, and environmental crises that impact all humanity.

Historically and still today, conventional school science serves to acculturate and even assimilate students into a Western scientific way of looking at the world to the detriment of Aboriginal Peoples' cultural identities and success within the discipline of science. According to Aikenhead (2006a), "when school science does not nurture students' Aboriginal identities or strengthen their resiliency, most students do not see its value and are not inclined to participate or achieve in these courses" (p. 1). This finding is supported by other researchers who have studied ways of nourishing *the learning spirit* among Aboriginal learners (Battiste, 2008). The intent of this project is to nourish the learning spirit of Aboriginal learners in school science (Cajete, 2000a; MacIvor, 1995; Kawagley, Norris-Tull, & Norris-Tull, 1998; Sable, 2005; Sutherland, 2004).

The issue of incorporating Aboriginal perspectives in school science is pressing. By the year 2016, close to 50% of children in Saskatchewan entering kindergarten will be of Aboriginal ancestry. Provincially and nationally, educators have an obligation to strengthen students' Aboriginal identities as they learn to master and critique Western scientific empirical data and investigation without, in the process, sacrificing their own culturally constructed ways of knowing. The Canadian Council of Learning recognizes and supports this assertion in their report entitled, "Redefining How Success is Measured in First Nations, Inuit and Métis Learning":

First Nations, Inuit and Métis have long advocated learning that affirms their own ways of knowing, cultural traditions and values. However, they also desire Western Education that can equip them with the knowledge and skills they need to participate in Canadian society. First Nations, Inuit, and Métis recognize that “two ways of knowing” will foster the necessary conditions for nurturing healthy, sustainable communities. (CCL, 2007a, p. 2)

The *Learning Indigenous Science from Place* research team hopes the results of this study will assist in encouraging positive systemic change to nurture Aboriginal students’ scientific literacy so they can successfully *walk in both worlds*, Aboriginal and Euro-Canadian (Battiste, 2000). We anticipate the implications of the research will nurture all learners in school science regardless of cultural background. We believe incorporating Aboriginal perspectives in school science will nurture students’ and educators’ understanding and appreciation of Indigenous knowledge systems that have not been a major part of school science curriculum in the past (Aikenhead, 2006a).

This final report is not meant to be comprehensive in scope as each Aboriginal community within the province will need to be consulted before any meaningful incorporation of First Nations and Métis perspectives can take place in school science. There are over 70 First Nations communities in Saskatchewan and six major Aboriginal cultural groups (Métis, Cree, Dene, Sauteaux, Dakota/Nakota, Assinboine). Our project was an ambitious one. We realized along the way that it could have easily been divided up along major cultural groups and even a separate project for the Elders and Teachers. Ideally, the results of the research project represents a vision, a beginning, and a starting base for all stakeholders touched by the issue to take meaningful action based on the information gathered and shared. We apologize ahead of time for any misrepresentations. We ask readers to take what they need and leave the rest.

1.1 Project Background

Indigenous Knowledge in the School Science Curriculum Committee

As with all things, the beginning is never truly the beginning. Although this research project commenced in 2007, there had been a long period of dialogue, talk, networking, and relationship building occurring within Saskatchewan and Canada in relation to Aboriginal education. Our project team wanted to build on the strengths of this movement. In 2005, the *Indigenous Knowledge in the School Science Curriculum Committee* was formed by a group of individuals who held a common belief in the importance of Indigenous science. Membership on the Committee is diverse including, among others, Aboriginal and non-Aboriginal educators, scholars, political representatives, educational administrators and senior officials responsible for science curriculum within Saskatchewan. Each volunteer member brings distinct expertise and contributes to exciting and dynamic discussion about science. The group was interested in examining ways of integrating Aboriginal knowledge systems, perspectives, and experiences into all school science curricula in Saskatchewan's public and First Nations' schools, but the focus of this study was targeted at grade six to nine.

Committee Principles

The *Indigenous Knowledge in the School Science Curriculum Committee* was established for the following purpose:

...to foundationally place Indigenous Knowledge and animate Indigenous Science within the Science curriculum. The Committee provides advice to Saskatchewan Learning [now Ministry of Education] curriculum writers, provides supports to animate Indigenous Science, and identifies gaps and effective practices in support of Indigenous Science (IKSSCC Work Plan 2007- 2008).

The project members recognize the potential benefits of sharing Indigenous knowledge with all students regardless of cultural background. It is important to note the Committee principles reinforce the recognition of Indigenous knowledge systems – not their *validation*.

Committee Partners and Stakeholders

Classroom success (i.e., a more equitable representation of Aboriginal content and student achievement in science courses) requires more than providing teachers with status quo instructional resources. Involving prime stakeholders and partners to explore and provide an enhanced science curriculum is imperative.

The Project Team has evolved a relationship over the past two years as a community-based committee of interested people including individuals from:

- First Nations University of Canada
- University of Saskatchewan
- First Nations and Métis communities
- Gabriel Dumont Institute
- Government of Saskatchewan, Ministry of Education
- Federation of Saskatchewan Indian Nations
- Meadow Lake Tribal Council
- Saskatoon Tribal Council

- Public & Catholic School Divisions
- Teachers
- Elders

As a project team, we were guided by an understanding that Elders and community members, especially traditional land users, are the authoritative stakeholders in negotiating an authentic and enhanced science curriculum that reflects Aboriginal perspectives. Elders and community members must be fully involved in all phases of curriculum development from visioning, planning, developing, implementing, and on-going evaluation. Appropriate consultation processes, frameworks, structures, and adequate funding must be negotiated and instituted before any kind curriculum development takes place. Anything less will constitute an imposed school science curriculum that will continue to perpetuate neo-colonialism and assimilation.

This research is well positioned to make a difference in the way curriculum is developed in the province of Saskatchewan and beyond. The inclusive approach undertaken by the project team brought together First Nations and Métis communities with educators, curriculum developers, policy makers and government institutions in preliminary research to effect new perspectives and foundations for school science. Such an undertaking will no doubt forge relationships, dialogue, discourse, and partnerships that will create new understandings in the way school science is taught from the foundation of Aboriginal communities.

1.2 Project Description

As the *Learning Indigenous Science from Place* project began to emerge various First Nations and Métis individuals, government and academic institutions, and a diversity of educators quickly became involved in the project. Monthly meetings were convened. Ideas and knowledge were exchanged. Minutes were taken to ensure continuity of action taken by team members. In February 2006, the Indigenous Knowledge in the School Science Curriculum Committee began to formulate a funding proposal to the Canadian Council on Learning. The proposal was accepted, and the Committee commenced with the research in early 2007. Researcher access to the communities involved following proper protocols and approval processes. In most cases, community access was granted quickly, however, in some cases the project team learned the importance of patience in going through several layers of approval (described in the methodology section). By the fall of 2007, the team had identified and contacted potential interviewees from First Nations and Métis communities. The interviewees included Elders, practicing teachers, pre-service teachers, and various traditional land users. Research assistants were hired to help with the project, contributing their scholarly expertise and gaining personal insight into the unfolding process of community-based action research. The resulting literature review and interview analysis completed by the research team constitutes the core data of the study.

Research Questions

This research project was designed to investigate how educators and education systems might take up place-based Indigenous science and apply it within the established school science curriculum. *Learning Indigenous Science from Place* is based on five central questions:

- What is a First Nations perspective of learning Indigenous science from Place?
- What is a Métis perspective of learning Indigenous science from Place?
- How can learning from Place help create a foundation for a science curriculum that is contextualized to place and to the people of the Place?
- How can the perspectives inform teachers of processes and content needed in science curriculum?
- What supports are needed for educators to engage in Indigenous science?

These broad research questions were used to develop a set of interview questions that were used as a guide for the interviews. The questions were not intended to uncover how we can stuff Indigenous knowledge into existing Western science units and lessons per se. Instead, we wanted to find out the possibilities, parameters, limitations, and challenges of incorporating Indigenous knowledge systems in school science curriculum from various perspectives including existing literature. The data analysis was intended to make a contribution in developing strategies and tools that educators and education systems can use as a guide for the integration of place-based Indigenous knowledge content in school science curriculum in Saskatchewan.

Goals of the Study

The underlying goals of the study include the following:

- To explore the concept of *Indigenous-based science education* from the perspectives and experiences of teachers, Elders and other community members in First Nations and Métis community contexts in Saskatchewan;
- To highlight best approaches, processes, and content used in First Nations & Métis contexts;
- To highlight barriers, challenges, and supports needed for science teachers in First Nations & Métis contexts; and to develop a set of strategies and tools educators and education systems can use as a guide for the integration of place-based Indigenous knowledge content in science curriculum at the K-12 level.

Benefits of the Study

Advancements in western science play an increasingly significant role in the everyday life world of Aboriginal students, but so too does the wisdom of Indigenous knowledge systems. School science curriculum framed to include the worldview and perspectives of Indigenous Peoples has many benefits.

The project team initially identified the following benefits that would materialize as the study progressed:

- An honouring of Indigenous knowledge systems
- A sharing of worldviews
- Community-based focus
- Building research capacity
- Creating partnerships and networks
- An honouring of Indigenous methodologies
- Uncovering best practices
- A guide for curriculum developers
- Evidence for educational policy development
- Contribution to equitable representation of First Nations and Métis perspectives in science education
- Examining Western and Indigenous goals of science education

Although diverse, First Nations and Métis communities have a shared vision. Their overall goal is to move beyond a colonial past into a postcolonial present, and to forge new relationships by a mutual sharing of knowledge perspectives for the benefit of all humanity. An enhanced school science curriculum from the foundation of First Nations and Métis contexts reflects this postcolonial goal.

1.3 Aboriginal Identity

One of most important things to all human beings is having a sense of identity. Names given by parents, surnames inherited from previous generations, spirit names revealed through ceremony, tribal affiliations, associations to circles of friends and colleagues, and membership in societies, nations and other political organizations are all cherished parts of an individual's identity. Just as you or I would be

offended if we were repeatedly identified by an incorrect name, Aboriginal individuals are sensitive to labels that are inaccurate, or inappropriately applied. There are different perspectives that have given rise to the identity of Aboriginal Peoples in Canada. One perspective of the identity of Aboriginal Peoples comes from the legal definitions entrenched in the Constitution Act, 1982. Other perspectives of identity come from within distinct groups of Aboriginal Peoples themselves.

Constitution Act, 1982

The Constitution Act, 1982, Section 35 (2) states "aboriginal peoples includes the Indian, Inuit and Métis peoples of Canada." (Department of Justice, n.d.)

The term *Aboriginal* refers collectively to Indian, Inuit and Métis Peoples. The term *Aboriginal* may also be used to identify someone when their specific nation is unknown. It is important to recognize that there is no actual Aboriginal Nation; rather, this is a generic term that helps us describe a particular person or group of persons. Since the term *Aboriginal* is used as a proper noun, it is a display of respect to capitalize the noun. A similar situation is observed with the term *Peoples*.

The term *Indigenous* is not used in the Canadian Constitution; however, it is another term that is useful in making general references to individuals or groups of people. There are many interpretations and definitions of *Indigenous*. The International Labour Organization includes this information in Section IV of Convention 169:

Peoples in independent countries who are regarded as indigenous on account of their descent from the populations which inhabited the country, or a geographical region to which the country belongs, at the time of conquest or colonisation or the establishment of present State boundaries and who, irrespective of their legal status, retain some or all of their own social, economic, cultural and political institutions. (International Labour Organization, 1989)

Throughout this research study you will notice that the terms *Aboriginal* and *Indigenous* are both used. The term *Indigenous* includes all Aboriginal Peoples of Canada, but the term *Aboriginal* does not include all Indigenous Peoples of the world.

First Nations

The Constitution Act, 1982 uses the word *Indian*, although most people today use the term *First Nations*. It is important to recognize that First Nations Peoples did not use either term historically. *Indian* and *First Nations* are English terms used for convenience. Each nation originally inhabiting this land had their own name to identify themselves as a group. For example, European colonizers used the word *Cree* to identify *Nehiyawak* (spelling varies). There are 630 First Nations communities in Canada. The Assembly of First Nations represents most of the First Nations in Canada, stating,

Historically the First Nations have a unique and special relationship with the Crown and the people of Canada, as manifested in treaties and other historical documents. In essence, the special relationship is one of (negotiated agreement with a view toward) peaceful coexistence based on equitable sharing of lands and resources, and ultimately on respect, recognition, and enforcement of our respective right to govern ourselves. The AFN exists to promote the "restoration and enhancement" of this relationship and to ensure that it is mutually beneficial to the First Nations people. (Assembly of First Nations, n.d.)

Métis

The Métis National Council represents Métis People from Ontario to British Columbia. The Métis share a common history, culture, language, kinship connection, traditional territory and way of life. It is estimated there are over 350,000 Métis in Canada. According to the Métis National Council,

Métis means a person who self-identifies as Métis, is of historic Métis Nation Ancestry, is distinct from other Aboriginal Peoples and is accepted by the Métis Nation. (Métis National Council, n.d.)

There are other groups of people in Canada who identify as *Métis* but are not represented by the Métis National Council. They also have a unique mixed European and First Nations heritage, however, apply different criteria for their membership and political representation.

Inuit

There are approximately 45,000 *Inuit* in Canada. They live in 53 Arctic communities in four geographic regions: Nunatsiavut (Labrador); Nunavik (Quebec); Nunavut; and the Inuvialuit Settlement Region of the Northwest Territories (Inuit Tapiirit Kanatami, n.d.). This research study does not address the unique education issues of Inuit but it is hoped that the study is reviewed in Inuit communities and is useful in supporting the concept of learning Indigenous science in relation to Place.

Cultural Diversity

Among Aboriginal Peoples there is a great deal of cultural and linguistic diversity. Identifying, respecting and celebrating diversity contributes to a healthy vibrant society. The United Nations Education, Scientific and Cultural Organization explains,

...culture should be regarded as the set of distinctive spiritual, material, intellectual and emotional features of society or a social group, and that it encompasses, in addition to art and literature, lifestyles, ways of living together, value systems, traditions and beliefs. (United Nations Education, Scientific and Cultural Organization, 2002)

The First Nations and Métis Education Branch, Ministry of Education, Government of Saskatchewan holds the following goals for its role in pre-kindergarten to grade twelve education:

1. All students achieve wellbeing and learning success
2. Cultural identity and diversity are affirmed in the learning program
3. Teaching and learning are guided by Indigenous Knowledge, research and best practices
4. Learning environments foster respect of self and others
5. Every school is a part of a larger learning community
6. The leadership of the provincial education system is shared through co-management and co-governance. (Government of Saskatchewan, 2007)

The application of these goals to build a culturally appropriate science curriculum specific to a region requires the consideration of diverse Aboriginal cultures. Education authorities work to find common principles upon which to build appropriate policy and curriculum for schools and learners, while respecting cultural and linguistic differences. A challenge for educators is to avoid trivializing or minimizing differences among Aboriginal Peoples, as well as to understand that many important culturally specific teachings exist outside formal school settings.

2. LITERATURE REVIEW

In this section, a literature review is provided that serves as a framework for the research project and the research questions posed. The review is divided into five areas that include the following:

- Historical Overview of Aboriginal Education in Canada
- Historical Overview of Saskatchewan Learning Policy
- The Concept of Indigenous Science
- The Concept of Indigenous Science Education
- Promising Practices: A Summary of the Literature

A literature review in qualitative studies is a continuous process that is never completed. The literature review is not meant to be comprehensive, our aim was not to repeat what others have already written but to survey the terrain and identify the literature gaps in order to provide a rationale for undertaking the study. Aikenhead (2006a), McKinley (2007) and Hammond and Brandt (2004) provide literature reviews and evidence of the increasing interest on cultural perspectives in school science.

There is a wealth of literature that exists in relation to Aboriginal education in general and more specifically under the rubric of cultural studies in science education (Aikenhead, 2006). The following construction illuminates the complexity of thought that exists in what has become known as Indigenous science education discourse (Aikenhead, 2006a; Aikenhead & Huntley, 1997, 1999(a)(b); Cajete, 1986, 2000; MacIvor, 1995). We begin the literature review with an examination of the history of Aboriginal education. We draw attention to the policy directions that have been undertaken by the federal and provincial governments and the current challenges facing teachers as they struggle to meet the need of Aboriginal learners in school science. Our overall purpose is to trace the evolution of advancements made in relation to the inclusion of Indigenous knowledge systems in the science curriculum. The literature review ends with a summary of promising practices that have been constructed around common themes uncovered during the course of this research project. We ask readers to turn their attention to the history of Aboriginal education in Canada in order to understand the importance of incorporating cultural and linguistic content in school science.

2.1 Historical Overview of Aboriginal Education in Canada

The literature on Aboriginal education suggests that science education must be considered within the larger context of Aboriginal history, colonization, societal struggles, and cultural survival (Barman, Herbert, & McCaskill, 1987; Kirkness, 1992; Battiste & Barman, 1995; Villeneuve, 1996; Goulet, 2005; St. Denis, 2002). Indigenous science and Indigenous science education cannot be understood within a social vacuum disconnected from spiritual, historical, political, social, and economic roots. It is important for curriculum developers and science teachers to have some basic understanding of this context as a foundation for developing effective teaching practices in specific Aboriginal contexts.

Traditional Education in Aboriginal Contexts

Prior to European contact, and continuing to present day, Aboriginal Peoples had their own forms of education based on holistic ways of viewing the natural world. Although different groups had their own specific ways of educating their children, there are commonalities. There is, first and foremost, a shared worldview in which Indigenous People see themselves as an integral part of the natural world. There are

however, different ways of expressing and reinforcing this shared worldview depending on the culture. Child-rearing practices are also similar. Educational systems among Indigenous Peoples tended to be non-coercive. There was a heavy emphasis on observation, teaching by example and modeling practice. Although direct instruction was important, parents often adhered to the ethic of non-interference, by allowing the child to develop naturally according to their purpose and *giftedness*. Teaching was non-intrusive and subtle, and reflected the cultural values required for community-well being. As in any society in general, age was respected, and it was Elders who often taught lessons through storytelling and other forms of expression (Little Bear, 2000; Miller, 1996).

Indigenous pedagogies included ways of transmitting knowledge through language and other symbolic means while respecting other cultures, perspectives and realms of being (Battiste & Henderson, 2000; Miller, 1996). Much of the education occurred within the context of the natural social setting. Although complex, Indigenous knowledge systems were not regimented or institutionalized in a formal way as they are now (Gresko in Barman, Hebert, and McCaskill, 1986). Chief John Snow of the Stoney First Nation describes traditional education of the Nakota:

There was no formal education as such, but education was interwoven into the life of the tribal society. A very important responsibility of the tribal members was to pass on valuable information to the next generation by the spoken word. Parents, grandparents, and elders told and retold stories and legends to the children by the campfires, in the teepees, on the hillsides, in the forest, and at special gatherings during the day and at night. It was an ongoing educational process about religion, life, hunting, and so on. Other topics were bravery, courage, kindness, sharing, survival, and foot tracks of animals, so it was a very extensive study of many things. (Snow, 1977, p. 6)

Education “took place informally through the acquisition of specific skills, attitudes, and knowledge needed to function in everyday life within the context of a spiritual worldview” (Barman, Hebert and McCaskill in Barman, Hebert and McCaskill, 1987, p. 3). Learning life skills needed later as adults could take place through playing games (Miller, 1996), while other types of learning – such as the number system – required a more formal educational setting (Sealey in Lussier and Sealey, 1980). Storytelling was also an integral aspect of education: moral lessons, values, and lessons from the natural world were often transmitted this way (Little Bear, 2000; Miller, 1996). For instance, science education, such as learning about Creation, flora and fauna, and different species often came through storytelling (Miller, 1996). Learning specific skills occurred within the context of doing, practicing, and participating in everyday life activities, and instruction was received implicitly or by repeated example and demonstration. Traditional Indigenous education reflected and encompassed cultural values, epistemologies, and social systems: it is, as McKay and McKay put it, “a total way of life” (McKay and McKay in Barman, Hebert and McCaskill, 1987, p. 64).

This concept of totality is reflected in a series of *Holistic Lifelong Learning Models* (Appendix 1 and 2) developed by First Nations, Métis and Inuit individuals from across Canada in collaboration with the Canadian Council on Learning. The respective models were endorsed by national Aboriginal organizations such as the Assembly of First Nations, the Métis National Council and the Inuit Tapiriit Kanatami. These models are considered a good representation of how Aboriginal education might be understood. As the First Nations and Métis models demonstrate, learning in traditional contexts intersected with all aspects of life, occurred at all stages, and involved the entire community. This is still important in contemporary society. Learning is as much a spiritual, social, and cultural process as it is a cognitive one, and it occurs at every opportunity throughout the day and the course of one’s lifetime.

To remove the process of learning from the social, cultural, and spiritual contexts in which it occurs creates a disjuncture between the learner and community. It is these interrelated constructs and connections that must be understood in order to appropriately integrate Aboriginal principles back into the learning process after a long history of Residential Schools in Canada, which is the topic of the next section.

Education under Colonialism

First Nations and Residential Schools

Ample literature suggests that Residential Schools in Canada left a devastating impact on the quality of life in many Aboriginal communities. For over one hundred years, various churches supported by governments ran Residential Schools for the purpose of destroying Aboriginal cultures, spiritual beliefs, traditional values, and entire knowledge systems and ways of being. In Saskatchewan, some 20 Residential Schools dotted the province's map between 1865 and 1975 (AFN, 2007a). The intergenerational social and psychological impacts of abuse that were experienced by many students in these institutions are still felt today. The story and impact of Residential Schools in Canada is well documented and exemplifies the larger narrative of colonialism, the loss of Indigenous knowledge systems, and the relentless pursuit of the colonizers in acts of cognitive, cultural, and intellectual imperialism (AFN, 1994; Bull, 1991; Caribou Tribal Council, 1991; Haig-Brown, 1988; Ing, 1991; Jaine, 1993; Johnston, 1988; Miller, 1996; Milloy, 1999).

Like all assimilation policies of the 19th and 20th centuries in Canada, the Residential School system was based on racist (or racialized) premises of linear evolution that inaccurately and inappropriately deemed Indigenous Peoples as *unprogressive* and *uncivilized* (RCAP, 2.10). The goal of *civilization* would, according to this thinking, be achieved through an educational system based on three principles: separation, re-socialization, and assimilation (RCAP, 2.10). Children were separated from their own cultural teachers, family members, Elders and traditional knowledge keepers. They were not allowed to speak their own languages and were separated for long periods of time from their natural learning environments. A new worldview, language, belief system, a new way of life and new skills were forced upon them as an attempt to *re-socialize* and assimilate young native students.

The Residential School system had detrimental consequences for the students, their families, and following generations. The imposition of this foreign educational system and philosophy disrupted traditional systems of Indigenous education that had been in place for centuries. The intergenerational transmission of Indigenous worldviews and knowledge systems relating to the natural world was severed, and it is this link that communities seek to re-establish in resuming control over their education and establishing effective partnerships with existing school systems through meaningful involvement and consultation. Learning Indigenous science as a relevancy of place is one of the ways in which we can move further towards this goal.

Métis Education

Métis experiences with formal education processes have a unique history in Canada. Educational experiences among the Métis varied. During the fur trade era some children were taught in traditional ways, learning skills that centered on the buffalo hunt. In some cases, if families could afford it, Métis children were sent away to the Red River Settlement, the United States or Europe to attend schools (Racette, 2006).

The establishment of missions and schools by churches during the 19th century provided early formal educational opportunities for the Métis who were living in or near established settlements. In Saskatchewan, the first school was established in 1840 at an Anglican mission at Cumberland House. An Oblate school was established at Île-à-la-Crosse in 1860. By the 1880s, there were eight schools in and around St-Laurent (Racette, 2006). Prior to 1910, Métis attended Residential Schools along with First Nations Peoples, but this situation changed at the turn of the century. While there are numerous individual exceptions, those that were not recognized as *Indians* under the *Indian Act* were not permitted to attend Residential Schools after 1910, thus placing the responsibility for Métis education with the provincial government (Racette, 2006).

But neither did the Métis generally have access to the public school system: the remoteness of some Métis communities, the incompatibility of seasonal work with the school year, and a policy which long ignored the plight of Métis communities all contributed to a lack of education for the Métis (Sealey and Lussier, 1980). This situation was exacerbated by the Saskatchewan government's refusal to take full responsibility for Métis education. Until the mid-1940s when the CCF government took power, the vast majority of Métis remained without access to provincial and federal school systems (RCAP, 1996, 3.5; Barron, 1997). When education did become widely available for the Métis in Saskatchewan, it was done with an integrationist platform as its underlying premise (Barron, 1997, p. 31). Consequently, education was conducted through a western-centric curriculum that either ignored specific cultural needs or assumed that the Métis would be destined for labour jobs or an agrarian life after their formal education ended (Barron, 1997, p. 51).

Aboriginal Control of Education

In the early 1970s, Aboriginal Peoples and organizations began to mobilize politically. Through their efforts, they regained the strength and political power necessary for resuming control over their lives (Kirkness & Selkirk-Bowman, 1992). First Nations and Métis Peoples have long asserted their inherent right to control and management their own education systems including how school science is developed from the foundation of their local community foundations.

In 1972, as the federal government was closing Residential Schools and abandoning the policy, the National Indian Brotherhood (NIB) released a report titled *Indian Control of Indian Education (ICIE)* – a policy paper presented to the Minister of Indian Affairs and Northern Development. This proposal called first for parental control and involvement in the education of their children, a starting point that encompassed the role of locality and community in learning. In this way, the ICIE policy addressed concerns of First Nations parents who wanted their children to succeed while maintaining a strong cultural identity. The development of culture-based approaches in specific community contexts to teaching in all subject areas was forwarded not only as a vision to a better way of life, but also as a way of curbing the high drop-out rate among First Nations populations (National Indian Brotherhood, 1972). The proposal also recommended that Indigenous communities acquire jurisdiction over education, that amendments be made in the curriculum that would reflect Indigenous cultures and values, that the teaching of Indigenous languages be incorporated, that the development of culturally-attuned teacher training programs be instituted, and that the necessary resources be applied to both facilities and services.

The major thrust of the Indian Control on Indian Education policy led to the development of First Nations teacher education programs, band controlled schools, locally-developed curriculum, and places of higher learning in order to meet the cultural and academic needs of the communities. This landmark

policy document has been used as the facilitator for First Nations communities taking control of their own education systems.

The specific effects of this policy have been felt in Saskatchewan. In 1972, the Saskatchewan Indian Cultural College (now the Saskatchewan Indian Cultural Center) was established to support First Nations in their capacity to deliver educational programs. Some success has also been achieved in control over schooling, particularly in the north. Île-à-la-Crosse, a predominantly Métis community, gained control over its school system in 1976 – the same year that the Northern School Division (now the Northern Lights School Division) became board-elected. In 1973, the James Smith, Thunderchild, and Little Pine First Nations took control over their education. Others quickly followed suit. Similar advances were made in post-secondary education. Three programs – the Indian Teacher Education Program (ITEP) was established in 1972 at the University of Saskatchewan, the Northern Teacher Education program (NORTEP) was established in La Ronge in 1977, and the Saskatchewan Urban Native Teachers Education Program (SUNTEP) was established in 1980. These programs offer fully accredited Bachelor of Education programs with the goals of preparing teachers of Métis and First Nations ancestry, and of producing teachers who are culturally sensitive to Métis and First Nations needs. A culturally supported First Nations environment in post-secondary education was further expanded when, in 1976, the Saskatchewan Indian Federated College (now the First Nations University of Canada) was established.

The Royal Commission on Aboriginal Peoples Report

The advancements made in Aboriginal education as described previously could not have been possible without the collaborative work of native and non-native people. Despite the foundation that has been laid by the work of many educators, serious problems and challenges remain. Aboriginal students are still leaving from school in record numbers. Many will never return. One of the most informative investigations into these and other problems plaguing Aboriginal Peoples was the Royal Commission on Aboriginal Peoples (RCAP, 1996). The Commission recognized a widespread systemic dysfunction of the relationship between Aboriginal Peoples and the state, and made recommendations based on the obvious need for critical changes. Between 1991 and 1995, RCAP took research submissions and testimonies from individuals, organizations, and communities – both Aboriginal and non-Aboriginal – and conducted public hearings and round tables on a host of issues relevant to Aboriginal Peoples. The Commission's extensive mandate was to "investigate the evolution of the relationship among Aboriginal Peoples (Indian, Inuit and Métis), the Canadian government, and Canadian society as a whole" (RCAP, 1996, Appendix A). Aside from major issues such as self-government, land and resources, legal status, and cultural concerns, the Commission dedicated significant space to educational matters. In fact, investigating Aboriginal education was stipulated in the Commission's original instructions. They stated that:

In particular, the Commission may investigate aboriginal control over primary and secondary education on reserves and in native communities (including issues of funding), the promotion and protection of aboriginal cultural identity in educational institutions (including institutions where aboriginal students are a minority group), the encouragement of aboriginal children to complete secondary education, and access to and funding for post-secondary education (including college, university and technical training). (RCAP, 1996, Appendix A)

These broad instructions provided the Commission with the necessary authority to investigate a wide scope of educational matters relevant to Aboriginal Peoples. Its report, released in 1996, comprises several hundred pages – thousands if one includes the many reports, written submissions, and hearing

transcriptions. The fundamental finding of RCAP was the need for the participation of Aboriginal Peoples in all areas of policy making. This point was evidenced as much in the area of education as in any other, particularly in the 173-page chapter entitled, “Education” in Volume 3, “Gathering Strength” (RCAP, 1996, 3.5). The report highlighted a number of systematic problems, such as the continued failure of education to ground Aboriginal youth in a strong and positive identity and the absence of Elder involvement in education. Indeed, the relationship between formal educational policy and the survival, strengthening, and inter-generational transmission of Aboriginal cultures and languages were stressed throughout the report. This relationship was articulated primarily through a cultural understanding of Aboriginal education. The report elaborated this understanding in the following way:

Education is a lifelong, continuous process requiring stable and consistent support. First Nations people of every age group require appropriate formal and informal opportunities for learning and for teaching. The education provided must be holistic. Education processes and institutions must address the intellectual, spiritual, emotional, and physical development of participants. (RCAP, 1996, 3.5.2)

The statement above bears the same fundamental principles as laid out in the First Nations and Métis *Holistic Lifelong Learning Models* (Appendix 1 and 2) published by the Canadian Council on Learning. Learning encompasses all aspects of life and is not confined to formal classroom training. Education “proceeds according to four stages of the life cycle: the child, the youth, the adult, and the elder” (RCAP, 1996, 3.5.2). Education is seen as a process, not an event. Accordingly, education cannot be separated from the larger social and cultural matrix from which it is defined.

Based on the testimony and submissions of various Aboriginal communities and individuals, RCAP recognized two sets of relationships of interest to education. First, the relationship between learning and the life cycle is integral to the learning process. The four stages of the life cycle – child, youth, adult, and Elder – constitute the circle of life. The report noted, “learning at one stage has implications for subsequent stages” (RCAP, 1996, 3.5.2). Fundamental to this relationship is intergenerational transmission: “as individuals mature and perhaps attain the status of Elder, they are able to transmit to younger generations the knowledge and wisdom acquired through a lifetime of learning” (RCAP, 1996, 3.5.2). The second relationship noted in the report is the connection between learning and development. Essentially, this relationship points to the holistic nature of education, where a person’s intellectual, spiritual, emotional and physical aspects must be addressed in education. These two sets of relationships – the life cycle and holistic learning – are intertwined. Accordingly, education must be understood as a larger, inclusive process.

The absence of such an inclusive process has created a gap between Aboriginal student cultural perspectives and the realities of Western-based education. This gap has resulted in alienation for the students from their learning, their communities, and their cultures. Almost 70% of the total Aboriginal school-age population attend provincial schools, most of which give little or no consideration to specific cultural needs of these students. The RCAP report elaborates:

Most Aboriginal students attend schools where there is no special effort to make them or their families feel part of the life of the school. Aboriginal parents say they are excluded from their children’s education. There is a gap between the culture of the home and that of the school. In very few instances are Aboriginal Peoples among the representatives on school boards. (RCAP, 1996, 3.5.1)

RCAP has made a number of recommendations that would benefit the education of Indigenous Peoples, which are based on the premise that “Aboriginal people rightly expect education to serve as a vehicle for cultural and economic renewal” (RCAP, 1996, 3.5). Repeatedly, RCAP pointed to a discontinuity between Aboriginal culture and home life with formal institutional education. The report expanded on this gap:

A common concern of parents is when schooling becomes a threat to their developing child’s identity, primarily when the values and world view that prevail at school contradict or ignore the existence of a difference perspective the child lives with at home. In the case of students of Aboriginal ancestry, this situation is all too common. The result can be that the child experiences serious conflict and doubt about the validity of his or her own identity. When an Aboriginal child’s identity has been threatened, they will withdraw into themselves; become silent and refuse to participate as a means of protecting themselves from criticism and rejection; attempt to abandon their previous identity and mould themselves to the culture which they perceive as more valid or acceptable; they may take on non-productive and rejecting attitudes which generally culminate in failure or dropping out. (RCAP, 1996, 3.5.3.2)

Clearly, the failure of educational policy to incorporate Aboriginal perspectives and content in the curriculum reaches far beyond a focus on drop-out rates and the under representation of Aboriginal Peoples in scientific careers. It has a direct impact in lives of individual grassroots people and more importantly is linked to community-well-being.

The Commission provided recommendations that offered a solution. Fundamental to these recommendations was the need for on-going collaboration between federal, provincial, territorial, and Aboriginal governments. The Commission recognized that the inadequacy of Aboriginal education was not an *Aboriginal problem for Aboriginal Peoples to fix*. The Commission showed there is a shared responsibility. It is only through cooperation and partnership that such inadequacies can be resolved. The recognition and priority of Aboriginal languages in these recommendations played a central role. RCAP also recommended the involvement of parents and communities in schools with Aboriginal students. Most importantly, RCAP recommended changes in curriculum that would “include the perspectives, traditions, beliefs and world view of Aboriginal peoples” (RCAP, 1996, 3.A). These recommendations correspond with the NIB report, and are based on principles of Aboriginal control, development, and design of education. As the Report points out, the concerns raised currently about Aboriginal education are primarily the same ones that have been raised since 1972. And while there has been some progress, it has been at a snail’s pace (RCAP, 1996, 3.5).

Contemporary Challenges

While major advancements have been made in Aboriginal education since the early 1970s, much remains to be done. Nicholas (2001) shows education systems continue to perpetuate colonialism. Education must be deconstructed so barriers that prevent teachers and communities from incorporating Indigenous knowledge in schools and curriculum can be identified and challenged. Nicholas states that band-operated schools are often forced to accept the imposition of federal and provincial curriculum mandates, teacher certification, and the use of the English language as a medium of instruction. In addition, they have very little funding and resources, exacerbating the challenges to developing culturally inclusive teaching methods. In science education, teachers who are heavily influenced by Euro-Western perspectives consider these perspectives as the only rational and objective way of uncovering truth while regarding Indigenous knowledge and methods as primitive, archaic, and irrelevant (McGregor, 2000).

Despite major developments in Aboriginal education and the changing nature of teaching in science education, much research is needed. St. Denis (2002) argues that Aboriginal Peoples continue to leave school in greater numbers than their non-native counterparts, demonstrating that not much changed statistically since the first studies were done. The literature in Aboriginal education reflects a complexity of issues that serve as indicators of this failure. In the area of science education, MacIvor (1995) has identified attendance, retention, motivation, attitudes toward school, and integration of Aboriginal cultures and languages as being problematic at the elementary and secondary levels. In the United States, where much of the research has been conducted, Cajete (1988) revealed that junior high was the period in which native students begin to lose interest in science. Consequently, only a handful of Aboriginal students gain entry into science-related programs and professions. Either way, it is evident that culturally appropriate curriculum will benefit Aboriginal students and lead to an increased success rate.

The relationship between the importance of cultural content and the persistence of challenges for Aboriginal Peoples in education becomes more evident when viewed from this perspective. The statistics on Aboriginal education provide broad overviews and critiques of Aboriginal education in Canada. According to the RCAP, more than half of all native children (57%) drop out of school before graduation compared to 15% for non-natives. These statistics from the 1990s correlate with more current numbers: using a recent Auditor-General's report, the Society for the Advancement of Excellence in Education (2005) reported that 6 out of 10 Aboriginal students in Canada drop out before grade 12 and 59% of adults have not completed high school. The report estimates it will take almost 28 years to close the high school completion gap between Aboriginal youth and their non-native peers. The implications of these statistics are problematic for both native and non-native communities given that the Aboriginal youth population is the fastest growing sector in Canada. Much of the disparity in the quality of schooling among Aboriginal communities is related to systemic problems that will require systemic solutions.

Learning Indigenous Science from Place is a project that reinforces the larger process of decolonizing education in Canada. The project is intended to assist communities in coming to understand *Indian control of Indian education* in relation to school science. After over one hundred years of Residential Schooling in Canada, Learning Indigenous science in relation to place seeks to strengthen the cultural and linguistic identity of youth. Learning Indigenous science in relation to place is also intended to make science relevant and meaningful for Aboriginal learners. It involves the collective effort between curriculum developers, teachers, parents, Elders, and other community stakeholders to *nourish the learning spirit* of all students regardless of cultural background. In this way, this research project seeks to uphold the principles originally set out in NIB's 1972 policy report, and again in RCAP's recommendations in 1996. It is our hope that this study will contribute towards the larger effort to decolonize education and integrate Aboriginal worldviews, epistemologies, methodologies, pedagogies, values and principles into the Saskatchewan science curriculum.

2.2 Historical Overview of Saskatchewan Learning Policy

A History of Saskatchewan Learning Action Plans, 1981 to Present

Since 1982, the Government of Saskatchewan's departmental education authority has been guided by the recommendations and expertise of a continually evolving Aboriginal education advisory committee—first the Native Curriculum Review Committee, then the Indian and Métis Education

Advisory Committee (IMEAC), and currently the Aboriginal Education Provincial Advisory Committee (AEPAC). The evolving committee and subsequent action plans are significant because of the work to include Aboriginal content and perspectives in provincial curricula. This section documents the development of provincial action plans with respect to Aboriginal education, from 1981 to the present. In addition to the action plans, this section reviews Government of Saskatchewan supporting documents, including *Indian and Métis Education Policy from Kindergarten to Grade 12* (Saskatchewan Education, 1995c), and *Building Partnerships: First Nations and Métis Peoples and the Provincial Education System* (Saskatchewan Education, 2003). Lastly, this section concludes by considering the recently revised *Science 10 Curriculum Guide* (Saskatchewan Learning, 2005).

In 1981, Saskatchewan's Education Minister mandated the Curriculum and Instruction Review Committee to review the K–12 education system. The result was the document *Directions* (Saskatchewan Education, 1984) that laid out the foundation for the *Core Curriculum* (Saskatchewan Education, 2000b), a very important priority because it emphasizes the importance of and commitment to the inclusion of Aboriginal content and perspectives in *all* curricula.

The Core Curriculum is recognized as a central feature of the provincial education system. It is a curriculum that creates spaces for Aboriginal voices, well beyond the Native Studies program. Integrating Aboriginal content and perspectives across the curriculum, within all subject areas is the goal for all students. (Saskatchewan Education, 2005, p. 4)

The *Five-Year Action Plan for Native Curriculum Development* (Saskatchewan Education, 1984) was developed by a Native Curriculum Review Committee and included a series of recommendations primarily concerned with organizational objectives such as policy development, the need for an ongoing Aboriginal education advisory committee, inclusion of the North, and the inclusion of Aboriginal content and perspectives in the curricula. The recommendations would remain intact through to the most recent edition, *Action Plan, 2000-05*.

This initiative reached maturity when, "The Indian and Métis Education Advisory Committee forwarded a revised plan in 1995 titled *Indian and Métis Action Plan*" (St. Denis, et al., 70). The Indian and Métis Education Advisory Committee identified five areas of particular importance, including: evaluation, governance, teachers and administrators, external relationships and communication.

One of the most important documents with respect to policy is the *Indian and Métis Education Policy from Kindergarten to Grade 12* (Saskatchewan Education, 1995c). Guided by the Five Year Action Plan for Native Curriculum Development (Saskatchewan Education, 1984) and its successors such as the Indian and Métis Education Action Plan (Saskatchewan Education, 1995b), this document outlines three major curriculum objectives, which are:

- The inclusion of Indian and Métis content in all core curricula for all students in the province;
- The development and implementation of programs for and about Indian and Métis students, for example: Native Studies and Indian Languages programs;
- The development, identification and coordinated distribution of instructional resources and locally produced materials for core and other curricula. (p. 4)

Principles and Guidelines for Indian and Métis Curriculum Development offers recommendations for curriculum development and states: "Improvements to the education of Indian and Métis students are

dependent upon the changes in the processes of development, the instructional approaches taken, and the presentation and representation of curricula and materials” (p. 9). Three areas in particular are highlighted: Involvement of Indian and Métis Peoples, sustainability of instructional approaches, and adequacy of curriculum. In the attempt to make curricula *adequate*, curricula and materials will “concentrate on positive images” and “reinforce and complement the beliefs and values of Indian, Métis, and Inuit peoples”, as well as “include historical and contemporary issues”, emphasize “Indian/Métis Studies, Indian languages, and English language development”, and “reflect the legal, cultural, historical, political, social, economic and regional diversity of Indian, Métis, and Inuit Peoples” (p. 10). Perhaps the most relevant aspect with respect to curriculum development for our project is the assertion that “knowledge within Indian and Métis communities and institutions will be utilized in the development of Indian and Métis content” (p. 9).

Five years later, AEPAC produced *Action Plan, 2000-05*. This policy renewal marked a shift in focus from organizational objectives to the student and community. Reflecting on the history of action plans, AEPAC wrote: “Now that the groundwork and structures are in place, we would like to shift our attention to *actualization of Aboriginal content and perspectives* in Saskatchewan schools – all schools, and not only those that have a significant population of Aboriginal students” (Saskatchewan Education, 2000a, p. 2 emphasis added). The province defines *actualization* as “effective implementation and ongoing renewal” and notes that, “the awareness is still lacking that *all students* in the province stand to benefit if the recommendations of [AEPAC] and its predecessors are actualized” (p. 2). This commitment is reinforced in the document’s 12 recommendations, 5 principles, and 4 areas of change. In particular, AEPAC notes the following principal two-part goal: (Saskatchewan Education, 2005, p. 2).

- Aboriginal young people with grade 12 and post secondary educations, flourishing in all professions;
- Aboriginal and non-Aboriginal students and young people are knowledgeable about Aboriginal Peoples and their history. (Saskatchewan Education, 2000, p. 4)

In the fall of 2003, Saskatchewan released *Building Partnerships*, a policy framework for Pre-kindergarten to Grade 12, outlining how the province would strengthen partnerships (such as with AEPAC) at the level of policy. The policy suggested involvement of First Nations and Métis stakeholders in policy discussions, adequate First Nations and Métis representation on advisory and reference committees, and the use of effective processes for seeking and receiving policy advice (Saskatchewan Education, 2003, p. 36).

In 2005, an interim report, *Learning Community in Aboriginal Education 2004-07, Priorities Report*, was released by AEPAC for the province. The report assessed the action plan for 2000-05 and reviewed the priorities for 2005-07. The 5 principles were reaffirmed, one of which was expanded. Six further *opportunities* were identified (Saskatchewan Education, 2005, pp. 12-13).

Recently, Saskatchewan Learning has undertaken the project of science curriculum renewal, the first of which to be renewed was *Science 10 Curriculum Guide* (Saskatchewan Learning, 2005). Not only does *Science 10* offer the most recent declaration of the province’s commitment to the inclusion of Indian and Métis content and perspectives within curricula, it also provides the most current example of policy put into practice in the form of curriculum. In fact, this commitment has been formally enshrined in the *Science 10* section, *Core Curriculum Components and Initiatives*. The Core Curriculum “includes broad

initiatives that guide the selection of teaching materials, as well as instruction, in the classroom” (p. 5), one of which is *Indian and Métis Content and Perspectives*. The Core Curriculum reads:

It is an expectation that Indian and Métis content and perspectives be integrated into all programs related to the education of kindergarten to grade 12 students in Saskatchewan, whether or not there are Indian and Métis students in a particular classroom. All students benefit from knowledge about the Indian and Métis peoples of Saskatchewan. It is through such knowledge that misconceptions and bias can be eliminated. (p. 6)

The Saskatchewan Core Curriculum acknowledges five facets in particular with respect to including Indian and Métis content and perspectives within science education:

1. This approach begins with understanding and respecting Indigenous knowledge and ways of knowing (p. 6);
2. A second facet of this approach capitalizes on the responsibility and authority of the teacher to adapt instruction in order to be responsive to the interests and needs of their students and local communities (p. 6);
3. A third facet ... recognizes the need for Indian and Métis students to experience greater success in science classes (p. 7);
4. A fourth facet can be accomplished through the creation of cross-cultural units of study (p. 7);
5. The final responsibility for accurate and appropriate integration ... rests with teachers (p. 7).

The curriculum notes that the “STSE [Science-Technology-Society-Environment] emphasis of the science curricula provides teachers with many opportunities to begin this process” (p. 7), which are supported by the document, *Diverse Voices: Selecting Equitable Resources for Indian and Métis Education* (Saskatchewan Education, 1992).

Over the course of the last three decades, the evolving advisory committee currently known as the Aboriginal Education Provincial Advisory Committee has guided the inclusion of Indian and Métis content and perspectives within Saskatchewan’s education policy. The developments have been documented in the recommendations and objectives captured in the advisory committees’ action plans. This is an ongoing process that has matured from initial considerations aimed at developing organizational objectives to the current focus of policy actualization. This process is supported by the continuing development of policy, various partnerships, and academic ties.

The recently revised Saskatchewan *Science 10 Curriculum Guide* (Saskatchewan Learning, 2005) describes the goal of inclusive policy: “The purpose of Science 10 curriculum is to help all students, regardless of gender or cultural background, develop scientific literacy” (p. 1). The inclusion of Indian and Métis content and perspectives is motivated by the recognition of two aspects: most significantly, “the need for Indian and Métis students to experience greater success in science classes (p. 7); secondly, “All students benefit from knowledge about the Indian and Métis peoples of Saskatchewan”. However, the means required to achieve this desirable goal are only just being put into place. The curriculum places a considerable emphasis on the teacher to facilitate the inclusion of Indian and Métis content and perspectives: *Science 10* “capitalizes on the responsibility and authority of teachers to adapt instruction in order to be responsive to the interests and needs of their students and local communities, while still respecting the foundational and related learning objectives” (p. 6). Furthermore: “The final

responsibility for accurate and appropriate integration ... rests with the teachers" (p. 7). Thus, it will be of critical importance for all levels of Saskatchewan education systems and Aboriginal communities to assist teachers' personal and professional development in discovering ways of successful integration of First Nations and Métis perspectives in Science 10 curriculum. Teachers cannot bear this burden alone. The current shortage, or absence, of specific curricular units, objectives, lessons and supporting resources for Science 10 with a First Nations and/or Métis perspective will mean a need for additional research and development in this area. While Saskatchewan provides a leading example at the level of inclusive educational policy, it still has a considerable way to go in order to parallel such achievements at the level of curricula, educational resource and professional development.

2.3 The Concept of Indigenous Science

Place as an Aspect of Learning Indigenous Science

In order for a science curriculum to be effectively adapted to suit Aboriginal perspectives, learning from *Place* must be an integral part of the experience. Understanding what *Place* means from an Indigenous perspective is a concept necessary to understanding and learning Indigenous scientific knowledge and processes. Aside from the more literal meaning of geography, house, town, residence, or other physical and tangible space, *Place* also includes less tangible characteristics. *Place* – or *sense of Place* – also suggests the concepts, memories, histories, ideas, emotions, relationships, identities (both individual and community) and objects associated with a particular physical space. Cajete explains that *Place* is integral to Indigenous cultures:

Indigenous people are a people of *Place*, and the nature of *Place* is embedded in their language. The physical, cognitive, and emotional orientation of a people is a kind of map they carry in their heads and transfer from generation to generation. This map is multi-dimensional and reflects the spiritual as well as the mythic geography of a people (Cajete, 2000b, p. 74).

Place can be aesthetic, ceremonial, economic, familial, historical, political, spiritual, or scientific. Edward S. Casey captures the complexity of *Place* in the following way:

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*. (Casey in Feld and Basso, 1996, p. 27)

This quote suggests that *Place* is a complex concept that is difficult to articulate. Part of this problem is a result of the ubiquity of *Place*. As Clifford Geertz tells us, "It is difficult to see what is always there. Whoever discovered water, it was not a fish" (Geertz in Feld and Basso, 1996, p. 259). *Place* is often assumed and rarely defined.

Although challenging, exploring the concept of *place* is crucial in understanding the *Place* of local knowledge in school science. Indigenous articulations, perspectives, and local concepts are important because there has been a shift from living in oral literate societies to living in a contemporary written literate society. The challenges in articulation are linked to a difference in knowledge systems. Indigenous knowledge systems are normally expressed orally, experientially and symbolically; consequently, relaying that knowledge through a western model has limitations (Battiste, 2002; Aikenhead and Ogawa, 2007).

An additional difficulty in articulating the concept of *Place* and its role in Indigenous knowledge systems is language. Articulation of the concept of *Place* in Indigenous languages is often viewed as fundamental to its accurate articulation (Basso, 1996; Battiste, 2002; Little Bear, 2000; Harris, 2002). According to Battiste (2002), the survival of Indigenous languages is by far the most significant factor in the survival of Indigenous knowledge. This is because Indigenous languages have symbolic, verbal, and unconscious elements that act to structure and order Indigenous knowledge and worldview. Thus, the understanding of the concept of *Place* has lost meaning in a dual translation: from Indigenous languages to English, and from oral to written traditions. In addition, the contextuality of *Place* renders it inseparable from the land, culture, society, locality, worldview, philosophy, and spirituality. To extract it for the sake of defining it thus takes away its inherent interconnectedness to other aspects of life. As Aikenhead and Ogawa note,

Reading an article is not an adequate experience in coming to know how to live in nature. Ways of living in nature is action-oriented (verb-based); it cannot be given, accumulated, banked, and assessed by paper and pencil examinations. It must be experienced in the context of living in a particular place in nature, in the pursuit of wisdom, and in the context of multiple relationships. (Aikenhead and Ogawa, 2007, p. 21)

Michell (2005) makes a similar point about Woodlands Cree way of life, “which cannot be learned entirely from the written word; it must be lived and experienced” (p. 32). *Place* is understandably, then, a concept that is difficult to define within the space of this written report. Nonetheless, some attempts have been made to articulate Indigenous concepts of *Place* in English-language literature, and it helps build an understanding of the concept. According to the literature, there are five central dimensions of *Place* that are common among various Indigenous groups as follows.

Dimensions of Place

- 1) First, *Place* is **multidimensional**. It entails both physical and emotional characteristics and refers to more than just a geographic space. Thus, it encompasses all aspects of life. *Place* indicates a physical element or *Place dependence* (Stokols and Shumaker, 1981) and an emotional element or *Place identity* (Proshansky, 1978; Proshansky, Fabian, & Kaminoff, 1983; Korpela, 1989). Eric Riggs describes the all-encompassing character of *Place*:

Geography is not only a matter of location, distance, and elevation, but is additionally permeated with meaning and cultural significance. Indeed the worldview and cosmology of many indigenous cultures is indistinguishable and inseparable from the physical geography. (Riggs, 2004, p. 303)

Place is “created by the setting combined with what a person brings to it” (Steele, 1981, p. 9). In other words, *Place* is the interaction between location and resident (Cajete, 2000b). Edward S. Casey distinguishes between *Space* and *Place*: *Space* is the tangible, mappable, measurable while *Place* includes “locations where one chooses to stay or return” (Cruikshank, 2005, p. 67). The multidimensionality of *Place*, then, can be understood to have a dual characteristic: the spiritual and the physical. These two aspects encompass a wide range of perspectives that cannot be separated into parts (Cajete, 2000b).

- 2) Second, *Place* is a **relational** (or relationship-based). This notion of *Place* as a relationship is evident in many definitions and studies about Indigenous Peoples and their connection to the land, and thus might be considered a fundamental and shared aspect of sense of *Place* in an Indigenous context (Carlson, 2001; Cajete, 2000b). Indeed the principle of interrelatedness is central to

Indigenous epistemologies (Colorado, 1988). Vine Deloria Jr. captures both the aspects of relationship and multidimensionality by *Indian metaphysics*, which he defines as “the realization that the world, and all its possible experiences, constituted a social reality, a fabric of life in which everything had the possibility of intimate knowing relationships because, ultimately, everything was related” (Deloria and Wildcat, 2001, p. 2). This epistemological framework entails two fundamental and related concepts: power and *Place*. While power refers to *spiritual power* or *life force*, *Place* refers to a “familiarity with the personality of objects and entities of the natural world” (Deloria and Wildcat, 2001, p. 2). In other words, *Place* is a spiritual relationship with the tangible world that connects other aspects of life.

- 3) Third, *Place* is **experiential** (Aikenhead and Ogawa, 2007; Michell, 2005; Cajete, 2000b; Casey in Feld and Basso, 1996): it is the experiences that an individual has on their land – in their *Place* – that gives *Place* its meaning. Indeed, much Indigenous knowledge is created through experience (Scott in Nader, 1996). This includes both the remarkable and the unremarkable; it is life lived every day (Basso in Feld and Basso, 1996). To learn Indigenous science, learners must actively participate in the natural world (Michell, 2007), a process that can be transferred to formal, curriculum-based science learning (Kawagley, 1995; Kawagley and Barnhardt, 1999). Cajete cites the lack of practicality and its experiential approach as one of the major inhibitors of Aboriginal students’ success in the classroom (Cajete, 1988). In addition, Pauline Chinn notes, “that Science studies connecting science and society provide opportunities for personally meaningful, experiential, inquiry and Place-based learning fundamental to scientific and environmental literacy” (Chinn, 2007, p. 1248). Eric Riggs reiterates the impact of this approach, arguing that field-based methods to teaching science result in higher success rates (Riggs, 2004). Such a *hands-on* approach to learning provides a tactile and tangible connection between knowledge and life; it is what makes learning meaningful and practical. Thus, Indigenous knowledge and learning become contextual geographically, socially, culturally, spiritually, and physically (Battiste, 2002). Indeed, it is this contextuality and *sense of Place* that makes learning Indigenous knowledge experiential.
- 4) Fourth, *Place* is **local**. *Place* is site-specific and locality is central to its understanding. In Canada, Indigenous cultural diversity is captured in 53 different First Nation languages belonging to eleven different language families (MacIvor, 1995). As Cajete (2000b) states, “native people interacted with the places in which they lived for such a long time that their landscapes became reflections of their very souls” (p. 183). People, then, become inseparable from the land they inhabit, and *Place* becomes as integral to Indigenous identities as culture is. A few examples illustrate this concept. Adelson (2000), who has done research among Cree People in northern Quebec, asserts the “history of the people and the history of the land do not simply correspond to each other – they are one and the same” (p. 29). Similarly *Nîhîthewâk Ithîniwak* like other Indigenous societies around the world consider themselves an intricate part of nature and have developed a way of life that reflects the boreal forest of northern Canada (Michell, 2005; Brightman, 1989, 2002; Siggins, 2005). *Nîhîthewâk* and the *Places* they occupy shape and form the worldview, culture, language, epistemology, ways of knowing, knowledge systems, values, and teacher practices in science education (Michell, 2005). While this project thus recognizes the commonality of certain concepts specific to Indigenous cultures, it also continues to respect and emphasize the centrality of locality to each of those groups. The concept of *Place* is as unique, individual, and local as the people who create it. According to Pomeroy (1994), localization of science curriculum is based on the argument that students will see science learning as relevant, if they can situate it in the context of their lives.

- 5) Fifth, and most essential, *Place* is **land-based**. Although First Nations and Métis Peoples come from diverse cultural contexts, there is a shared worldview in which humans are intricately connected to the land (Kawagley & Barnhardt, 1999; Knudtson & Suzuki, 1992; Michell, 2005). Leroy Little Bear elaborates:

In Plains Indian philosophy, certain events, patterns, cycles, and happenings take place in certain places. From a human point of view, patterns, cycles, and happenings are readily observable on land: animal migrations, cycles of plant life, seasons, and so on. The cosmos is also observable, and patterns are detected from a particular spatial location within the territory of a particular tribe. (Little Bear, 2000, p. 78)

Land is a central aspect of group identity among Indigenous cultures, and thus, so is the sense of *Place* that is tied to the land. It is the relationship between the land and the people who inhabit it, the connection people have to the land, and the role of *Place* in the history, culture, and community. Appreciating the connection to and relationship with the land that Indigenous Peoples have is essential to understanding the concept of *Place* and its role in Indigenous knowledge. As Marie Battiste states,

Indigenous knowledge is also inherently tied to land, not to land in general but to particular landscapes, landforms, and biomes where ceremonies are properly held, stories properly recited, medicines properly gathered, and transfers of knowledge properly authenticated. Ensuring the complete and accurate transmission of knowledge and authority from generation to generation depends not only on maintaining ceremonies, which Canadian law treats as art rather than science, but also on maintaining the integrity of the land itself. (Battiste, 2002, p. 13)

RCAP reiterated this view:

Land touches every aspect of life: conceptual and spiritual views; securing food, shelter and clothing; cycles of economic activities including the division of labour; forms of social organization such as recreational and ceremonial events; and systems of governance and management. (RCAP, 1996, 2.2.4.3.2)

Hence, land or *Place* cannot be viewed in isolation of other cultural aspects. Knowledge, economy, society, and spirituality are all interconnected. In the context of Indigenous science, *Place* might be better and more simply understood or defined, then, as *the product of the relationship with and connection to the land*. Michell (2007), discusses science education among the Woodlands Cree and elaborates on this notion:

The fresh air, the sights and sounds of nature always leave me deeply connected and whole. For me, it wasn't just the physical aesthetic beauty of it all nor the momentary awe experienced when one is walking through a forest. It is a deep sense of spiritual connectedness that is hard to describe in human words and most likely would be misunderstood and perhaps even discarded by a person who thinks from a secular and positivist Western science perspective. Being out on the land allowed me to become aware that I was connected to something much more greater than myself. For people of *Nîhîthâwâk* heritage, the concept of experience is culturally defined and goes beyond human interactions to embrace an essence of what I come to know as an *interconnected spiritually imbued relatedness*. (p. 7)

Place in Education

With this view of *Place*, then, its role in science education becomes evident. Learning from Place refers to “the learning of traditional knowledge, processes and practices from living in a particular place” (CCL, 2007a). An enhanced science curriculum *recognizes* Indigenous knowledge as a total knowledge system that describes and explains nature in culturally powerful ways. This knowledge resides in Aboriginal languages. Its validity is delimited by its geographic setting of those who hold it. Indigenous Knowledge systems are *Place-based* knowledge systems (Michell, 2005). Place-based education is a method that includes experiential learning in local natural and social settings. It includes a trans-disciplinary and cross-cultural synthesis of Place-related knowledge and pedagogy, and service learning or other forms of community outreach (Gruenewald, 2003a, 2003b; Sobel, 2004). *Place-based* teaching is conscious of, and empowers the senses of *Place* of students and teachers; and it promotes local ecological and cultural sustainability (Sobel, 2004; MacIvor, 1995; Tuhiwai Smith, 2002).

2.4 The Concept of Indigenous Science Education

Indigenous Knowledge, Worldviews, and Epistemologies

To the question, *what is Indigenous knowledge?* Marie Battiste and Sákéj Henderson (2000) reply, “No short answer exists” (p. 35). In fact, they warn against the Eurocentric temptation to classify or categorize *Indigenous knowledge*, thereby restricting it to a fixed definition. This warning arises because knowledge, as a socio-cultural linguistic artefact, cannot be directly (literally) translated: “Eurocentric structures and methods of logical entailment and causality ... derive from a noun-centered language system, and they are ineffective in verb-centered Indigenous language systems” (Battiste and Henderson, 2000, p. 40). Therefore, complications may arise when attempting to understand *Indigenous knowledge* from a Eurocentric (Western) point of view.

Specifically, Battiste and Henderson (2000) identify that (1) Indigenous knowledge does not fit into the Eurocentric concept of *culture*; (2) it is not a uniform concept among all Indigenous Peoples; and (3) it cannot be separated from its bearer and codified into a definition (pp. 35-36). Part of the reason why Indigenous knowledge resists the Western tendency to define is because it cannot be reduced to distinct categories. Battiste and Henderson (2000) explain: “No separation of science, art, religion, philosophy, or aesthetics exist in Indigenous thought; such categories do not exist” (p. 40).

Similarly, *Indigenous science* cannot be subsumed as a category of *Indigenous knowledge*. In Western knowledge, the study of nature (small ‘n’) is reserved for science; Indigenous knowledge makes no distinction because Nature (big ‘N’) is the source of knowledge. In fact, Battiste and Henderson (2000) assert, “The best way to understand Indigenous knowledge is to be open to accepting different realities (however one uses this term)” (p. 40). Michell (2007), for example uses the terms *Indigenous knowledge* and *Indigenous science* in an interchangeable way. With these considerations in mind, the attempt here will be to *understand* Indigenous knowledge and not *classify* it.

Indigenous perspectives are embedded within Indigenous worldviews. An Indigenous worldview provides the filter from which Place-based epistemologies, methodologies, and pedagogies can be articulated. Although Aboriginal Peoples come from diverse cultural contexts, there is a shared worldview in which humans are intricately connected to the natural world (Michell, 2007; Battiste, 2000; Kawagley & Barnhardt, 1999; Knudtson & Suzuki, 1992). This sentiment is captured by Lakota thinker Vine Deloria, Jr., who observed that there are two great truths about Indigenous People: First,

Indigenous nations share a certain unanimity in their views on the natural world and on the behaviour of humans in that world. Second, the diversity of ecologies or living lodges has resulted in distinct nations with diverse worldviews (Henderson, 2000, pp. 259-260). While Aboriginal worldviews in Canada are similar in that they are *Place-based*, they are, by the very same token, as *diverse* as the places from which they emanate: “Indigenous peoples’ worldviews are cognitive maps of particular ecosystems” (Battiste & Henderson, 2000, p. 40). Pueblo scholar Gregory Cajete (1994) explains the unanimity among Indigenous worldviews as being rooted in Nature: “Indian people traditionally understood the human psyche and the roots of human meaning as grounded in the same order that they perceived in Nature. They experienced Nature as a part of themselves and themselves as part of it. They understood themselves literally as born of the Earth of their Place” (p. 83). Therefore, in order to understand Indigenous worldviews, one must understand how Indigenous worldviews perceive Nature and the ecological order.

Because Indigenous Peoples have experienced particular ecosystems for millennia, they are privy to the ecological patterns of constant flux and connectedness inherent in Nature. Moreover, these patterns are reflected in their worldview: “Aboriginal worldviews are empirical relationships with local ecosystems, and ... by living in an ecological space for millennia, Aboriginal people have established a worldview that sees the order of life as a state of flux” (Henderson, 2000, p. 259). Sákéj Henderson (2000) identifies two important ways in which Aboriginal worldviews understand ecosystems: “First, they understand the ecosystems as an eternal system tolerant of flux and refined by endless renewals and realignments. Second, they understand that each ecosystem encapsulates and enfolds many forces or parts, none of which can enfold or encapsulate the whole. The forces express nature instead of creating it” (p. 260). Thus, Indigenous worldviews reflect these two aspects of ecological order: Nature exhibits a harmonious and relational order that is subject to constant change or flux.

A worldview that recognizes and reflects Nature’s constant flux “leads to a holistic and cyclical view of the world” (Little Bear, 2000, p. 78). Leroy Little Bear (2000) explains: “If everything is constantly moving and changing, then one has to look at the whole to begin to see patterns” (p. 78). All life is an intrinsic part of Nature’s pattern. More importantly, all life is imbued with spiritual energy. “In Aboriginal philosophy, existence consists of energy. All things are animate, imbued with spirit, and in constant motion” (p. 77). It follows from this understanding that “If everything is animate, then everything has spirit and knowledge. If everything has spirit and knowledge, then all are like me. If all are like me, then all are my relations” (p. 78). This sentiment is embodied in the Lakota phrase, “Mitakuye Oyasin”, meaning, “We are all related”, which, Cajete (1994) notes, “is a guiding principle of Indian spiritual ecology reflected by every tribe in their perception of Nature. It is a deeply spiritual, ecological and epistemological principle of profound significance” (p. 74). The implications of such a profound principle are significant.

Reflecting the ecological connectedness of Nature, “the Aboriginal worldview asserts that all life is sacred and that all life forms are connected” (Henderson, 2000, p. 259). Because all life is related, the ecological imperative (if it can be referred to as such) is one of harmony: “Most Aboriginal worldviews are founded on the belief that all life forms were created to adapt to ecological change” (Henderson, 2000, p. 260). All life being equal, humans must similarly adapt to the constant flux of Nature’s order: “Indigenous cosmologies generally describe the universe as chaotic, in the strict mathematical sense of a system defined by random as well as non-random forces. Everything is expected to change, in both predictable and unpredictable ways, thus requiring human vigilance and adaptation” (Battiste & Henderson, 2000, p. 46). Indigenous knowledge does not only embody the framework of Indigenous

worldview from which it came, but it embodies the implied responsibilities that humans have towards the natural world.

Indigenous epistemologies are Place-based and include a variety of knowledge sources. For Indigenous People, worldwide, the land is the ultimate source of knowledge (Battiste & Henderson, 2000, p. 41). More specifically, “all knowledge flows from the same source: the relationships between a global flux that needs to be renewed, the people’s kinship with the other living creatures that share the land, and the people’s kinship with the spirit world” (Battiste & Henderson, 2000, p. 41). As such, Indigenous knowledge is “the expression of the vibrant relationships between the people, their ecosystems, and the other living beings and spirits that share their lands” (Battiste & Henderson, 2000, p. 42). Erica Irene Daes (1994) stresses that the land or ecology plays the role of the Indigenous knowledge system’s “central and indispensable classroom” (para. 9; in Battiste & Henderson, 2000, p. 41).

Place, however, is not only the source of knowledge, it is also the authority. Because the validity of Indigenous knowledge is delimited by its geographic and ecological setting for those who hold it, it is called *Place-based* knowledge (Battiste & Henderson, 2000; Hampton, 1995; Kawagley & Barnhardt, 1999; Michell, 2005). Similarly, Aikenhead (2002) writes: “The power of Aboriginal science [Indigenous knowledge] rests with its validity for a particular place” (p. 293). Because Indigenous knowledge is specific to a particular *Place*, it is not easily transferable to different contexts. For Indigenous Peoples, knowledge is as dynamic as the very *Place* it reflects: “Indigenous knowledge is not static but, like the shifting dynamics of particular ecologies, changes over time” (Battiste & Henderson, 2000, p. 48). As such, Indigenous knowledge “is more than mere ecological awareness; it is a *living relationship* with a specific environment that is not conceived of as either universal or conventional” (Henderson, 2000, p. 260; emphasis added). Battiste (2002) summarizes Indigenous knowledge as it has been described thus far:

Indigenous knowledge thus embodies a web of relationships within a specific ecological context; contains linguistic categories, rules, and relationships unique to each knowledge system; has localized content and meaning; has established customs with respect to acquiring and sharing of knowledge (not all Indigenous peoples equally recognize their responsibilities); and implies responsibilities for possessing various kinds of knowledge. (p. 14)

The term *Indigenous knowledge* is meant to convey “a complete knowledge system with its own concepts of epistemology, philosophy, and scientific and logical validity” (Erica Irene Dais in Battiste and Henderson, 2000, p. 41). It contains linguistic categories, established customs, and responsibilities for the holders of knowledge. Indigenous knowledge is *Place-based* in the sense that the land and the communities are both the source and the authority of the knowledge. Because there are diverse ecologies, there are diverse systems of knowledge that flow from these places. Indigenous knowledge is both *local* (to a *Place*) and *diverse*. Having experienced Nature for millennia, Indigenous knowledge systems embrace the constant flux and connectedness of diverse ecological orders. Indigenous knowledge is concerned with adapting all life, holistically, to the constant flux of ecosystems. As such, Indigenous knowledge can be described as a *living relationship* with Nature. For this reason, Indigenous knowledge is *social* and *relational*. Because Indigenous worldviews and epistemologies share a radically different conception of Nature, they offer the possibility of a radically different conception of science: “Indigenous epistemology is guided by Indigenous worldview frameworks that provide a lens for different perceptions of scientific knowledge and ways of thinking, and acting on complex problems and natural reality” (Michell, 2007, p. 78). In the next section, we explore the definition of science and the importance of including Indigenous science within this definition.

Defining Science and Indigenous Science

The definition of *science* can be problematic when incorporating Indigenous knowledge systems in school science. With an increasing multi-cultural diversity in Canada, one must ask the question, is science multicultural or does it represent the Eurocentric-Western worldview? The term *science* is problematic because of its political history and neo-colonizing potential. Citing MacLeod & Collins (1981), Aikenhead (2006a) explains:

The political history of the word *science* in England privileges a very narrow meaning (the canonical Western science content taught in universities), which today can act in a neo-colonizing way. The word *science* was deliberately chosen in 1831 when some natural philosophers founded the British Association for the Advancement of Science and thereby professionalized natural philosophy into a new social institution, which they called *science* for very political reasons. (p. 5)

According to Harding (2006), “the term [*science*] is a Western one and can seem to commit yet one more case of Eurocentrism when [one] insist[s] on using it to characterize knowledge systems not so conceptualized by their makers” (p. 11). Because Indigenous knowledge is inseparable from the culture to which it belongs, some authors prefer the term *Indigenous knowledge* to *Indigenous science* (Semali & Kincheloe, 1999; Aikenhead, 2006b, p. 9). Others use the two terms interchangeably (Michell, 2007). In the interest of social equity, Aikenhead (2006b) uses the term *Indigenous science* because it seems more equivalent to the term *Western science* (p. 9). Conversely, when referring to school science, Aikenhead (2006b) uses “the term *Western science* to draw attention to the fact that the scientific enterprise associated with traditional school science evolved within Euro-American cultural settings” (p. 10). To teach science from a Eurocentric perspective that assumes universal validity constitutes neocolonialism (a process equivalent to saying there is only one science and it is modern western science). One proposed solution to the problem of the Eurocentric (and thus neo/colonial) connotations of *science* is to expand the definition of *science* to include Indigenous Knowledge systems (i.e. Indigenous sciences).

Harding (2006) uses the term *science* “to mean any systematic empirical study of ourselves and the world around us” (p. 10). Such a broad definition, however, is not to be confused for scientific relativism, Harding warns: “To regard all of these different knowledge (or practice) systems as sciences is not to regard them as equally accurate, comprehensive, or useful with respect to any particular questions we might ask” (p. 11). Aikenhead (2006a) offers a broader and inclusive definition of *science* from a socio-cultural perspective in the following way: “science is a rational, empirically based description-explanation of nature. This concept includes, among others, the Eurocentric cultural perspective (Western science) and Aboriginal cultural perspectives (Indigenous knowledge) held by First Nations, Inuit and Métis peoples in Canada” (p. 3). Ogawa (1995) reinforces this perspective and argues that, “every culture has its own *science* and refers to this *notion of science* in a given culture as its *Indigenous science*” (Michell, 2007, p. 33).

Indigenous knowledge systems are identified by such phrases as *Native science* (Cajete, 2000), *Aboriginal science* (Christie, 1991), *Maori science* (McKinley, 1996), *Yupiaq science* (Kawagley, 1995) and *ethno or ethnic science* (Ovando, 1998). Cajete (1986) and Ovando (1988) use the terms *native science* and *ethnoscience* to refer to a traditional form of Indigenous-based science education which includes “the methods, thought processes, mind sets, values, concepts and experiences by which Native American groups understand, reflect and obtain empirical knowledge about the natural world” (c.f.

Pomeroy, 1994, p. 66). Cajete (1986, 2000) “asserts that the *ethnoscience* of each Indigenous people is unique in that it reflects adaptation to a certain *Place*” (Battiste & Henderson, 2000, p. 40). Michell (2007) has explored the work of Cajete (1986, 2000) and explains that the term *ethnoscience* is based on the assumption that each cultural group differs in their knowledge of and experiences with the natural world: “In essence, *ethno-science* represents the perceptions, interpretations and applications of inquiry characteristic of a particular cultural group. The study of *ethno-science* is about coming to understand how particular cultural groups perceive, learn and act in relationship to their particular environments” (p. 37). However, it can be difficult to escape the Western privileging of *science*.

Citing Ogawa (1995), Michell (2007) notes, “The use of the terms *Ethno-science* and *Ethnic* are problematic. The terms privilege Western science because they do not accept Euro-Western science as *ethnic based*; which it is at least from a multi-science perspective” (p. 37). This sets up an ethnic–non-ethnic binary for science, in which it is assumed that Western science, detached from culture and ethnicity, is objective and Indigenous science, coloured by culture, is subjective. Harding (2006) reminds us “Binary making ... has been a persistent practice of the imperializing modern West” (p. 12). While recognizing *Indigenous science* as *science* can be problematic, it can also be beneficial. Harding (2006) identifies some of the benefits in *levelling the playing field* and keeping *both eyes open* when comparing different knowledge systems recognized as scientific. These include recognizing how each knowledge might be better suited for certain contexts or problems (p. 11), recognizing the strengths and limitations of each knowledge system, and re-imagining how to improve the relations between knowledge systems and their economic, social, political, and cultural projects (p. 22). Similarly, Aikenhead (2006b) writes, “such comparisons harbor hidden Eurocentric assumptions about non-European knowledge systems, but nevertheless, dichotomous comparisons can serve as a first step in a journey toward wisdom” (pp. 112-113). Related to the strategy of expanding the definition of science to include *Indigenous science* is the effort to integrate the two systems of knowledge.

Comparing Indigenous Science and Western Science

The similarities and differences between Indigenous and Western science have received a great deal of attention in the literature (Aikenhead, 1997, 2001; ANSC, 2008; Cajete, 2000b; Christie, 1991; George, 1999; Hammond & Brandt, 2004; Jegede, 1995; Kawagley et al., 1998; Kawagley & Barnhardt, 1999; McKinley et al., 1992; Snively & Corsiglia, 2001; Stephens, 2000). Michell (2007) argues there is a need to explore, delineate, and articulate “these similarities and differences in specific First Nations contexts for curriculum development purposes” (p. 62).

While there are similarities and commonalities Indigenous Peoples did not develop along parallel lines. One of the commonalities Indigenous Peoples share is a worldview of interconnectedness. Each *Place* however will have different expressions of their worldviews, epistemologies, methodologies, and pedagogies in relation to school science.

Because of the diverse cultural contexts, the interpretation of nature is also diverse and thus the knowledge/science content of each system is not easily translatable. Kawagley (1990) explains that Aboriginal and non-Aboriginal people “use the same method and thinking processes to seek answers to the same questions. However, the different value concepts, perspectives, and philosophy determine how they interpret the empirical data and how they relate to the natural world” (p. 14). For more examples of comparisons see Appendix 3.

Aikenhead (2006) cautions that dichotomous comparisons may harbor hidden Euro-centric assumptions about Indigenous knowledge systems. Binary opposites can lead to erroneous and stereotypical assumptions about which knowledge is better than the other. Rather, these knowledge systems are recognized in post-colonial discourse as *ways of thinking* or *ways of knowing* that are incommensurate and equally valid while acknowledging each group's heterogeneity (Aikenhead, 2007, in press). From an Indigenous perspective, we are all related, and each knowledge base has an equal place within the metaphoric wheel of life.

The following comparisons between Western science and Indigenous science have been constructed from existing literature. We believe it is necessary for people to see the uniqueness of each knowledge system as the first step towards understanding and celebrating cultural difference.

Comparing knowledge systems is a way of illuminating and rejecting the positivist Western science paradigm as the sole model for seeking truth. More importantly, the comparisons serve as a point of clarity that positivist Western science thinkers may want to think about. As with most dichotomous comparisons, they can be challenged as partly accurate and useful.

WESTERN SCIENCE CONCEPTS

- Science is a Subset of Euro-Western Culture
- People are Separate from the World Around Them
- What Counts as Science - Is What Can be Measured
- Focus on Physical World - Absence of the Sacred
- Scientific Method - Compartmentalized Knowledge
- Fragmented Worldview - Linear - Hierarchical
- Mechanistic - Reductionist - Rational
- Impersonal Mathematical idealized – De-Contextualized
- Exploitative - Materialistic - Ideological - Elitist.

INDIGENOUS SCIENCE CONCEPTS

- Physical & Spiritual Are Not Separate
- Holistic - Communal - Contextual
- Inclusive - Cooperative - Peaceful
- Focus on Natural Laws & Land
- Respect & Reverence for all Life
- Reciprocity and Interdependence
- Balance & Wholeness - Inner & Outer Harmony
- Nourishing the Learning Spirit
- Sustainable Ways of Being

Integrating Indigenous Science and Western Science in Education

The Cape Breton University's Institute for Integrative Science and Health has broadened the term *science* to include "More holistic sciences, such as those of Aboriginal and other Indigenous peoples" (CBU, 2008). Their website identifies integrative science as an effort to bring together Indigenous and Western scientific knowledge and ways of knowing to create living knowledge for the 21st century.

Integration represents a popular contemporary pedagogical approach to teach science to Aboriginal students, and to a lesser degree, to non-Aboriginal students. Aikenhead (2002) notes, “The issue of bridging the two knowledge systems (Western science and Aboriginal science) for the benefit of Aboriginal students is not new (Maddock, 1981; Pomeroy, 1994).

One proposed bridge lies within the field of *Traditional Ecological Knowledge* (TEK) (Johnson, 1992, 288). TEK came into widespread use in scholarly circles in the 1980s (See also Johnson, 1992; Inglis 1993; Lukey, 1995; Johannes, 1989, 1993; Williams & Baines, 1993). It is important to note the concept of TEK was constructed by Western academics (Aikenhead, 2002, p. 289). Given its heritage, TEK may be attractive to Western scientists and academics because of the apparent compatibility with Western standards of science and applicability to the Western academic scheme of organizing knowledge into disciplines.

Battiste and Henderson (2000) explain how “The Traditional Ecological Knowledge of Indigenous peoples is scientific, in the sense that it is empirical, experimental, and systematic” (p. 44). McGregor (1994, 1995(a)(b); 1999; 2000) uses the term *Traditional Ecological Knowledge* to refer to a branch of *Indigenous knowledge* literature that is usually connected to the disciplines of biology and the environment. However, “There is no universal agreed upon definition of Traditional Ecological Knowledge” (Michell, 2007, p. 34). The practice of TEK may be more revealing of the problems that come with integrating different knowledge systems. Aikenhead (2002) cites McGregor (2000), who found that interest in TEK usually originates outside Aboriginal communities, resulting in non-Aboriginal scientists determining the agenda, which perpetuates the colonial exploitation of Indigenous knowledge (p. 289). Elsewhere, Nadasdy (1999) studied several cases where Aboriginal holders of TEK participated with government scientists in resource management and environmental impact assessment studies. Nadasdy’s study revealed that “TEK was used by government scientists to avoid a two-way integration of the two knowledge systems and to reinforce a Western cultural bias that controlled the decision making over local land and animal issues” (Aikenhead, 2002, p. 289). Given the systemic and hegemonic power relationships inherent in such processes as integration, “McGregor (2000) concludes that we should not integrate or bridge Western and Aboriginal sciences, as TEK attempts to do” (Aikenhead, 2002, p. 289). Instead, we should actively support a post-colonial model she calls *co-existence*, which promotes functioning of both systems *side by side*. Battiste (2000), MacIvor, (1995), Sainte-Marie (2000) and Urion (1999) embrace the concept of *co-existence*. Other models that balance two cultures include *two-way learning* (Ritchie & Butler, 1990), *cross-cultural learning* (Aikenhead, 1997, 2006a), and *bi-cultural instruction* (Cajete, 1999; Kawagley, 1995, 2000).

The matter of cross-cultural science education, however, is not a simple matter. Ogawa (1995) warns that *Indigenous science* is more than just a single knowledge system comparable to Western science. Instead, it is “a body of stratified and amalgamated knowledge and cosmology” (p. 1). For this reason, “A simple [curricular] transformation from one system to another is not often feasible (McKinley, 2005). According to Aikenhead (2006b) “integration can fail depending on the context” (p. 123). Therefore, it would be a mistake to attempt to simply *translate* contemporary curricular objectives, (derived as they are) from the Western worldview to an Indigenous worldview and language system. Whether the two knowledge systems are compatible depends on the context. This means great care should be taken when attempting to make a cross-cultural science curriculum.

In the case of *Rekindling Traditions* (Aikenhead, 2002), there was success incorporating Western science into an Indigenous science curriculum. Aikenhead explains the process: “After the unit is firmly

grounded in an Aboriginal framework (accomplished in one to three lessons), the next move is to introduce students to relevant Western science content from the Saskatchewan science curriculum” (p. 295). The units were successful because Western science did not displace *Indigenous science*; instead, Western science enhanced *Indigenous science*: “Western science can powerfully clarify one small aspect of Aboriginal science” and when it “did not replace Aboriginal science, it enriched an aspect of it” (p. 295). However, there is literature that recommends keeping both knowledge systems separate. Garrouette (1999) published a paper entitled *American Indian Science Education: The Second Step* which provides a synthesis of the contrasting assumptions in Western scientific and American traditional thought systems and the importance of keeping these two models of inquiry separate when designing Indigenous-based science curriculum. Clearly, there is no simple formula for cross-cultural science education. For these reasons outlined here (and more), “Creating a balance between two worldviews is the great challenge facing modern educators” (Battiste, 2000a, p. 202).

Environmental Movements and Science Education

Part of the inspiration for the *Learning Indigenous Science from Place* research project has emerged from work being done in national and international forums such as the United Nations Convention on Biological Diversity (CBD), the declaration by the United Nations Educational and Scientific and Cultural Organization (UNESCO) in declaring the UN Decade on Education for Sustainable Development and the need for ongoing inclusion of Indigenous perspectives in resolving global environmental issues which affect all of us. In an effort to stimulate discussion and action on sustainable development globally, UNESCO declared,

The goal of the United Nations Decade of Education for Sustainable Development (2005-2014, DESD), for which UNESCO is the lead agency, is to integrate the principles, values, and practices of sustainable development into all aspects of education and learning.

This educational effort will encourage changes in behaviour that will create a more sustainable future in terms of environmental integrity, economic viability, and a just society for present and future generations. (United Nations Educational, Scientific and Cultural Organization, n.d.)

There are few Aboriginal individuals active in these important international forums indicating an underlying issue of the public education community’s inability to inspire and impart Aboriginal students with the skills to address global biological diversity issues from an Indigenous perspective. Currently, in Canada, academic science education is a process based in Western Eurocentric philosophies and ideologies that are not conducive to the preservation of traditional knowledge. In order for Indigenous Peoples to engage in global environmental issues it is important to examine the need for traditional knowledge and perspectives, as well as the educational infrastructure that must be in place to support the perpetuation of that knowledge. Without supporting educational infrastructure, Aboriginal Peoples are left in a void between the forces that acknowledge the importance of traditional knowledge in addressing biological diversity issues, and an education system that does not promote the generation of traditional knowledge, innovations and practices.

An opportunity is at hand to encourage Canadian educational systems to support Aboriginal-based ontology, epistemologies, and pedagogical practices. Researching and creating better paradigms within which human being can thrive and the environment can be conserved is a challenge of being able to see the value in local traditions, innovations and practices and incorporate them into our contemporary lives. In order to promote Indigenous science education, non-Indigenous education systems must

increase their understanding of Aboriginal worldviews, epistemologies, pedagogies, and new Indigenous education systems must be supported as equitable and beneficial processes.

Aboriginal Epistemology

In describing the difference between Aboriginal epistemology and Western epistemology, Ermine (1995) has said,

Those people who seek knowledge on the physical plane objectively find their answers through exploration of the outer space, solely on the corporeal level. Those who seek to understand the reality of existence and harmony with the environment by turning inward have a different incorporeal knowledge paradigm that might be termed 'Aboriginal epistemology'...The inner space is that universe of being within each person that is synonymous with the soul, the spirit, the self, or the being. (p. 103)

Indigenous Peoples do not seek understanding, nor convey cultural teachings within the group through objective processes. Indigenous knowledge systems are the sum total of diverse streams of knowledge gathered over time, accepted by the community and synthesized into collective knowledge as necessary for survival. Traditional teachings are provided for the learner to integrate intangible elements of self within the comprehension process. It is a process of cultural breathing. Knowledge is drawn in, internalized and expressed by individuals and by collectives. The cyclical process is repeated as naturally as one draws breath. Individual and collective kinship patterns, experiences, relationships, interpretations of community practices, spirituality and history are all important factors that contribute to cultural epistemology.

In order to maintain equilibrium within the world, complex systems of reciprocity found within traditional knowledge must be understood and practiced by the teacher and the learner. One's actions impact upon one's environment, resulting in a tremendous responsibility carried by the individual, and the community, that must be considered carefully before carrying out a particular action. This responsibility is not only to the physical world or others in the community, but it is also a responsibility to the spiritual world.

Aboriginal philosophy of Plains Indians holds that all things are animate, have spirit, are in constant motion, that interrelationships between entities are of paramount importance and that referential space is more important than time (Little Bear, 2000, p. 77). This philosophy provides the foundation for values and customs such as the acceptance of wholeness or totality, strength, independence and respect, non-interference for others' wholeness, totality and knowledge, sharing, humour, honesty and kindness. These values function to maintain the relationships that hold creation together (Little Bear, 2000, p. 79-80).

Teachings of *respect* are complex and require contextual knowledge and reflection. Respect for one's self, respect for one's fellow human beings, respect for the earth and respect for the spiritual realm are all inherent within the concept. Teaching and learning the complexities of respect transcend a lifetime. It is a never-ending process of living to achieve different *levels* and *layers* of understanding. Learning is not a linear process. One acquires spiritual and intellectual growth through dynamic interaction with other beings sharing their environment, often by cyclical or repetitive experience.

Aboriginal Peoples need to remain in contact with their cultural environments, and retain contact with traditional teachers, in order to ingrain, experience and internalize traditional teachings. Continuity of

contact with cultural teachers contributes to the retention and synthesis of traditional knowledge critical for the holistic development of Aboriginal children. Researchers, teachers and learners working to have traditional knowledge respected for what it is and how it exists must do so in a manner consistent with the nature of traditional knowledge in its holism and sacredness. Internalizing traditional knowledge facilitates the revitalization of self, the collective and existence of the natural world.

Theories of Ecological Education

Theories of ecological education provide opportunities to consider a context for educational foundations supporting the future of human survival. Examining the intricate and complex relationships inherent in the natural world can help humans understand our own roles within these, and all other, relationships.

Theory places firsthand knowledge in diverse contexts, deepens insights, and provides for critical reflection. Insights from the multiple practices and theories of environmental justice, indigenous knowledges, feminism and ecofeminism, critical pedagogy, environmental thought, deep ecology, bioregionalism and the other educations...all have much to offer environmental education, just as environmental education can enrich the theory and practice of each. While not wishing to minimize the important differences and tensions between these movements and educations, each contributes to a diversity of voices, each is grounded in specific communities and experiences, and each combats injustice and works towards more inclusive politics and social change. (Russell, Bell, & Fawcett, 2000, p. 209)

Developing an intimate knowledge of the environment sustaining us can help us personally to discover a sense of *Place* and, with it, all the responsibilities we hold in ensuring the continued health of a particular place. For some, development of having a sense of Place begins in childhood with exposure to the natural world in which a sense of wonder is inspired. For others, development of a sense of wonder and respect may come later in life in other forms. For all, development of the realization of our inextricable interconnectedness with the natural world is essential to its appreciation and the action necessary for preserving ecological integrity. Educators versed in ecological theory must play key roles in inspiring colleagues and students to integrate ecological awareness into curricula. The goal of ecological education is transform our selves from passive witnesses of environmental destruction to involved active participants in actualizing attitude and lifestyle changes necessary for our human survival.

Smith and Williams (1999) challenge readers to rethink contemporary cultural assumptions about our relationships with nature and to seek out ecologically sustainable lifestyles through education. The amount of literature and media regarding environmental crises raises awareness, but can also serve to generate feelings of helplessness and fear preventing people from becoming active problem-solvers. Rather, Smith and Williams encourage exploration of practical activities across curriculum and age groups to discover possible directions that might be pursued to develop a more ecologically sustainable culture. They share the following *Principles of Ecological Education*:

- Development of personal affinity with the earth through practical experiences out-of-doors and through the practice of an ethic of care;
- Grounding learning in a sense of place through the study of knowledge possessed by local elders and the investigation of surrounding natural and human communities;
- Induction of students into an experience of community that counters the press toward individualism that is dominant in contemporary social and economic experiences;

- Acquisition of practical skills needed to regenerate human and natural environments;
- Introduction to occupational alternatives that contribute to the preservation of local cultures and the natural environment;
- Preparation for work as activists able to negotiate local, regional, and national governmental structures in an effort to adopt policies that support social justice and ecological sustainability;
- Critique of cultural assumptions upon which modern industrial civilization has been built, exploring in particular how they have contributed to the exploitation of the natural world and human populations. (Smith & Williams, 1999, pp. 6-7)

Smith and William's (1999) work draws on ideas and models presented by a variety of educators to encourage a re-conceptualization of the relationship between education and the environment, and the purpose of education itself. Recognizing the role education currently plays in our ability to participate in a competitive global market, Smith and Williams acknowledge curriculum must be implemented with a balanced perspective, allowing students to consider all sides of controversial issues, including "bringing ecological interdependence and an ethic of care in from the margin to the center of the debate" (Smith & Williams, 1999, p. 16).

Russell, Bell and Fawcett (2000) reviewed several forms of environmental education programs across Canada. Some of the approaches adopted include holistic models identified in Saskatchewan and Ontario that are supportive of interdisciplinary responses to complex environmental issues. The integration process involves grouping subjects such as English, drama, physical education, leadership, environmental science and geography together. Additionally, secondary students can teach elementary students or undertake apprenticeships in jobs with an environmental focus. Integrated programs such as these promote "critical aspects of environmental education: grounding learning in authentic, "real world" experiences; demonstrating links between subject areas; fostering student responsibility; increasing student-teacher contact; and improving relations among students" (Russell, Bell, & Fawcett, 2000, p. 200). Inclusion of traditional Aboriginal philosophies and practices encourages students to explore relationships between land and culture, sense of Place, earth and cosmos, multi-cultural perspectives and concepts of the sacredness of nature.

Other schools throughout Canada identify as Green Schools and are moving beyond traditional environmentalism to include development, equity, health, peace and rights studies. Green Schools provide an opportunity to engage those within the school as well as members of the broader community. Russell, Bell and Fawcett (2000) acknowledge that comprehensive participation is the exception rather than the rule in environmental education. Generally, the weight of providing strong environmental education programming falls on one or two committed teachers. Departure of these educators can mean the collapse of environmental programming. Increased environmental education within teacher training programs is necessary to stimulate growth of school-based environmental education (p. 201).

In examining human-environment relationships, Russell, Bell and Fawcett (2000) describe one of the most contentious definitions of equating *environment* with *resources*. People living in modern, industrialized societies generally imagine humanity to be different from, and superior to, all other life resulting in the notion that the environment is to be controlled and used solely for our benefit. Alternatively, Indigenous worldviews hold a radically different premise that humans are part of, not

separate from, environmental processes. Russell, Bell and Fawcett (2000) believe Indigenous perspectives hold more promise for educators who struggle with *resourcist* assumptions and are seeking to encourage an understanding that dilemmas we face have deep cultural roots in modern industrial society's profound alienation from the "more-than-human world" (p. 204).

Orr (1992) directly addresses the formation of attitudes, ecological literacy and formal education processes which shape our mental landscapes, language and observational abilities. Ecological literacy has become difficult for us as a result of living in an age of increasing specialization promoted by a largely indoor education. The need to look at the roots of our ailments, not just the symptoms will contribute to cultivating a sense of Place and building a competent public who recognize that our lives depend on educating to live sustainably (pp. 86-88).

Orr (1992) holds the position that

...it is a mistake to think that all we need is better technology, not an ecologically literate and caring public willing to help reduce the scale of problems by reducing its demands on the environment and to accept (even demand) public policies that require sacrifices. It all comes down to whether the public understands the relation between its well-being and the health of the natural systems (p. 90).

In order to rethink education substance and process, Orr provides the following foundations of ecological literacy that will contribute to education for sustainable living:

- All education is environmental education;
- Environmental issues are complex and cannot be understood through a single discipline or department;
- For inhabitants, education occurs in part as a dialogue with a place and has the characteristics of good conversation;
- The way education occurs is as important as its content;
- Experience in the natural world is both an essential part of understanding the environment, and conducive to good thinking;
- Education relevant to the challenge of building a sustainable society will enhance the learner's competence with natural systems. (Orr, 1992)

The guiding foundations provided by Orr (1992) provide a framework for recognizing what is taught and not taught in schools, how our attitudes are shaped by the roles we see ourselves in, the need to combine different perspectives and *knowledges* to more fully understand systems and to move away from dictatorial attitudes in our interactions with the natural world. "The concept of sustainability implies a radical change in the institutions and patterns that we have come to accept as normal" (p. 94). Challenging attitudes of limitless consumption requires seeking out developed theories and practices promoting ecological literacy.

One of the leading scholars in Indigenous education is Dr. Gregory Cajete, a Tewa Indian from New Mexico. His book *Look to the Mountain: An Ecology of Indigenous Education* provides a personal synthesis and translation of tribal educational principles for contemporary education. Cajete explores traditional universal concepts found in various Indigenous cultures such as wholeness, self-knowledge,

spiritual development and the wisdom needed to accept our interconnectedness with the earth and cosmos. Cajete believes “a contemporary application of Indian education must creatively integrate the orientation of economic survival and ecological sustainability if it is to serve the needs of Indian people living in contemporary times” (Cajete, 1994, p. 216). Drawing on stories, song, art and philosophies of Indigenous cultures, Cajete’s work culminates in a model of Indigenous Stages of Developmental Learning. At the centre of the model is the goal of “finding the center completedness” which results from a profound transformation of self (Cajete, 1994, p. 211). The stages of transformative education are embedded in a context of respect for the spirit of the child, moving through basic education, societal education / survival skills, myth / ritual / ceremony, integration with tribal culture, visioning, individuation, enlightenment / wisdom, and finally, transformational understanding.

Cajete’s work is complex and comprehensive. It is more than a study of Indigenous knowledge. It is a theoretical framework for lifelong learning processes supporting traditional values and practices. Achieving personal transformation and centeredness involves the exploration of a variety of approaches to learning. Educators must be willing to engage themselves in holistic teaching and learning processes in order to provide an Indigenous context of education. Cajete provides several characteristics that exemplify the transformational nature of Indigenous education. Briefly summarized, they include:

- Learning happens of its own accord, if the individual has learned how to relate with his/her inner Center and the natural world;
- Experiences of significant hardship were a necessary part of an individual’s education, and that such circumstances provided ideal moments for creative teaching;
- Empathy and affection were key elements in learning. Also, direct subjective experience combined with affective reflection were essential elements of right education;
- An innate respect for the uniqueness of each person created the understanding that each person was their own teacher in their process of individuation. Indigenous education integrated the notion that there are many ways to learn, many ways to educate, many kinds of learners, many kinds of teachers, each honored for their uniqueness and their contribution to education;
- Each learning situation is unique and innately tied to the creative capacity of the learner. When this connection to creative learning and illumination is thwarted, frustration and rigidity follow. Learning therefore, had to be connected to the life process of each individual. The idea of life-long learning was a natural consideration;
- Teaching and learning are a collaborative contract between the teacher and learner. In this sense the teacher was not always human but could be an animal, a plant, or other natural entity or force;
- Learners need to see, feel and visualize a teaching through their own and other people’s perspectives. Therefore, telling and retelling a story from various perspectives and at various stages of life enriched learning, emphasized key thoughts, and mirrored ideas, attitudes, or perspectives back to learners for impact;
- There are basic developmental orientations involved with learning through which we must pass toward more complete understanding;
- Life itself is the greatest teacher and that each must accept the hard realities of life with those

that are joyous and pleasing;

- Learning through reflection and sharing experience in community allows us to understand our learning in the context of greater wholes. In a group there are as many ways of seeing, hearing, feeling, and understanding as there are members. (Cajete, *Look to the mountain: an ecology of indigenous education*, 1994, pp. 212-214)

In *Igniting the Sparkle: An Indigenous Science Education Model*, Cajete takes a further step by sharing a culturally responsive science curriculum he has been teaching at the Institute of Indian Arts in Santa Fe, New Mexico for twenty-five years. This curriculum integrates Native American traditional values, teaching principles and concepts of nature with those of Western science (Cajete, 1999, p. 9). Cajete cites Peat (1996) in coming to a description of Indigenous science, in that,

... It is a broad category that includes everything from metaphysics to philosophy to various practical technologies practiced by Indigenous peoples both past and present. At its most inclusive definition *Indigenous science* may be said to include practically all of human invention before the advent of Cartesian-mechanistic science. These include areas such as astronomy, healing, agriculture, study of plants, animals and natural phenomena. Yet Indigenous science extends beyond these areas to also include a focus on spirituality, community, creativity, appropriate technology which sustains environments and other essential aspects of human life. (Cajete, 1999, p. 81)

Further, Cajete goes on to say,

Indigenous science includes exploration of basic questions such as the nature of language, thought and perception, the movement of time, the nature of human feeling, the nature of human knowing, the nature of proper human relationship to the cosmos and a host of other questions about natural reality. Indigenous science is the collective inheritance of human experience with the natural world. It is a map of reality drawn from the experiences of thousands of human generations which gave rise to a diversity of technologies for hunting, fishing, gathering, making art, building, communicating, visioning, healing and being. (Cajete, 1999, p. 81)

These theoretical frameworks and perspectives offered by various authors provide a just a snapshot of views on ecological education. Diverse approaches and manifestations are possible given basic frameworks. Local adaptations to relevant community-based knowledge systems will enrich educational experiences for students and educators alike. Common to all theories is the idea that building practical curricula for ecological education involves getting out of the classroom into nature, and extending the support network of the educator to include other community members knowledgeable about local traditions. Similarly, in the Aboriginal communities, opportunities for inclusion of traditional knowledge holders to interact with *formal* educators will result in a broadening of experiences for students, stronger relationships between community members and schools, and an expanded base of experience for educators. Within school systems, educators, administrators and other key people need only consider the alternative to not building an ecologically aware and active public to find motivation to begin or expand their efforts in ecological education. In the next section, a summary of promising practices is provided for educators.

2.5 Promising Practices: A Summary of the literature

This literature review presents the main themes found in studies that offer promising practices and/or recommendations that support First Nations, Métis and Inuit student achievement and positive learning outcomes in school science. While there are many studies that examine Aboriginal education in Canada, few offer practices and recommendations that have proven to be successful in schools.

Although the historical and ongoing experiences of racialized students are similar in terms of experiencing exclusion, segregation, and poor classroom instruction in schools, the educational needs of, and within, each group are often very different. However, Indigenous Peoples in all colonized territories, internationally and within Canada, share common experiences in relation to cultural loss. They also have a shared vision in restoring once flourishing Indigenous knowledge systems through the vehicle of school science education.

According to the literature, there are important cultural and linguistic considerations that can be used to guide the development of curriculum unit plans, lessons, activities, materials, and resources. All students regardless of cultural background have the potential to benefit from Indigenous knowledge ways shared by Indigenous Peoples who have interacted with the Canadian landscape for centuries. Indigenous knowledge systems are an inseparable part of the diverse cultural heritage of Canada that should be maintained and passed on for the benefit of all humanity. Although literature pertaining to instructional approaches is cited below, parallel articulations of Indigenous-based science education among Canada's diverse Aboriginal Peoples remains virtually non-existent and undocumented. School science curriculum research and development is needed from the foundation of Aboriginal communities.

One of the major reasons why Aboriginal students struggle in school science is because curriculum content is imported and the presentation of units and lessons are still predominantly Euro-western based. Indigenous knowledge is not respected or, if included at all, is usually a token aspect of programs and courses. Many teachers are fearful of overstepping their boundaries. Cultural content is usually an add-on with no real goal of reinforcing the holistic worldview of Indigenous Peoples. Worst, First Nations culture is taught in isolation from other subject areas. Culture camps are treated as separate events with no direct connection to science for example. Overall, there is no real and meaningful balance of perspectives in school science.

Aboriginal students do not see the application of school science as being relevant to their situations, experiences, and community contexts. They do not see the connection between their culture and science. They do not see the contemporary importance of their Indigenous knowledge as making a potential contribution to the survival of the entire human race. Yet, if we only look deeper within our communities we have so many practical examples of traditional knowledge that personify an intimate understanding of the natural world.

More often than not, school science occurs in stuffy classrooms completely detached from the land. The teacher stands in front of the students as the expert or authority figure. Students are seated in rows, military style. Teaching and learning occurs from the top down. Students are seen as being devoid of bringing any prior knowledge and understanding of science especially from an Indigenous perspective. In many situations, they are often forced to memorize formulas, technical vocabulary and fragmented pieces of knowledge that they cannot place within the larger cultural life context.

Getting through the curriculum and satisfying Western standards becomes a priority for teachers. This type of learning and instruction violates the wholeness of life leading to alienation and incomplete learning for many students. Today, mainstream schools and universities continue to present science as if it were a totally separate entity from arts, humanities, and social sciences, when really it is only a part of the whole. The human and spiritual elements are missing from school science learning.

Cultural advisor and scholar, Joseph Couture states, *all ways are good if they are done in the right way*. Whether one is Cree, Dene, Inuit, Mohawk, or any other Indigenous group, there are common threads and holistic life philosophy based on relationships with self/family/community/nation/ nature/ cosmos, trust and respect, stories and legends, dance and song, ritual and ceremony (Couture, 2000, p. 163). It is these commonalities that need to be shared as a foundation for teaching school science.

Kawagley (1990) who has done research on the Indigenous science of Alaskan Peoples argues that Indigenous and non-Indigenous students use the same method and thinking processes to seek answers to the same questions. However, different value concepts, perspectives, and philosophy determine how they interpret the empirical data, and how they relate to the natural world (p. 14).

MacIvor (1995) states Indigenous societies have rich and diverse approaches to educating and passing on knowledge of the natural world. Some common approaches include: experiential learning; sharing circles, storytelling; drawing, painting, singing, drumming, making models, Elder guidance; observation; apprenticeship; ritual & ceremony; dreaming & imagination; supervised and unsupervised participation; intergenerational teaching.

Cajete (1986) found that Native American methods of teaching and learning include: experiential learning (learning by doing and seeing), storytelling (learning by acting listening, imagination, and coding), ritual/ceremony (learning through initiation, connecting to the spirit), dreaming (learning through the unconscious and imagery), the tutor (learning through apprenticeship, informal and formal), and artistic creation (learning through creative synthesis). These methods of teaching and learning are not unique to Indigenous science education. However, they definitely resonate with environmental related education and outdoor education.

Garrouette (1999) examined various Indigenous-based science programs published in the *Winds of Change Journal*, within a ten-year period (1986 to 1996). The findings revealed that most writers did not pay attention to the radical differences between the central ontological and epistemological themes underpinning Western and Indigenous science. Most writers who shared assumptions of the basic sameness of the two models offered the following strategies for incorporating Indigenous content into science curriculum: Introduction of Elders or special tutors; attention to learning styles; using classroom examples familiar to Indian children; tinkering with practices and presentation of material; encouraging students to study harder; and concentration on environmental or technological issues relevant to reservation communities. However, these are not unique strategies that are only available to Indigenous students. Garrouette states, it is “business as usual in the science classroom so long as selected items from traditional teachings or practices are permitted to co-exist alongside accepted scientific dogma” (p. 103). Indigenous science knowledge is basically inserted into the existing Western scientific framework that has a criterion by which the world and everything in it is judged and evaluated. Garrouette argues it is possible to teach science keeping the two models of inquiry distinct without having to coerce one set of knowledge claims to fit the other. Still, there are commonalities that exist which can be used as a starting base for teaching science that is relevant for all students regardless of cultural background. It is

important to teach students the existence of different models of inquiry of which Western science is only one way of perceiving and explaining the world.

Garrouette (1999) provides a classic example of a science program with Alaska native students that keep the two models of inquiry separate and equal:

The 1993 class investigated rocks from the island [on which the Indian children live], conducted geochemical sampling for trace metal contamination, investigating radiation again, and built positive thinking skills through various exercises. The class observed the splitting of walrus hide to be used in making a skin boat. The elders [who participated in the program] talked about reading ice conditions, weather, the ocean currents and the rules for hunting. (p. 107)

Garrouette states that implementing Indigenous based approaches to science education is difficult and complex. It is difficult to find the right mix of teachers, and to come up with a consensus in communities about what parts of traditional knowledge should be taught and how and who should teach them. She recommends that each tribe and community will have to come up with programs specific to their contexts and traditions. In order for transformation to occur in the way science is taught in these contexts, there is a need to redefine the definition of science to include Indigenous ways of knowing. This will require a multifaceted approach to research from within each community by focusing on diverse perspectives that include Elders, teachers, students, cultural support workers, hunters, trappers, women, and other traditional land users. Aikenhead (2006) suggests long term “consensus making research and development”, a type of action research on a grand scale accompanied by implementation within a large educational jurisdiction where the status quo of science education is discussed and renegotiated (p. 132).

Rowland and Adkins (2003) made several recommendations to improve science education for Native Americans in the United States. These recommendations include: changes in curriculum and teaching strategies such as the use of cooperative learning approaches; experiential learning; active hands-on learning; integrating science with other subjects; making connections to the world of the learner; and paying special attention to teaching the language of Western science. Other recommendations include making connections to the student’s Indigenous cultural knowledge of science by: focusing on Indigenous science contributions made by native people; viewing science broadly to include Indigenous ways of knowing the world and their cultural basis; connecting with Indigenous native science by relating science education to topic and themes important to Indigenous Peoples; exploring differences between Indigenous science and Western science; and centering Indigenous science education on the study of the environment and relating that study to Indigenous beliefs that connect them to the earth (Hines 2003, p. 104). These recommendations are critical to science education as they move away from focusing too much on the memorization of facts and figures towards relevance and connection to the student’s socio-cultural life world.

Michell (2007) undertook a narrative study with native and non-native teachers in northern Saskatchewan. The following is a summary of thematic patterns found within the narratives provided by teachers that can be used as examples of school science practice, and more importantly, as possible research sites and curriculum directions;

- Science Units that are guided by the mental, spiritual, emotional, and physical development of students within the context of their families, communities, and wider social world;

- Science curriculum and lessons that revolve around Cree people and their traditional seasonal cycle;
- Science lessons and activities that connect students with the land and environment;
- Science lessons and activities that connect students with community Elders;
- Science curriculum that involves English, Scientific English, and Cree language;
- Science curriculum that involves traditional Cree values;
- Science lessons and activities that connect students to their everyday life;
- Science lessons and activities that connect students with community resource people both native and non-native;
- Science lessons and activities that connect students with role models of Cree heritage;
- Science curriculum that involves the history and evolution of Western science as well as the similarities and differences in relation to Cree worldview and knowledge systems;
- Science curriculum that involve field trips, cultural camps, and excursions to fish camps, trap lines, and other gathering places that will allow students to observe and engage with nature; and then share their knowledge using traditional and contemporary modes of communication;
- Science curriculum that involves classifications of plants, animals, and fish using multiple language concepts such as English, Linnaean Latin, and Cree;
- Science curriculum that is focused on the integration of science with other subjects such as environmental education, outdoor education, biology, chemistry, english, native studies, Cree language, and computer science.
- Science lessons and activities that allow students to do research in their own communities; for example, by exploring Indigenous Knowledge within their Cree culture that has allowed people to live in a sustainable manner for centuries;
- Science lessons and activities that revolve around the impact of resource extraction activities in northern Cree communities such as mining, logging, and fishing;
- Science lessons and activities that revolve around learning Western science that extends one's understanding of Cree ways of knowing and the traditional tools and technologies used for survival.

The above are broad suggestions and examples of practice. Community-based, participatory, and action research projects with adequate funding are needed to support teachers and university researchers in the development of localized curriculum and alternate performance assessment indicators in Cree contexts. However, Aikenhead (2006) reminds curriculum developers the idiosyncratic nature of materials produced through action research that inhibits transferability to other contexts.

Teaching release time needs to be negotiated so science teachers are free to participate in short-term and long-term curriculum development projects. There is also a need to develop culturally sensitive

ways of storing, disseminating, and sharing Indigenous-based science curriculum and assessments so teachers can put more energy into implementation (Pomeroy, 1994).

A Summary of Common Themes in the Literature

Despite the great cultural diversity, there are common themes that emerge across the literature in relation to curricular possibilities in Aboriginal contexts. The literature shows that current research that examines effective urban practices for Aboriginal students is limited. Therefore, several of the studies examined in this review are taken from rural projects that have proved to be successful. Similarly, several studies and practices reviewed have been taken from international contexts (Australia, New Zealand, United States).

Primary themes that emerge in the literature suggest that effective school practices include the following:

- Holistic Knowledge and Spirituality
- Indigenous Knowledge of Local Populations
- Student Engagement
- Strong Community and Parent Relationships
- Effective Teacher Education and Pedagogy

Some promising practices are mentioned through out this literature review. Appendix 4 contains a *Promising Practices in Indigenous Science Education* list, which includes selected examples along with brief descriptions of the practices.

Holistic Knowledge and Spirituality

Several studies emphasize the need to resist the deficit model of Aboriginal education by designing educational practices that are guided by spirituality, traditional values, and principles of balance and respect. Curriculum development involves the entire community and most especially the Elders (Riecken, Tanaka, & Scott, 2006, 29; Goulet, 2001). Doige (2003) highlights the importance of spirituality in effective educational practices for Aboriginal students in the following way. “A synthesis of what these educators have to say is condensed in three principles that need to influence curriculum and pedagogy: (a) to accept and thus validate Aboriginal epistemology as a basis for learning; (b) to create a relational, safe learning environment that values students; and (c) to promote authentic dialogue” (p. 149). A spiritual orientation to the natural world is a central concept of Indigenous science education.

Indigenous Knowledge of Local Populations

School curriculum, practices, and programs that value and incorporate local Indigenous knowledge have proven to be successful in increasing Aboriginal student success and academic achievement (Pattniak, 2004). Ignas (2004) explains, “contemporary educational research is clear: improvements in educational outcomes are connected to valuing Indigenous and minority students' cultural context and their communities' local level knowledge” (p. 49). The literature suggests curriculum that reflects both western and Indigenous knowledge is integral to the success of all Canadian students. Barnhardt and

Kawagley (2005) explain, “Our challenge now is to devise a system of education for all people that respects the epistemological and pedagogical foundations provided by Indigenous as well as Western cultural traditions” (p. 10). Cross-cultural science embraces both traditions. However, “Cross-cultural science projects have typically produced guidelines describing Indigenous knowledge, but they have not conducted research into how science teachers follow those guidelines to develop material subsequently used in their classrooms” (Aikenhead, 2006b, p. 58). As such, this work still needs to be done.

Best Practices in relation to Indigenous knowledge and local populations include:

- *Forests for the Future* social studies and science curriculum project (BC)
- *Aboriginal Knowledge and Science Education Research Project* (BC)
- *Alaska Rural Systemic Initiative* (AK)

According to the literature, incorporating Indigenous knowledge systems in science curriculum has proven to be successful in increasing student success rates in several programs within Canada and the United States (Snively & Williams, 2006; Ignas, 2004; Barnhardt, 2005).

Student Engagement through Technology and Mentoring

While some changes may take several years to accomplish, there are practices that teachers can use in the classroom that promote Indigenous knowledge through student engagement. Hands-on-learning activities and practical skills such as engaging in mini-research projects are key. The use of digital cameras in Aboriginal student education emerged as one strategy in the literature (Snively & Williams, 2006; Riecken et al., 2006). Teachers utilize this method in an effort to connect youth with Elders through small research projects that involve interviewing Elders and community members. Students provide visual images to complement their documentation and interpretations of local knowledge and history. Because of their direct relevance, these programs have proven to be successful in engaging youth in school science.

School and university partnerships are also instrumental in enhancing the achievement levels of Aboriginal students. *Traditional Pathways to Health* is a research project developed through collaborative efforts between University of Victoria researchers, and Aboriginal teachers and students from two school districts. The project enables Aboriginal youth at three high schools in Victoria to use digital video to highlight, “their own positive activities, culture, and traditions as important dimensions of their lives that help to keep them well” (Riecken, et al., 2006, p. 35). The following are three examples of schools that have utilized and found the project to be successful:

- Career and Personal Planning (CAPP) at Victoria High School (BC) has a course option for Aboriginal students with an emphasis on making connections with Elders and other Aboriginal role models (p. 34).
- The Westshore Center for Learning and Training (BC) has developed a separate First Nations graduation program with a strong cultural focus that engages adult and youth learners with Aboriginal artists, poets, dancers, and writers (p. 34).

- In First Nations Leadership 11 at Esquimalt High (BC), the philosophy of the course is the belief that First Nations values and beliefs are essential to the understanding of self and others as leaders (p. 34).

The student engagement theme includes mentoring, apprenticeship, and one-on-one teacher/student opportunities. Mentoring for example has been successfully employed in the areas of Aboriginal women's health (Banister & Begoray, 2006). Other models include, success coaches (Costas, 2006) and Pre-service teachers' working with students (McCluskey, Baker & McCluskey, 2005).

Strong Community and Parent Relationships

The literature stresses the importance of building respectful and inclusive relationships with Aboriginal communities and parents (Cadwallader, 2004). Studies show that parental involvement is an important contributor to student success (Friedel, 1999, p. 140). Incorporating Aboriginal knowledge systems in school science requires on-going consultation with Elders, traditional lands users, and parents who possess diverse skills related to their heritage.

Parental involvement in Aboriginal communities varies and in many situations, parents who went through the Residential School system may be reluctant to participate in school activities. Developing ways to involve parents in creative ways is the key to fostering an interest in science among youth. One such promising practice is the *Three Stars and a Wish* writing project that was implemented in Winnipeg to engage Aboriginal parents and students who resisted becoming involved in the school as a result of negative experiences (Katz and McCluskey, 2003).

Effective Teacher Education and Pedagogy

Numerous studies (Ignas, 2004; Riecken et al., 2006; & Kanu, 2005) emphasize the importance of educating pre-service teachers and providing opportunities for on-going professional development in relation to incorporating Indigenous knowledge systems if schools are to address the needs of Aboriginal students and increase academic achievement levels.

Rowland & Adkins (2003) reviewed the literature about science education for Native American students. They found two themes for fostering success and achievement (pp. 104-109).

The first theme is to increase and improve science instruction. This includes:

- Using Group or cooperative learning approaches which have been found to be effective (Swisher & Deyhle, 1992; Gilliland, 1992b; Garcia & Ahler, 1992; Hoffman, 1992).
- Using active/experiential/hands-on learning approaches to teaching (Gilliland, 1992a; ORBIS associates, no date).
- Integrating science with other subjects and disciplines (Ovando, 1992; Gilliland, 1992b).

The second theme includes infusing Indigenous knowledge systems in school science. This includes:

- Focusing on diverse Indigenous knowledge and skills related to survival in particular places that people occupied (Williamson, 1994; Cajete, 1994; Gilliland, 1992b; Ovando, 1992).

- Assisting students to identify, delineate, highlight, and celebrate similarities and differences that exist between Indigenous and Western science (Simonelli, 1994; Kawagley & Barnhardt, 1999; Garrison, Denetclaw, & Scott, 1995; Aikenhead, 1997, 2002, 2006a, 2006b).
- Collaboratively working with communities and traditional land users in relation to incorporating a land-based ethic into school science (Cajete, 1994; Gilliland, 1992b; Caduto & Bruchac, 1989).

In addition to the above examples, the literature on cultural studies in science education provides further strategies and examples of effective teacher education in school science. Cross-cultural border theory is a new way of thinking about school science. According to this theory, students both native and non-native experience school science as a cross-cultural event. Aikenhead (2006) explains: "Science teachers can help students negotiate difficult border crossings, but this help is normally absent in science classrooms because teachers are unaware that cultural borders exist for their students (Contreras & Lee, 1990; McKinley et al., 2004; Phelan et al., 1991)" (p. 120). Furthermore, most science teachers are unaware of the cultural nature of the school science they teach (Aikenhead & Huntley, 1997; Aikenhead & Otsuji, 2000; Haidar, 2002; McKinley, 2005).

According to cross-cultural border theory, the worldview of Aboriginal students and Western science are different. When worldviews come into contact with each other, students face a cross-cultural experience (Aikenhead, 2002, p. 289; Cajete, 1999; Maddock, 1981; Sutherland, 1998). Some educators advocate the co-existence and integration of the two knowledge systems in school science (Aikenhead, 1997, 2002, 2002a, 2006b; Battiste, 2000; MacIvor, 1995; Sainte-Marie, 2000; and Urion, 1999). In Australia and Aotearoa/New Zealand, models of *co-existence* are often called *two-way learning* (Ritchie & Butler, 1990), and in the United States they are called *bi-cultural instruction* (Cajete, 1999; Kawagley, 1995, 2000).

The term *cultural broker* has been used to describe the theory in which teachers facilitate student border crossings into and out of school science (Aikenhead, 1997; Mitchie, 2004; Stairs, 1993/94). Aikenhead (2006) describes the ways in which culture brokers act: "They acknowledge that a border exists, they motivate students to cross it, they employ language of both the students' culture and the culture of Western science, they explicitly keep track of which culture comprises the context at the moment, and they help students resolve cultural conflicts that may arise (Aikenhead, 1997; Chang & Rosiek, 2003; George, 1999b; Jegede & Aikenhead, 1999; Rollnick & Rutherford, 1996; Sutherland & Dennick, 2002)" (p. 121). Cultural brokers motivate students by developing authentic relationships, by understanding the specific history of the students' culture, and by maintaining high expectations (McKinley et al., 2004; Aikenhead, 2006, p. 121). The role of cultural broker is very similar to multicultural pedagogy (Erickson, 2004; Hines, 2003). Rowland & Adkins (2003) refer to "Ovando (1992) [who] pointed out that the multidisciplinary teaching of science concepts is especially compatible with the ways many Native American cultures organize knowledge" (p. 105).

One warning about effective teacher education and pedagogy concerns the specificity of culture. Effective teaching practices are not necessarily transferable. Aikenhead (2002) explains: "There is a great diversity in cultures from community to community across the north. This means that teaching materials developed in one community are not necessarily transferable to another community. Teaching materials must fit into the meaningful cultural context of the local community; otherwise, many students will find the science curriculum inaccessible (Cajete, 1999; Stairs, 1994)" (p. 290). In other words, effective

teaching and pedagogy of Indigenous science must reflect the diversity of both Indigenous Peoples and Indigenous knowledge.

Conclusion

Aboriginal student success and retention rates remain lower than that of non-Aboriginal students throughout Canada (Gallagher-Hayashi, 2004). To create meaningful education for Aboriginal students much work needs to be done. Gallagher-Hayashi explains,

Clearly, we are not making a place for these students, a place where they feel welcomed, rather than like strangers. There is no one clear reason why these students are falling behind. Certainly the effects of the Residential School system, low socio-economic factors and societal racism have all played a part. Just as there is no easy answer as to the cause, there is no easy answer for a solution - but as educators it is incumbent upon us to search for that solution until it is found. (p. 20)

Educational recommendations and needs identified by Aboriginal communities need to be incorporated within mainstream urban schools. This literature review identifies several examples of effective practices and recommendations. There are other examples in development, or thriving across Canada indicating a need for a broader collaboration of science educators and Aboriginal communities. Additional research is needed specifically for the purpose of obtaining Aboriginal Peoples perspectives in school science. There is a definite need to train pre-service and practicing teachers on how to successfully integrate Indigenous perspectives into their normal teaching practices. The examples provided offer educators a starting base from which they can modify their own practices as each community and school will be different. Finally, it would be beneficial to have a virtual forum where strategies science teachers use could be shared and evaluated over time to determine if they lead to a increase in Aboriginal student success rates in science education.

3. RESEARCH METHODOLOGY AND METHODS

In this section, the research methodology and methods used to gather the data for this study are outlined. This includes a rationale for the methodology used, a description of the research site, the participants involved, the snowball sampling method, interviews, convention for citations, ethical considerations, and the data analysis approach used for the findings.

3.1 Community-Based Action Research Approach

This research project is qualitative in nature. It is based on a community-based action research approach. The action research model draws upon a collaborative approach to investigation that seeks to engage participants, that is traditional land users and teachers, as equal and full participants in the research process. The approach reinforces the application of practical knowledge to community-defined issues and problems in a way that provides long-term improvement in the quality of life of a group of people (Fletcher, 2003). Action Research addresses pressing community issues because it is community-based, action-based, and focused on knowledge gathering (Stringer, 1999).

The Action Research approach is appropriate in that the questions asked are not provided by some distant scholarly interests but arise among those who will benefit most from the research. Much research has been done in First Nations and Métis communities where communities have asked, “What is the benefit?” This research is not based on further advancing an empiricist science paradigm but is directed toward the needs and interests of an established community of individuals, groups, institutions and governments who are interested in being involved in making science relevant to Aboriginal students and informing others of the knowledge inherent in Indigenous ways of knowing. It is directed where it will have greatest relevance: in the schools, among teachers, in the curriculum, and in cooperation and collaboration with First Nations and Métis communities for the ultimate benefit of the learners, both Aboriginal and non-Aboriginal. It is grounded in the deeply felt concern of the community members to make science context and praxis a meaningful development of skills, knowledge, values, and applications in multiple realities, not just for those belonging to one way of thinking. Action research provides an opportunity to view validity from another perspective.

Community involvement and input is thus central to this project. In every school, classroom, and community across Saskatchewan, stories, events and experiences have the potential to inform and create tools, strategies, curriculum content, partnering protocols and processes that would assist other teachers immensely. Both First Nations and Métis Holistic Learning Models (Appendix 1 and 2) emphasize the link between learning and community, and the value of each member’s input. Knowledge already exists: we need only to have these publicly shared.

3.2 Methods Used

The main methods used to collect data for this study include audio-interviews with individuals and groups as well as key documents and literature related to Indigenous science education.

3.3 Research Site

The research site for this study was limited to the province of Saskatchewan. The project team concentrated on First Nations and Métis schools and community contexts. Several trips were made into the communities throughout the research process for both consultation and actual interviewing.

Sometimes the trips took several days due to geographical distance between the communities. Access to research sites included phone contacts and letters to School Divisions, local Chief and Councils, Local Community Councils, and principals of participating schools. In some situations, approval for access to the communities took longer than anticipated. Some organizations only meet at certain times of the year.

We wanted to be respectful in terms of letting people know what we were doing within their communities. We found out very quickly researcher patience is critical in these contexts. It is the Place that ultimately determines the timing and pace of your study. Once permission was granted to access the research site(s) and ethics clearance was obtained from the University of Regina, we proceeded with the study.

3.4 Research Participants

The research participants included First Nations and Métis teachers, Elders and traditional land users. Geographical distance between communities, budgetary constraints, gravel roads, and all the unexpected perils related to travel in Saskatchewan highways especially the northern part of the province required the project team to try and get a diverse sample of participants.

We did not have the privilege of doing a long-term in-depth study to fully flush out what it means to be teaching Indigenous-based science education from each community. To the project team, this study was about relationship building, the first step in the research process in these contexts. At times, we felt very awkward asking questions at the beginning of the interviews, as we did not go through the relationship-building phase. Still there was an element of *relatedness* with these participants that is hard to explain and which allowed them to share with us so openly. We wanted to keep on interviewing but the costs of going back and forth to these communities can become quite energy draining. Follow-up conversations included in-person interviews, phone calls, and email exchanges.

3.5 Snowball Sampling Method

The snowball sampling method was used to locate research participants. According to Berg (2001), “the basic strategy of snowballing involves first identifying several people with relevant characteristics and interviewing them. These subjects are then asked for the names of other people who possess the same attributes as they do” (p. 33). It was common for the participants in this study to provide the project team with names of other people who might be interested in participating in the study.

3.6 Interviews

The principal source of data for the project was a set of semi-structured conversational interviews with both individuals and focus group participants. In conversational interviews, the researcher and participants are co-participants and co-constructors of knowledge in the research process (Kvale, 1996).

In the early part of the research process, we constructed and piloted a set of interview questions based on the broad research questions guiding the study. We arrived at two sets of interview questions, one set for Elders and traditional land users and another set for teachers and pre-service teachers. At the end of the data collection phase, we ended up with several hundred pages of interview transcriptions. We found that even though we had an interview guide, there were times when the conversations went

off topic to other school and community concerns other than school science. These talks provided a picture of the overall context of our research sites.

Throughout the interviews, we concentrated on key questions with prompts during the interview process in order to solicit feedback and clarity of the responses in relation to emerging themes. Central to conversation interviews is the notion of reflexivity in reference to both spoken and written texts. According to Clandinin and Connelly (2000), the purpose of conversational interviews is to engage in reflective and probing conversations so that a clearer identification of the practical principles guiding teachers can be formulated. They state, “Indeed, there is probing in conversation, in-depth probing, but it is done in situation of mutual trust, listening, and caring for the experience described by the other” (p. 109).

Although the project team used a set of semi-structured focus questions, we were able to ask other questions that were not in the guide as a normal part of responding to the conversations. Copies of the transcriptions were sent to each participant for verification and accuracy of statements. We made sure that we provided opportunities for the Elders to respond back to the transcriptions to ensure accuracy of statements made.

Our role as researchers was to carefully observe and consciously record as many details as possible in relation to the perspectives, experiences and lives of the participants. According to Peltó and Peltó (1978, as quoted in Hampton, 1993), “when the researcher has observed and participated in the event and has command over a considerable portion of the relevant information he or she is in a position to vastly improve the data by systematic checking with key people” (p. 272).

3.7 Convention for Citations

Citations of transcripts in the text of the final report include the coded name of the participant, the sequence of the interview (whether it was interview 1 or 2), and the page number (e.g. KG, 2, 32). Citation of Field notes include: the coded name of the participant, followed by the words ‘Field Notes’, and then the date of the recorded field note (e.g. VG, Field Notes, October 19, 2006).

3.8 Ethical Considerations

This research study began with obtaining approval from the University of Regina ethics review board. Each interview participant was required to sign a consent form prior to the actual interview. The researchers took time to go through the consent form with each participant to ensure they understood the study was all about and what their role would be.

The project team also had a letter for each participant that outlines the parameters, expectations, and purposes of the research so that they were well informed. A condensed biography of the researchers was included in the package as an aid for participants to understand who the researchers were and the purpose of the study. Every effort was taken to follow cultural protocols appropriate to Aboriginal contexts. By following these steps, we were fortunate that none of the participants withdrew from the study after signing the consent forms.

Although anonymity is not always guaranteed in research, interviews were audio-recorded, transcribed, and analyzed using strict confidentiality measures in order to protect the privacy and anonymity of the interviewees. The option to use a pseudonym was given to all participants. The actual full names of

teachers, schools, and communities are not identified in the final text. In small communities where everyone knows each other, people naturally want to find out who you are and what you are doing. In our conversations, we did not identify the names of the participants who we were interviewing only the kind of research that we were doing.

3.9 The Ethics of Conducting Research in Aboriginal Communities

Our project team wanted to ensure that we conducted our research in a way that was respectful to the people and communities we approached. We took the initiative to educate ourselves by reviewing key documents in relation to the ethics of conducting research in Aboriginal communities.

Among these key documents is the Tri-Council Policy Statement (TCPS), which includes the Canadian Institutes of Health Research, the Social Science and Humanities Research Council, and the Natural Sciences and Engineering Research Council. This policy pays particular attention to research involving Aboriginal Peoples. Another key document is The First Nations Regional Longitudinal Health Survey (RHS) by the Assembly of First Nations (AFN) which includes a *Code of Research Ethics* with four fundamental principles that include: ownership, control, access, and possession. These are collectively known as the 'OCAP' principles (Schnarch, 2004).

Aside from TCPS's basic tenet of respecting human dignity, the policy also recognizes that "Aboriginal Peoples have a unique interest in ensuring accurate and informed research concerning their heritage, customs, and community" (TCPS, 2005, 6.2). Aboriginal Peoples have not always been treated with respect and sensitivity by researchers, and their *Indigenous Heritage* has been expropriated. According to the Royal Commission on Aboriginal Peoples Report (1996):

In the past, research concerning Aboriginal peoples has usually been initiated outside the Aboriginal community and carried out by non-Aboriginal personnel. Aboriginal people have had almost no opportunity to correct misinformation or to challenge ethnocentric and racist interpretations. Consequently, the existing body of research, which normally provides a reference point for new research, must be open to reassessment (RCAP, 1996, 5.E).

There are countless examples over a long history of the misappropriation of Indigenous culture and knowledge systems. More recently, Indigenous scientific knowledge and other Indigenous intellectual property has come under threat as they gain credibility among westerners. Brian Schnarch's article (2004) describes these issues in detail and thus serves as a useful starting point for understanding these issues.

In accordance with these policies and concerns, our research project *Learning Indigenous Science from Place* seeks to treat Aboriginal communities with sensitivity and to respect the ownership of their knowledge and other Indigenous Heritage. It is equally important that, as teachers and other members of the educational profession seek to include Indigenous knowledge into a science curriculum, that special attention be accorded to the ownership and copyright of that knowledge (TCPS, 2005).

The principles contained within these key documents apply equally to teachers and schools developing curriculum, lesson plans or course materials that include Indigenous Knowledge Systems. Such individuals and institutions should consider themselves researchers for the purposes of collecting information and abide by the ethical principles that accompany responsible research.

Intellectual Property Rights and Indigenous Heritage

The concern about what amounts to intellectual property rights has been expressed extensively in the literature (see especially Battiste, 1998; Battiste and Henderson, 2000; Tuhiwai Smith, 2002). In many Indigenous societies – including those in Saskatchewan – stories, traditional knowledge, and information have ‘owners’. Getting the approval and permission of these individuals or groups when repeating, disseminating, copying, or teaching this information is necessary, as is acknowledging and citing those sources just as one would cite or reference a published source. It is important that teachers and others in the educational sector consider and abide by these principles when integrating Indigenous knowledge into science curriculum.

Researchers need to be mindful of the intellectual property rights of Indigenous Peoples when conducting research in Aboriginal contexts. Copyright and ownership of Indigenous knowledge must be acknowledged and negotiated before any research is initiated. This includes research for the purposes of developing curriculum and resource materials used for teaching.

Indigenous Heritage refers to the intellectual and cultural property of Indigenous Peoples (Battiste and Henderson, 2000). It is also sometimes referred to as *Indigenous Knowledge*, cultural property, or intellectual property. The term *Indigenous Heritage* refers to all of these without falsely separating the physical from the spiritual, the tangible from the intangible, or the concrete from the abstract. It is also the term adopted by the United Nations in their *Draft Principles and Guidelines on the Protection of the Heritage of Indigenous People* (Battiste and Henderson, 2000; Wiessner and Battiste, 2000).

Indigenous Heritage may come in the form of stories, artwork, designs, symbols, traditional medicinal practices, or knowledge about the land. The *United Nations Principles and Guidelines on the Protection of the Heritage of Indigenous People* defines it in more detail:

The heritage of Indigenous peoples includes all moveable cultural property as defined by the relevant conventions of UNESCO; all kinds of literary and artistic creation such as music, dance, song, ceremonies, symbols and designs, narratives and poetry and all forms of documentation of and by Indigenous peoples; all kinds of scientific, agricultural, technical, medicinal, biodiversity-related and ecological knowledge, including innovations based upon that knowledge, cultigens, remedies, medicines and the use of flora and fauna; human remains; immovable cultural property such as sacred sites of cultural, natural and historical significance and burials (United Nations, 2000, sec. 13).

It is essential that, like any other copyrighted information, this knowledge be used only with consent of the appropriate community representatives or permission of the individual who owns it. In their *Guidelines for Health Research Involving Aboriginal Peoples*, The Canadian Institute of Health Research (CIHR) explains:

Protection of Indigenous knowledge refers to appropriate sharing of knowledge in a way that understands that some knowledge is sacred, that is, involving the Creator, Land, and the Ancestors. This must be interpreted in a manner appropriate to the particular context and community. For example, one community or region may prohibit the sharing of knowledge related to plants; it should not be assumed that the same prohibition will apply to all regions or research contexts (CIHR, 2005, 3.6).

The International Society of Ethnobiology's *Code of Ethics* provides a principle, the *Principle of Acknowledgement and Due Credit*, which emphasizes the importance of referencing sources, including those from Indigenous Peoples:

This principle recognises that Indigenous peoples, traditional societies and local communities must be acknowledged in accordance with their preference and given due credit in all agreed publications and other forms of dissemination for their tangible and intangible contributions to research activities. Co-authorship should be considered when appropriate. Acknowledgement and due credit to Indigenous peoples, traditional societies and local communities extend equally to secondary or downstream uses and applications and researchers will act in good faith to ensure the connections to original sources of knowledge and resources are maintained in the public record (ISE, 2004, sec. 16).

One of the major ethical concerns in research is the use of sacred and spiritual knowledge ways of Indigenous Peoples:

Although sacred knowledge is often held collectively by an Aboriginal community, sacred knowledge may, in some cases, be considered to be held by certain designated individuals and not necessarily the community. For example, some Elders may be keepers of sacred knowledge. Another example of specialized authority occurs when a sacred society (rather than an individual Elder) or a clan is given the responsibility of keeping traditional knowledge. For example, the Blackfoot rely on the "sacred bundles" as the source of authority on important spiritual and cultural matters and the band councils would never presume to interfere with the decisions of a society that is responsible for a sacred bundle and its knowledge. In such cases, a thorough review of values and beliefs will help to clarify for the researcher, the community, and the individual Elder the best way to proceed (CIHR, 2005, sec 1.5.2).

It is important that researchers follow and abide by the protocols and customs, which vary from nation to nation, community to community. It is the responsibility of researchers to find out what the appropriate steps are in accessing, gathering, and using information held sacred by communities. Protocols are basically considered *a right way of doing things*. For example, it is a common protocol to offer Tobacco to Elders for their knowledge. It reinforces the underlying ethic of reciprocity inherent in a worldview of interconnectedness. Researchers need to give back in a mutual way. When research is conducted in a community, something is taken from these contexts – in the form of information, stories, and experiences. Michell (2008) explains this concept further:

As a Cree person, I understood there were proper ways of gathering knowledge according to my cultural teachings. I understood that research often involves taking something from nature. When you take something from nature, balance is disrupted. And when balance is disrupted, there is a need for the restoration of harmony. I understood from my Cree worldview that every aspect of creation is related and that certain protocols are used which respect this interconnectedness and balance (p. 4).

In order to correct this balance, the researcher must offer something back to the individual or community. This might include a gift of tobacco, assistance with chores or household duties, including help with expenses. Reciprocity in community-based research always includes sharing of research outcomes with those involved in the study. It should also include the researcher maintaining good relations long-term with those involved in the study. The exact nature of reciprocity will depend on the cultural expectations and norms of those whom one is conducting research with. In all situations, however, this constitutes a contribution to the individual or community and seeks to redress the

imbalance that research creates. It also acknowledges and respects the interconnectedness and interdependence that exists in the world (Michell, 2007, p. 8).

This concern and respect for Aboriginal communities and the knowledge that comes from these contexts is a principle that is used to guide responsible and ethical research. The First Nations Regional Longitudinal Health Survey (RHS) by the Assembly of First Nations (AFN) details these concerns in its *Code of Research Ethics* in four fundamental principles: ownership, control, access, and possession known collectively as 'OCAP' (Schnarch, 2004). These principles are described as follows:

Ownership: The notion of ownership refers to the relationship of a First Nations community to its cultural knowledge/data/information. The principle states that a community or group owns information collectively in the same way that an individual owns his or her personal information. It is distinct from stewardship or possession (see below).

Control: The aspirations and rights of First Nations to maintain and regain control of all aspects of their lives and institutions include research and information. The principle of "control" asserts that First Nations, their communities and representative bodies are within their rights in seeking to control research and information management processes which impact them. This includes all stages of research projects, and more broadly, research policy, resources, review processes, formulation of conceptual frameworks, data management, and so on.

Access: First Nations people must have access to information and data about themselves and their communities, regardless of where these are currently held. The principle also refers to the right of First Nations communities and organizations to manage and make decisions regarding access to their collective information.

Possession: While "ownership" identifies the relationship between a people and their data in principle, the idea of "possession" or "stewardship" is more literal. Although not a condition of ownership, possession (of data) is a mechanism by which ownership can be asserted and protected. When data owned by one party are in the possession of another, there is a risk of breach or misuse. This is particularly important when trust is lacking between the owner and possessor. (AFN, 2007b)

The four principles above provide a guideline for the ethical collection and use of Indigenous Knowledge Systems and any other form of cultural expression. Although created for First Nations contexts, these principles are applicable to all Aboriginal Peoples and communities, including Métis and Inuit Peoples (Schnarch, 2004, p. 1).

4. DATA ANALYSIS

The data analysis approach the project team employed was based on the broad research questions posed. In the analysis, the project team focused on the overall research project goal which was to investigate how educators and education systems might take up *Place-based* Indigenous science and apply it within the established school science curriculum. More specifically, the analysis is based on answering five central questions:

- What is a First Nations perspective of learning Indigenous science from *Place*?
- What is a Métis perspective of learning Indigenous science from *Place*?
- How can learning from *Place* help create a foundation for a science curriculum that is contextualized to *Place* and to the people of the *Place*?
- How can the perspectives inform teachers of processes and content needed in science curriculum?
- What supports are needed for educators to engage in Indigenous science?

In order to answer the research questions, our project team used the Clue Structure approach to data analysis. The Clue structure method of analyzing the transcript data includes paying attention to and describing the knowledge that emerges from the transcripts as categories that have already been empirically or philosophically established in the literature (Munby, Orpwood & Russel, 1980; Roberts & Russell, 1975).

The Clue Structure approach was used to link the data with the Holistic Lifelong Learning Models that were previously developed by Aboriginal Peoples across Canada. According to Alasuutari (1995), qualitative analysis of interview transcriptions require “paying attention to what is essential in the view of the theoretical framework and the particular questions asked, although even in the same study the material can be perceived from several angles” (p. 13).

The data were analyzed with a search for common patterns and themes as they resonated with the literature and distinct elements found in the Holistic Lifelong Learning Models for First Nations and Métis. The analysis consisted of a triangulation of data that include the literature review, promising practices, responses from the participants, and the Holistic Lifelong Learning Models.

4.1 Holistic Lifelong Learning Models

The Holistic Lifelong Learning Models were used as a guide in the analysis of the findings. The models were initially developed and articulated by First Nations, Métis and Inuit Peoples across Canada. The group consisted of education professionals, community practitioners, researchers and analysts in collaboration with the Aboriginal Learning Knowledge Centre and the Canadian Council of Learning. The models depict the “link between lifelong learning and community well-being, and can be used as a framework for measuring success in lifelong learning for First Nations, Métis, and Inuit peoples” (CCL, 2007b).

The symbols depicted in the models represent a broad framework of complex understandings related to how Aboriginal education is viewed in a holistic way. Each part of the three models represents an aspect

of learning, life, the community, the individual, and their interconnectedness. The First Nations and Métis Models contain a majority of similar thematic concepts, although the physical construct of each Model reflects unique understandings of how learning is influenced. For example, thematic differences include learning about *Health Care* as one of the key concept of Métis learning, while *Clan* and *Ceremonies* are identified as unique to First Nations learning. The First Nations model also includes an emphasis on the four dimensions of learning: spiritual, mental, emotional, and physical. These can be used to guide curriculum unit plans in school science.

First Nations Holistic Lifelong Learning Model

The First Nations Holistic Lifelong Learning Model, depicted by a living tree, represents the relationship between learning and community. The use of this image is meant to represent the importance that learning has in honouring and protecting the earth. It draws on the tenet that life is comprised of relationships: everything is connected in a circular, holistic, and cumulative way; learners are part of these processes and cycles. According to this view, learning is lifelong and experiential. In accordance with this model, learning is a product of the relationship with the land. This model depicts the multi-dimensional and multi-faceted approach to learning in First Nations communities. A full description can be found on the Canadian Council on Learning website (<http://www.ccl-cca.ca/ccl>).

Métis Holistic Lifelong Learning Model

The Métis Holistic Lifelong Learning Model, represented by a living tree within the context of a landscape, represents the relationship between learning and community. Learning is considered part of the *Natural Order* and is an organic, regenerative system. Learning is an aspect of health and well-being, and is understood in the context of *Sacred Act of Living a Good Life* – a view which emphasizes *doing*, *acting* and *experiencing* as ways of learning. Sacred Laws – which are themselves a distinct form of knowledge – govern all relationships. A full description can be found on the Canadian Council on Learning website.

5. RESEARCH FINDINGS

The following research findings are based on thematic categories that resonate with the Holistic Lifelong Learning Models for First Nations and Métis using the Clue Structure approach to analysis. Additional information that falls outside the specific thematic areas, or gap information, is also included.

5.1 Learning Indigenous Science from Place: First Nations Perspectives

SELF

We are all connected and we have to live in harmony with each other (VW, 1. 1).

- Self as an extension of the Natural World
- Cultivating a Holistic Worldview
- Different Worldviews and Interpretations of the Natural World
- Interrelatedness, Interconnectedness, Interdependence
- Focusing on Roles & Responsibilities in Creation
- Relationships within the Natural World

A common thread that weaved through the interviews was an understanding that the self is an extension of the land. Participants felt it was important for students to understand the spiritual orientation First Nations People have in relation to the world around them. According to the participants, although First Nations People are diverse they have a shared worldview in which they see themselves as being interdependent with the rest of creation (TC, 1. 1; KG, 1.1; VW, 1.1). Cultivating a sense of interconnectedness with the environment begins with learning and understanding that the self is an extension of all other entities that depend on one another for survival. All humans are part of the land and the land is a part of us because the Creator's spirit flows through all things. One participant expressed the concept of worldview in the following way,

In many First Nations worldviews, we look at creation as being a sacred event. Having said that, all creation is sacred in its own right and it has a spirit within it. Because that spirit or energy is transferable, we can get energy from each other. We can also look at the earth as being a living, nurturing kind of thing. We can get energy from a tree, an animal, or bird. However, we also have a reciprocal responsibility. Our responsibility is to make sure that the tree will be able to continue to be able to live in the environment, which needs to be able to do those things and do them properly. We thank the tree for giving us food and shelter. (KG, 1. 2)

The participant continued to explain that everything in creation has a role and responsibility to play. It is by understanding these roles and responsibilities that we come to understand who we are and our Place in the universe. First Nations classification systems are expressed in different ways based on this philosophical understanding. The participant explains this concept in the following way,

If there is a hierarchy we [humans] are at the bottom of that list. All the rest of creation is doing what the Creator wants it do. We are the only ones because we have ability to think and reason that also gives us the ability to scheme and to rationalize and to lie to ourselves and to believe that we need all of these other things for us to remain in balance. We have to do that because we are part of that creation and we have to be able to do our part to make sure that all of Creation has the resources available to do its basic function the way the Creator meant it to do. (KG, 1. 2)

First Nations worldviews reinforce a sense of kinship and relationship through the way other entities in Creation are personified as human relatives. Animals for example are treated as if they were a person's closest relative that gives up its life so we humans can live. Respect for this relationship is demonstrated by the use of protocols as shared in the following quote,

We look at the wind for instance as an entity onto itself, we look at the clouds, we look at the spirits, we look at the animals as our relatives. When we hunt animals, we have a sweat or engage in prayer. In our belief system, the animal already knows that they will be giving up their lives for our survival. We are the spirit, when we kill the animal we are part of that spirit. The spirit remains with us. We live in a world of spirits that affect a great deal with what we do and what we think whether we like it or not. (KG, 1. 5)

The participants made it clear there are different worldviews that lead to different perspectives of the natural world. Science teachers and students need to engage in critical dialogue in order to make worldview distinctions that underpin different knowledge systems. One participant expressed this sentiment in the following way,

I think it is really important that we all recognize where we are coming from in terms of our understanding. There are many inexperienced people that talk about or hear about Indian practices and beliefs. We all socialize and we have different experiences and we see different things, but there are times when we come up against information for which we do not have the knowledge or experiential base and it means that we can't process the information that we get or we process and it comes from a different perspective and it's the wrong perspective. (KG, 1. 3)

The participants recognize the challenges science teachers face in relation to incorporating First Nations worldviews and perspectives. The first step teachers can take is to model an open mind in relation to honouring different knowledge perspectives in their science classrooms. One participant spoke about this in the following way,

If you don't understand why Indians do a particular thing, I would ask teachers not to reject it as either impossible but rather to pursue it and simply say, 'I don't understand that', 'I don't understand why', and so 'Let's talk about it, let's discuss it, give me some examples, or whatever', and I am sure at some point you would improve your understanding. But don't make judgments. (KG, 1.3)

Connecting and developing relationships with First Nations Elders and other members of the community is one common way that teachers and students can learn about First Nations knowledge systems in a life long way.

ELDER INVOLVEMENT

There are many Elders some are gifted in education, while others can speak to anything and tell you in a traditional and cultural way. Some are gifted in different ceremonies. So you have to judge which area the Elder is knowledgeable in. You have to speak to them individually in order to find out where they are at and what they can help and talk about. We were totally immersed and surrounded in a scientific way with all we know in a traditional way but you have to really think about it because we may not know it is scientific yet, but it has already happened, said, and done. (VG, 1.4)

- Elder involvement in curriculum development
- Organizing a Pool of Elders
- Diversity of Elder Knowledge & Skills
- Respecting Female & Male Elder Perspectives in Balance
- Working with Elder Helpers
- Using Protocols when Accessing Elders
- Building Relationships with Elders
- Identifying Themes for Elders to Consider

A common theme expressed by participants was the importance of Elder involvement in school science. In traditional times, Elders played a central role in passing on First Nations knowledge systems and perspectives. Elders can fulfill this responsibility by taking part in the planning, development, implementation, and evaluation of science curriculum that incorporates First Nations perspectives.

One participant said, “I think [the Elders] should go hand and hand with the teachers. I think there should be Elders that go to these schools and talk not only to the students but also to the teachers. They should have Elders talking to them because they don’t know us and our people” (IP, 1. 1).

The participants alluded to the importance of science teachers modeling and fostering a sense of respect for Elders and their knowledge perspectives among youth.

The protocol was to always maintain respect for Elders. That was how we were brought up as children. Respect the Elders. Listen to what they have to say. Listen and don’t laugh at him. Don’t make fun of them. Having respect for your Elders was the number one teaching. Today, we don’t have that. Somewhere along the way, it disappeared. We now have young people laughing at old people. No respect whatsoever. We lost that. (TC, 1. 10)

Elders in First Nations communities are highly respected for the role they play in passing on First Nations culture, languages, values, ceremonies, songs, dances, and knowledge systems. When one of these

Elders pass on, life long wisdom and knowledge goes with them. One participant pointed out the urgency of connecting with First Nations Elders in the following way.

When an Elder passes on, it is like a library closing because the knowledge that person has goes along with them. That is why young people like you pump these old people for information, get as much information from them as you can so you can lose it later. There is nothing saying that you cannot use that knowledge. It is given to you to use. There are some Elders that I know who do not look at it that way. They think their songs and everything else is theirs. They don't share, but that's not the way to be because you have to share your information. (IP, 1. 2)

There are First Nations ways of knowing that are private and cannot be openly shared with others. However, one strategy is to identify and organize a pool of First Nations Elders and other knowledge keepers who possess a diversity of knowledge and skill sets. This resource list can then be used to learn school science concepts from different perspectives.

I am saying that there should be a pool of Elders. Gather names of Elders and have them available for the schools. Sometimes you will get an Elder that gives all his/her time, they will stay around that school to help out. It is important to let teachers and students know how we live and all of things we do. A lot of our young people live in the city, are born in the city, and raised in the city and they don't know anything about the way we live. (IP, 1. 1)

In the past several decades, many First Nations People have migrated from their reserve communities into rural and urban settings in search of better life circumstances. With these geographical moves, they leave behind their connection to the land, their cultural support systems and most notably the Elders. First Nations youth that live in cities require these connections for cultural continuity. Elders and other community members are gifted in unique and blended ways, based on the places from which they originate. First Nations knowledge systems are rooted in multiple domains. One participant spoke about the diversity of knowledge systems that many Elders possess.

Elders have their own specialties. Some are historians in their own right. Some have a particular understanding of the language, and teachings that underpin place names. Some people are pipe carriers. Some people are medicine men and healers. Many have an understanding of the history of their particular group, where they come from, why they are where they are. There are some who are good at finding medicines, what they are used for, how to assess people with what kind of medicine they need. And there are other specialties as well. These have to do with food gathering, trapping, and hunting. All of these are particular applications of knowledge depending on where their groups are situated. These are all survival techniques that have been defined to varying extents by different groups. (KG, 1.1)

Although teachers may have predetermined objectives to meet in relation to incorporating Western science concepts, the same cannot be said for incorporating First Nations perspectives. Each community and Place will determine what knowledge is appropriate for school science content. Elders also need to be involved in their own way and so consultation and relationship building is important. Sometimes Elders may suggest activities and the context in which the learning will take place. When the question was asked about Elder involvement, one participant had this to say,

They should, but in their own way. Very often Elders are called in to do disciplinary kind of things and that's not really what they really want to do. What they really want the children and grandchildren to be is to do things like learn their language and their relationships within that community, who they're related to and the kind of respect that they should show each other and their history. Those are the kind of things that Elders seem most interested in teaching young children. (KG, 1.1)

One participant talked about the importance of incorporating both male and female perspectives in school science. First Nations women have their own knowledge ways that must be honoured and respected alongside Western science perspectives. The participant highlighted the importance of including gender balance in school science perspectives in the following way,

I think they should be approaching Elders both the females and males because the women too have a lot of knowledge. They've obtained a lot of knowledge from their mothers and grandmothers. They were taught properly. The women were very much involved in the development of children, their families, communities, and their entire tribe. They would often gather together to decide what was best for their tribe. (TC, 1.10)

One participant suggested the inclusion of *Elder Helpers* in school science because they work very closely with Elders and are themselves unique in their knowledge ways. "They are our future Elders. That's that way we look at it. Some people say, 'how do you become an Elder?' That's the way you get to be an Elder and learn the ways of Elders by working with them. Then you get the knowledge from there and that knowledge can be given to anybody" (IP, 1. 2).

Science teachers and students must be aware there are proper protocols when approaching Elders for their knowledge. Protocols are expressed in different ways depending on the culture. However, a common theme that runs through First Nations cultures is the understanding that there are proper protocols involved when interacting with any aspect of the natural world. Many of the participants talked about offering Elders a pouch of Tobacco and a small gift. The act of offering Tobacco reinforces the ethic of reciprocity in First Nations contexts. While there are many of ways of demonstrating *the idea of giving back* for something that is taken, one participant said, "Tobacco is the number one protocol" (WL, 1. 2).

Elders were quick to point out their knowledge perspectives are not for sale and making money from their cultural teachings is strictly taboo. However, they live in a contemporary society in which their expenses must never be overlooked. For example if they drive from their home communities or camps to participate in school activities, they need coverage for their gas expenses. Elders need to be compensated well and appreciated for the knowledge they are sharing with others and "that way the Elder does not feel they are being taken for granted" (WL, 1. 2). One participant said sometimes Elders have to travel from their reserves and so they need money for gas as well as their meals and sometimes accommodation. Many Elders have to look after their families and grandchildren with very limited resources and sometimes with no supplemental income. When we take them away from their families, we take them away from feeding their families. One Elder in the study had this to say, "Why give me a blanket? I can't eat that" (VW, 1. 11).

One participant talked about *right ways* of working with Elders. He said, "There are right ways of talking to anybody including Elders". Teachers and students who are planning to approach Elders need to do so

with great respect using “words and perspectives that give the impression that the Elders are being respected” (WL, 1. 2). The participants pointed out the importance of being genuine and establishing a relationship with Elders as the first step. Learning First Nations knowledge perspectives has a heavy emphasis on process. The answers may not always come all at once. One participant stressed the importance of visiting Elders several times before asking them about traditional knowledge (VG, 1, 5). She said,

It does not take one visit with instant answers. You have to give Elders an idea of what you want from them. For example, you helped me prepare for this interview by giving me the topic and questions ahead of time. I gave them a lot of thought and prayed about the questions because I was going to speak about traditional ways. And some of these ways are very sacred and in order to respect that, I prayed and understood that it would be okay because it is going to help children. (VG, 1. 5)

Sometimes when an Elder is interviewed they expect the Elders to give them the answers right then and there. It should not be this way. It takes about four visits. Offer Tobacco, get to know each other and maybe the second visit tell them what you want and how it will be used for school. They will also find out whether that is the Elder who can speak in your classroom. Maybe the third visit will be the interview. Sometimes Elders knowledge does not come right away...and so you have to give them the time, room, and space to think. Also, the more they see you, there will be a trust relationship and an understanding that you are a nice person and easy to talk to. And always remember never to hurry up an Elder. Make sure you take the time to get to know them and build trust then they will speak openly to you. So that is the way to approach an Elder. (VG, 1. 5)

One of the ways to approach Elders for their perspectives in school science is to identify themes that are closely aligned with the curriculum units and objectives. This may require approaching several Elders or other knowledge keepers in the community. One participant had this to say,

I think a science teacher has to interview Elders on different themes. Once these themes are identified, then offer the Elder Tobacco and ask them what they think about what you are going to teach. That would help the teacher realize which Elder understands. They will tell you whether they know something or not. Then the teacher can always go to another Elder. In the process of doing that, the science teacher should bring with them Tobacco and a little gift thanking them for trying to help. And seek out another Elder that is knowledgeable and understanding. (VG, 1. 4)

Elder teachings bring a spiritual orientation to the natural world, a dimension that is missing from most Western science perspectives that depend on notions of objectivity, disconnectedness, and emotional distance. Being alienated from others and the natural world is something that is unheard of in many First Nation cultures, as all must live in harmony for the health and wellbeing of future generations.

SPIRITUAL

I think if it's taught both ways to the children, they will be able to understand our traditional way plus the mainstream way of science. And I think it will hold their interest. You really have to think about and understand traditional ways

and your culture. It sort of keeps you safe because you know it is coming from a sacred perspective. When I was young my grandparents used to talk about these things and how we should rely on that. (KG, 1. 2)

- Spirituality as a Way of Life
- Spirituality and Ceremonies as a Source of Knowledge
- Consulting with Ceremonial keepers
- Seasonal Ceremonies Honouring Renewal of Earth
- Clearing & Preparing the Mind through Ceremony
- Honouring Private Knowledge
- Honouring Women's Protocols

Spirituality is a way of life for First Nations People and as such is an inseparable part of school science. It is important that teachers and students explore the difference between spirituality and religion, as these are two different concepts that often cause a lot of confusion. Quite often when teachers hear about Aboriginal content, they automatically assume spiritual ceremonies. Spirituality as a way of life is more than engaging in healing practices, it is about learning a total philosophy of life long health and well being. Nevertheless, in order to incorporate spirituality in school science, teachers need to consult with Elders that are gifted with traditional ceremonial knowledge.

One participant spoke about First Nations spirituality as being inseparable from languages. He said, "If you are the spiritual type, it is important to know the language". From his perspective, people have drifted away from spirituality and many Elders with this knowledge are passing on without being able to share what they know using their own languages. He said "what is wrong with spirituality in our lives? You have a spirit and I have a spirit, what is wrong with that? Are we afraid? Otherwise it won't be complete without that spiritual aspect" (WL, 1. 3). He went on to talk about the loss of spirituality in many First Nation communities in the following way "...we are lucky to have some ceremonial people and I could call them Elders because they know lots regarding the spiritual world and ceremonies. Not every community does, some have been converted to European religions. I said some, not all" (WL, 1. 4)

All of the participants spoke passionately about First Nations spirituality and ceremonies as a way of life and most importantly as fundamental sources of knowledge. In many First Nations belief systems, the physical world and the spirit world are not separate as they are in Western science. One participant said, "We say that ceremonies belong to the people, which means that when the people come with that energy, which is the spirit that I talked about earlier, we bring that to a ceremony, and it re-energizes that ceremony, so it can be done another time" (KG, 1. 3). He went on to explain, "When we are talking about ways of knowing, we say that we are not only getting messages from natural things, but we also say that the people who have gone into the spirit world are able to help us, guide us, and give us wisdom if we beseech them in the proper way " (KG, 1. 4). With this teaching in mind, it raises the question of whether or not traditional knowledge is ever lost or whether or not it remains to be rediscovered through the use of proper protocols and ceremonies.

Teaching and incorporating First Nations perspectives in school science requires mental as well as spiritual preparation. One participant talked about preparing to teach and how he does this through spirituality and prayer. He shared this way of preparing to teach in the following way,

Before I teach, I pray. I pray that I will be given the right words, thought patterns, so that people will understand and that I will not offend anyone and that I will be able to transfer knowledge in a way that is efficient and meaningful. I put my life in the hands of someone else, a high power. I have a great deal of faith in that. And if you ask what I am doing next Tuesday, I don't know. I don't know where I will go. I follow my pipe. Spirituality is the essence of our connectedness. We get energy from other places, the spirit places, other people, and we recognize that there are things that affect our lives that we have very little control. (KG, 1. 5)

Another participant talked about the importance of *clearing the mind* through prayer, smudging, and engaging in ceremony as a way to prepare to receive traditional knowledge. She said that “each part of our body is sacred and that there are ceremonies that we do for the mind to help students understand. You have to keep in mind that we do our prayers and ceremonies to go along with whatever we are doing and learning. Sometimes when we lack that we get lost and don't have guidance” (VG, 1. 5). She shared her own learning experiences in the following way:

I totally respect the way my grandmother passed on her wisdom and knowledge with me. I used to sit with her on the floor and she would smudge me all over, pray, and smudge herself. She used to say, ‘the reason I did that my grandchild is when we pray together, you need to get all of the negative thoughts out of your mind, maybe you got up in a grouchy mood, or are angry, or you said something to someone in a foul mood that you were in. Or maybe you are thinking of something bad, or did something last night. So we smudge, pray, and ask our grandfathers to forgive you for all those negative things you've done, said, or thought about’. She said that way my mind was clear and I was able to absorb more of her teachings that stayed with me in my mind and my heart. That is the way we prepared to learn our traditional way or method. (VG, 1. 3)

She continued sharing her grandmother's words of wisdom “...my grandmother used to say you cannot learn by thinking negative things, or carry negativity in your heart. Learning does not work that way. You have to be very positive mentally, emotionally, and spiritually. That way you go to school happy. That was her way of helping me learn our traditional way of life and language” (VG, 1. 3).

One participant talked about the importance of focusing on seasonal ceremonies and teaching students about renewal in the natural world. For example, in the spring, many First Nations People engage in ceremonies related to growth and renewal of the earth. She said focusing on the growth of plants is similar to focusing on beans that children grow inside the classroom. However, she said, *from our traditional [Dakota] perspective, we look at it differently [with emphasis]*. For example, in the spring-time, prayers and ceremonies are performed that acknowledge new growth and renewal of Mother Earth. In addition, people put up a feast and “we pray for the continued health and growth of spring plants. To me that is traditional science and we assist in the growth of the plants, herbs, whatever, it's the new growth of things in the spring-time” (VG, 1. 1).

All of the participants spoke about different types of First Nations knowledge some of which are private and cannot be shared. One participant spoke about private knowledge in the following way,

There is more in-depth knowledge than what I am sharing with you here. I cannot speak about it, because it is too sacred. I have learned, heard, and seen them, but they are mine to keep, so I do not speak about that. You have to learn to respect that” and “the other thing is that we get our knowledge by not writing it down, but by hearing and listening. Always ask the Elder if you can write it down or if you want to use the knowledge in a certain way...be prepared as some Elders will so no. (VG, 1. 7)

One participant brought up the importance of learning to respect women’s protocols around ceremonies and the use of ceremonial tools during *moon time*. According to one belief, the proper protocol during one’s monthly menstrual cycle is to stay away from ceremonial and hunting tools and not step over them. Women go through a natural cleansing cycle in their bodies and are deemed to carry a lot of energies during this time. While there are many teachings surrounding this topic depending on cultural traditions, one participant explained it as a sign of respect in the quote below,

That’s how much respect they had for the various things that they used for their survival, spiritual lodges, prayers, songs, drums, their rattles and everything else they used. They looked after them really good. They never left anything on the ground. They hung up everything on the wall or tied them to a tree so that no one would step over them. Even hunting tools like guns, bow and arrows that the hunter used for hunting. (TC, 1. 3-4)

It was clear from the responses of the participants that teachers must strive to connect school science to the multiple knowledge domains inherent in the traditional life style of First Nations People as a way to make learning more relevant and meaningful for all learners.

CULTURE AND TRADITIONS

- Traditional Cultural Life Style (Trapping, Hunting, Fishing, Gathering)
- First Nations Knowledge Systems have Validity
- Mid Wives and their Medicinal Knowledge Ways
- Preservation of First Nations Knowledge Systems
- Intellectual Property Rights
- Ways of Using First Nations Knowledge
- Importance of using Traditional Protocols
- Student-led research projects on First Nations Knowledge
- Storytelling as a way of passing on First Nations Knowledge
- Hunting Stories

- Incorporating Humour in the Science Classroom
- Incorporating Feasts in the Science Classroom
- Oral Speaking Skills
- Sharing Cultural Experiences

Traditional Cultural Lifestyle of First Nations People

One of the common strategies identified by the participants is to develop school science curriculum that revolves around the traditional cultural lifestyle of First Nations People. It is important to connect school science with a bit of history and the sustainable ways First Nations People used to survive. First Nations People used different types of technologies that revolved around traditional seasonal cycles usually in rhythm with animal and plant cycles of a certain place. Out of these cycles of existence, they developed a worldview in which they saw themselves as intricate part of nature.

One participant introduced himself as a person of Saulteaux heritage whose people migrated West during the fur trade era. He said, they were originally a tribe of Ojibway People who broke away in order to escape the increasing encroachment of European settlers. They wanted “to be free as possible so they could continue their lifestyle of hunting, fishing, trapping, and gathering berries. That was their lifestyle. That is how they made a living and they were very close to nature” (TC, 1. 1).

First Nations Knowledge Systems Have Validity

One participant talked about First Nations Knowledge systems as having their own *content validity* based on long-term survival in particular places they occupy. He recommends that science teachers embrace and foster a sense of open mindedness in relation to incorporating different perspectives in school science. He said,

Teachers and students need to understand and unlearn that Western Science is the only way to look at the environment. From a First Nations point of view, the way we look at the environment around us is very different we know that. And I think we are not asking Western science teachers to embrace our belief system, but at least to acknowledge that there are other ways of knowing, other than what they are used to. First Nations knowledge ways are a product of a valid human experience in a relatively similar environment that has been developed over a long period of time and for this reason, it is valid in its own right. Validity has to do with the fact that First Nations People are still here today. We have survived using our own knowledge systems. (KG, 1. 2)

The idea is to foster a respect for different knowledge perspectives in school science and thereby creating cultural bridges that have the potential to enhance learning in students regardless of cultural background. The ability to blend these multiple perspectives in new and creative ways for the health and wellbeing of all people rests with the new generation of learners.

Mid Wives and Their Medicinal Knowledge Ways

One of the participants talked about the importance of incorporating the knowledge of traditional mid-wives in school science. Women have their own ways of knowing. One of these streams of knowledge has to do with the role and responsibilities associated with traditional mid-wifery. He said,

There was no such thing as hospitals in those days. Everybody had newborns at home. They had mid wives. The grandmother would be the one to deliver the child. The Grandmother would be the one to teach the daughter so that when she would come of age she would be the one to deliver. There were certain things that they used to deliver babies and how to make the baby come out earlier. They had medicine for all that. They would give the pregnant woman some liquid to drink so the individual would not suffer too much from pain. They had ways and means of easing the birth of a child. (TC, 1. 3)

Traditional mid-wives had knowledge of herbs, plants, nutrition, gynecology, and obstetrics. They counselled women about pre-natal care, natural childbirth, breastfeeding, and healthy ways of nurturing children. In order to incorporate this knowledge base, teachers must consult very closely with female members of the community especially female Elders who have special knowledge about Women's ways of knowing.

Preservation of Indigenous Knowledge

Many of the participants talked about the importance of preserving First Nations knowledge systems by researching, documenting, and recording the perspectives of Elders. One participant had this to say,

A lot of times you will get an Elder that does not want you to record nothing don't want you to write anything down. But when you write it down, it is there. You have it. If you don't write it down, then we will forget. It is gone with the Elder when he passes on. So much knowledge has been lost. Even medicine people have lost a lot of their knowledge. We used to have medicine to heal our own people. Nowadays they don't know enough to be able to heal one another. (IP, 1. 2)

Each community will need to develop research protocols and frameworks appropriate to their culture and community context. More importantly, the duty to consult and issues of intellectual property rights must be dealt with before any research takes place on the traditional territories of First Nations People.

Intellectual Property Rights and First Nations Knowledge

One of the participants highlighted the importance of teaching students intellectual property rights and patents in relation to sharing First Nations knowledge systems. He shared the following story,

I will tell you about passing on stuff. We had a meeting one time a couple of years ago in Saskatoon. That time, they called as many Elders as they could. I was included in that group. They told us not to reveal any of our medicines because they said that there are so many people that want to get these medicines and use a patent on them and so nobody else can use it after. There was one that they talked about who tried to patent the Sweat lodge. And it is those things that are really scary when they do that. But apparently that is what people do so we have to be careful whom you are passing on that stuff onto. Our people pass it on to our people as much as they can. Whatever I know is open to everybody. But when you get something like that, then it's kind of touchy. (IP, 1. 3)

The issue of intellectual property rights in relation to First Nations cultural knowledge is the focus of increasing attention among communities who share a history with intellectual piracy under colonial oppression. The history of Western science is not immune to the violation of ethics that underpin First Nations ways of gathering and sharing information.

Ways of Using First Nations Knowledge

One of participant cautions science teachers that they teach only that information which they feel comfortable. It is important that teachers do not go any further than what Elders teach them. The idea is to focus on the core content passed on by Elders.

The things Elders have given them are free to use, but not to go any further than what they have been told. I think that way they'll be able to do their teaching in a good way. But when you start going to Elders and pumping them for information, we have people that will do anything for money. Sometimes they'll give some of their black secrets with them and scientists start working on that. You shouldn't be bothering that kind of stuff. Just teach the stuff that Elders tell you. (IP, 1. 8)

There are proper ways of passing on different types of knowledge. Some are practical day-to-day survival skills and some are only shared at different times of the year for certain reasons. Many Trickster stories for example are shared only in the wintertime when people spend a lot of time indoors usually in the evening when the mind begins to enter the dream world. Teaching and learning First Nations knowledge systems is a life long endeavour that must be lived and experienced for prolonged periods of time in a particular place.

One participant spoke about the importance of young people learning directly from the Elders to bring some balance in their development and experiences. He said there is so much focus on book learning and the mental dimension in the curriculum. Elders in the community are often forgotten in the learning process and are often used for token prayer duties. It is not uncommon then that many will not share with others. He states "...We have all these books and that's what our young people are learning. They don't learn anything from the Indian people. My gosh, if books were written by our Elders, we would have lots of information for them but some Elders withhold what they have and won't tell anybody" (IP, 1. 8).

Student-Led Research Projects on First Nations Knowledge

One participant recommended that students be given opportunities to engage in guided research projects that connect them with their own Elders. Through these interactions, youth will learn valuable knowledge and proper ways of thinking, behaving, and making decisions based on a worldview of interdependence and respect.

I feel that students should go out and get that information because there is nothing written down. So when a student wants to write something about herbs or something like that, they need to go and see an Elder. And they need to make it right by giving them Tobacco and talking to them in the right way. Same thing with these science people, they need to take the time to go and see the Elders in a good way. Otherwise twenty years from now we'll still be in the same boat we're in now. (IP, 1. 8)

Building research capacity is a central focus in many First Nations communities especially in the areas of health and education. Exposing science students to both qualitative and quantitative as well as First Nations methodologies helps to fulfill a major aspect of learning to do research in post-colonial contexts.

Storytelling as A Way of Passing on First Nations Knowledge

Many of the participants talked about incorporating stories and storytelling as a way of passing on First Nations Knowledge. Storytelling is a traditional methodology in many First Nations contexts. The stories themselves are knowledge repositories as the languages and words that are used to convey them contain complex cultural teachings. Elders and Medicine people possess diverse knowledge perspectives in First Nation communities. Not all of them work with plants. Some are involved in ceremonies. Some are pipe carriers. Some of them work with the mind and stories. One participant has this to say about storytellers,

Storytellers are like doctors themselves because you listen to that person tell that story and you start to feel comfortable. It puts you in a different world altogether when you finish listening to the storyteller. Storytelling is a form of medicine. It's a gift that has been give to some people. When a person tells these stories, there is laughter. One person I know is Don Burnstick. He can talk to you, teach you, and also make you laugh. We had him in Saskatoon at Cedar Lodge. He came there, not as a comedian. He came as a doctor, a lecturer. He had a way of talking to people. And those kids, you could hear a pin drop. He would tell a funny story every once in awhile. There are those people who have that gift. To bring people in and out of reality and that's the kind of people you need and there's not very many of those people. There used to be a lot, but now it's dying off. (IP, 1. 5)

Hunting stories offer one avenue that science teachers can use in school science. Hunting stories contain valuable First Nations knowledge pertaining to conservation and sustainable ways of being and doing things. Trappers and other traditional land users have a considerable amount of knowledge in relation to the natural world and in particular the habitats and animals they hunt for existence.

The person that is a hunter knows the animal that is being hunted and that is the way he is able to do what he does. A trapper knows the area that he wants to trap. After a hunter has made a kill, they like to go back and talk about it because it gives them that same feeling. Every time he tells that story, the feelings come back to him. That is what he is offering to the people. He teaches respect for the animal by leaving Tobacco and sometimes a cloth. This is for the animal that has given its body to this man so he can survive. (IP, 1. 6)

According to this participant, hunting stories are expressed in different ways. For example hunting stories can come in the form of traditional song and dance all of which reinforce close relationships with the natural world. The participant offered the following example.

You will see at a Pow Wow event when they are dancing. When they do the Sneak Up dance. You know that guy is hunting and we have all kinds of ways of telling those stories. Those are the kind of things people are interested in, you know they get that feeling from listening to a hunter telling how he done it. There are so many things. I often used to listen to my dad talk. He was a hunter. I used to listen and I learned how

to hunt by just listening to him. He taught me how to trap and all of these things that we don't use anymore. (IP, p. 6)

While stories are a fundamental source of knowledge in First Nations families and communities, another domain of knowledge is from the realm of dreams, intuition, creativity, and vision.

Dreams as a Source of Knowledge

One of the participants introduced the importance of dreams and dreaming as a fundamental source of knowledge in First Nations cultures. In traditional times, young adolescents would be go out into an isolated natural setting to undergo a period of guided fasting, prayer, and vision questing. From these experiences, young people learned their lifelong role and responsibilities. He explained this type of knowledge in the quote below.

Dreams to us are like a window into a different world and we can get many things. We can develop ways to be interactive in our dreams and that is where the information comes from. Many of us have dreams and say somebody was there, but they didn't speak to us. For us, when we have a dream about somebody, could be anybody that has gone into the spirit world, we say that person wants to tell us something, or teach us something, but when they come in our dreams and don't say anything, don't share anything, and don't show anything, it means that we ourselves are not ready to receive whatever messages they have. (KG, 1. 4)

Visualization and art activities that involve symbols can be incorporated to help students express their dreams and connections to animals, plants, and other aspects of the natural world. Students can also explore and conduct research in relation to scientists who have made scientific discoveries based on what appeared in their dreams or the insights gained after having had flashes of intuition.

Incorporating Humour in the Science Classroom

One participant brought up the importance of striking a balance between serious academic learning and the use of humour and fun in school science. He explained that many teachers do not always understand there are different ways of passing on knowledge including the use of humour. He said, "Some elders like to have fun". However, he cautioned, "You can have fun, but make sure it is kept at an affectionate level". His advice to teachers is to "include humour as an intricate part of the introduction" and goes on to say "...now that we've had a laugh or two, now I am really going to talk about it in a non-condescending way" (WL, 1. 2).

Teachers role model the value of humility when they incorporate humour in science activities. Humour and fun are important in building relationships with students. He said, "Never down-grade your humanness. You are human and so don't hide behind the cloak for trying to be proper or don't be afraid of being laughed at. The kids will respect you. It has to do with respect and how you earn the respect of the children or your peers" (WL, 1. 6).

Incorporating Feasts in School Science

One participant talked about incorporating feasts as one avenue in learning about First Nations culture and traditional values. Traditional values are used to guide all thinking, behaviour, and decision making

in First Nations contexts. Traditional values are also the basis of all relationships. He said “have a feast in the gym and have band members mingle with the students. I find that feasts are good. All teachers, especially non-native teachers need to know about the culture in this way” (WL, 1. 4).

There are many traditional teachings that are reinforced in a feast. Elders are also given an opportunity to fulfill their responsibilities by passing on what they know to young people in these community events. He explained, “Maybe they will hear it [the teachings] ...a hundred a times...before it means something but as long as they are having fun and someone is paying attention to them that matters”. While he shared the importance of using feasts, there was an element of seriousness to his advice that had to do with reinforcing the value of equality, kinship relationships and community building by sharing food with others “...that’s the main one where there is food...Elders, parents, teachers and children gathering together. About three years ago, the Chief of FSIN came and ate like a regular Indian [Laughs]. It is very important”. The following statement sums up his perspective: “It is vitally important to the community to be a community”. (WL, 1. 4)

At the school science level, teachers and community members can also set up field trips to hunting sites where they will learn how the feast is an intricate part of the whole hunting cycle beginning with the dreaming, the knowledge of animal habitats and ways of honouring the animal after it has been killed and finally the rituals involved in the actual feast where consumption links the animal with the human in an never-ending cycle of transformation and change.

Oral Speaking Skills in the Science Classroom

One participant talked about the importance of incorporating and reinforcing oral speaking skills in school science. In traditional times, First Nations knowledge systems were passed on orally. Many First Nations people were gifted orators. He said, “long ago we had very good orators that got up and spoke. Let’s say you weren’t well spoken so you would call one of those speakers to convene” and that “there were always one or two people that had that role and got up and spoke to the people” (WL, 1. 5). Young people listened and observed these role models, and many became skilled speakers themselves.

He continued to share the history of traditional orators in the following way, “I think when I look back on it, they were more gifted than today because there was a very serious need for their kind of skills whereas today we have newsletters, radio, and televisions” (WL, 1. 5). Many traditional orators served to unify the community by the way they talked and shared. He explained, “When you go to a funeral...you have someone that can speak in those ways. They feel part of the whole process. Nobody speaks and everyone is quiet. People who feel disconnected can be unified by a good speaker...that is a gift in itself” (WL, 1. 5). And once the event is over and they have exercised their role, traditional orators “resume their place” as regular community members.

Learning to speak about the results of a science research project in a public forum can teach valuable skills related to the dissemination of knowledge. Students can learn creative ways of presenting First Nations knowledge systems using complex symbols that are linked to the natural world. Other ways include presentations at local, province or nation wide science fairs that focus on First Nations knowledge systems and Western science.

Sharing Cultural Experiences

All participants talked about the need to share cultural experiences in school science as a way to promote respect, tolerance, and compassion for one another's perspectives. It is important to teach students that people may not always agree with one another based on their worldview orientations. What may seem logical from one worldview may seem illogical in another worldview. One participant talked about the importance of science teachers sharing their own cultural background experiences and knowledge with students as a way to breakdown cultural barriers (WL, 1. 1.).

Exploring and learning about the local knowledge of First Nation communities can expand to include the knowledge systems of other Indigenous groups at the national and international levels. Through cross-cultural research activities, students will enhance their scientific literacy skills by learning the perspectives of diverse relatives that share the natural world.

NATURAL WORLD

In traditional times, we had to live with nature. You had to respect it because you are part of the land. Humans are only a little speck. We will never be greater than all these other things. Western science does not respect anything. They take the herbs and take the logs, and a lot of times without our consent. They are just there to make money. We grieve over these losses because they are disappearing rapidly now more than ever. That's why the weather is changing.
(VW, 1. 2)

- Multiple Domains of First Nations Knowledge
- Focus on Animals according to Place
- Traditional Medicines and School Science
 - Contemporary uses of Traditional Medicines
 - Access to Traditional Medicines
 - Threats to Traditional Medicines
 - Incorporating Stories of Traditional Medicines
- Traditional relationships with the Environment
- Traditional Ethics & Ethical Conduct of Animals & Plants
- Incorporating Environmental Issues
 - Resource Extraction Activities
- Science Camps and *On the Land* Experiential Activities
- Observations of the Natural World
- Four Elements – Water, Wind, Fire, Earth

- Traditional Seasonal Cycles, Weather Patterns, Astronomy
- Prehistoric Animal Stories

Multiple Domains of First Nations Knowledge

First Nations perspectives and knowledge systems emerge from multiple domains. Some are rooted in the natural world. In the following passage, one participant links certain types of knowledge with particular practices tied to certain places of origin.

Science teachers should be approaching those people within the community that have expertise or knowledge about something whether this is about trapping, food gathering, and somebody who is a good hunter. All of these people have knowledge within that area in which they live, and how they connect with it, how they live in harmony within that area and recognize that parts of that area are sacred for that particular productivity for different items or reasons, and bear in mind that these people live within that land as their Mother and they know. And there is a particular feeling that happens when you look at the land as your Mother. You have this view in your mind as you are walking in the bush or sitting on a hill and just feeling that energy that comes with that. So there is that kind of interaction that science teachers should know about and incorporate. This will not take anything away from Western science, it is going to increase and improve the ability of those young people who live in and appreciate why they live in that area of the world. (KG, 1. 3)

The participant explained that First Nations ways of knowing are tied to geographical differences with particular relationships with certain animals. These can be used for curriculum purposes as a starting base in exploring the diversity of life in particular ecosystems.

Some people live next to lakes, mountains, plains, northern tundra, etc. All of these places mean different things to people that live in that particular area. First Nations people also have specific cultural symbols and heroes tied to these places. For example in Dakota culture, the buffalo and eagle are the main messengers in terms of carrying beseechments to the Creator and back. And for the Dene in the north, the wolf and caribou, and for the West Coast people, they often talk about the raven. In the prairies, we don't have a particular relationship to the Giraffe, Elephant, or Lion because we are not familiar with them. These are the experiences of First Nations People within these environments within which they live. This is how they interpret all of that which is in these environments. (KG, 1. 6)

Stories of key animals and plants that occupy a particular place can be used to enhance school science learning while reinforcing the cultural heritage of First Nations People.

Focus On Plants and Animals According To Place

Another participant talked about the importance of linking school science with traditional knowledge related to plants and animals that occupy a particular place. First Nations People interacted with certain places for long periods of time. Their observations of the natural world were key to their survival. Students can be taught to sharpen their observational skills through prolonged periods of interaction

with the land. He said it took years to master a lot of the knowledge and people never wrote anything down.

They studied the plants. They had to study the plants because that's where they got their medicines. They studied the animals. If they killed an animal, they believed the Creator granted it to them. They just didn't kill it and butcher it. They used to have some sort of meditation. They would pray and thank the Creator and animal for giving itself to sustain their families. There were procedures as to how this was done. If they killed a moose, a deer, or an elk, there were certain procedures that they went through after they had skinned it. (TC, 1. 2)

He went on to explain that First Nations People made use of everything that was born out of Mother Earth. Nothing was wasted. Conservation skills were fostered and cultivated from a very young age. He said, "They call it Mother Earth which provides us with all our needs in order for us to live in this world. They used the various trees to sustain their livelihood. Take the maple trees for example. They used to tap the maple trees in the early spring so they could make their maple sugar. Maple sugar was used for very important feasts and lodges" (TC, 1. 2).

Traditional Medicines and School Science

One participant pointed out the importance of using Traditional Medicines with extreme caution and care. He shared his experience with using Traditional medicine for his diabetes in the following way,

I am a diabetic and when I took it, my blood sugar went right down to about four point something and I was shaking. So I am worried about giving that information out. However, if that medicine was refined and made so that someone could use it a little at a time, then I think it would be good. You see, in the Indian world, our nation, that is something that is really needed. But when it comes down to say, knowing how to use it, if someone passes on knowledge on how to use it, then no one will get into trouble. That is some of the kind of stuff that is really touchy. And so I would like to give that to science, so they could use it for our use. (IP, 1. 3)

Science teachers can guide dialogue and exploration about contemporary threats to traditional plants and medicines. One of the biggest threats to traditional medicines has been the use of chemicals in the farming industry for example. He said, "I would like science to know what we have out there. I would like them to know because more and more chemicals are being used by some farmers and by doing this, they are killing off the medicines. A lot of the medicines we used over fifty years ago, that we used to go out and pick are not there anymore because of the sprays and stuff like that" (IP, 1. 4).

Access to land is an important issue for First Nations People. Medicines grow in certain places. In traditional times and still today, people had to travel great distances when gathering and harvesting medicines. He said there are a lot of medicines that grow in northern areas where people need access across imposed boundaries.

They should make parts of them where Indian people have access to go get medicines. I think this would be one of the main things to do. I don't know if it is happening now. I know every year we go out to Chief's Mountain on the other side of the border and the medicines that we go pick over there. My god it's something else. There is so much

medicine. It's just amazing. I often say that every plant that grows on the mountain is a medicine. Even just being there, the feeling that you get. It's a wonderful feeling. I don't know science. We are dealing with something Indian people do not really know too much about. (IP, 1. 5)

Many of the participants expressed the importance teaching young people the validity of traditional medicines and their continued importance in contemporary times. Young people need to experience and see for themselves traditional medicines in action. One participant shared a story about his grandson and how he demonstrated the value of traditional healing through direct experience.

The young people have to know that Elders have medicine that can help you out. A lot of times when you are suffering from stress, you are depressed, and all of these things, we have medicines to help your mind and body. Those are the kind of things young people have to know. I recall one day. I was outside. I have a little shed where I keep my medicines. I was doctoring a person there. I have medicine in my mouth when I work. I had finished and my grandson came and said 'where is the Tylenol? I have such a headache' and I said, 'you don't need Tylenol, just sit there'. And I blew his head and he said, 'what did you do Grandpa, I don't have a headache anymore'. I showed him the medicine I used works. I really changed his mind. He really believes in that stuff now. You know he can smudge up. Now he puts his heart into it and so this is good. Those are the kind of things when you are teaching will help. (IP, 1. 5)

One strategy that science teachers can use is to share stories of traditional medicines as an important way to generate interest among young people. For example, one of the participants talked about venereal diseases in the 1920s and 1930s. He said, "There were no cures for these diseases. Penicillin had not been discovered yet. But I remember my grandmother taught me that medicine. I can cure some of these diseases. Science did not know anything about Penicillin instead they locked some of these people in a sanatorium where they would waste away. The old Indian people knew those things" (IP, 1. 12).

Traditional Relationships with the Environment

One participant spoke about fostering relationships with the land and environment by setting up learning experiences that will allow students to emotionally bond with the natural world. He said,

The land is one of our Mothers. It serves us. It nourishes us. That is where we get our nourishment from and a lot of people do not realize that. The other thing is that people do not honour Mother Earth like we should. We make pavement all over the place and we never walk bare feet on the grass. We never take off our shoes and walk around on Mother Earth bare feet to enjoy that feeling that we get from there. Or lay on your back to look at the clouds. To be in 'Awe' with the way the Creator has made Mother Earth. There are not very many people that do that anymore. So that is what you have to do. We have to honour Mother Earth. Right now, it is deplorable how they are treating her just for a few bucks. (IP, 1. 7)

Similarly another participant expressed the importance of teaching science students how First Nations people traditionally related to the land in the following way. "I think they should learn their relationship to the land and different parts of the land that are significant for different purposes. There are sacred

sites, and places where medicine sits, places that should be revered and also, places for beseechment and offerings” (KG, 1. 1).

Traditional Ethics and Ethical Conduct In School Science

Many of the participants spoke about the importance of adhering to traditional ethics and ethical conduct in relation to the treatment of other entities in the natural world. One participant shared her concerns about ethics by using the dissection of animals in laboratory experiments as an example.

A lot of times, high school students, First Nations and non-First Nations are taking Biology classes and they tell me that they have to dissect a frog or snake and it's not our way as First Nations People. We could teach our students to look at diagrams to explain everything in detail, but you never, ever with your hands start to destroy it or anything like that. There was one Biology teacher that said the animals were pickled and prepared for dissection. But it's not our way and we should never, ever do that. In a spiritual way, these creatures are put on Mother Earth and we should never do that to them. We walk with great respect for the winged, animals, and those that crawl on the ground. So as First Nations People, I think we got no business doing that to them. But yet today in Biology class, I understand they have to do that. (VG, 1. 2)

One way of acknowledging the spirit of the animals used in scientific experiments is to use proper cultural protocols such as offering Tobacco or smudging the laboratory and glass bottles containing the animal body parts. Another way is for the students to approach Elders directly for advice. One participant recommends that,

...the student take Tobacco and offer it to an Elder and explain that they have to do this in order to live in the white man's world to get their education. I think as Elders, we would be prepared to pray and smudge with them to ask the grandfathers to help the individual. They'll have to have a ceremony, praying to these reptiles, amphibians, and whatever, because we believe they have a spirit and they'll make offerings to the spirit and the keepers of the ground. That would help the students. (VG, 1. 2)

Incorporating Environmental Issues

One participant talked about the need to focus on environmental issues related to resource extraction activities that are taking place in the traditional territories of First Nations People. He said, “you know a man once said that we are the only ones that will dirty it up and live in it and that's what we are doing. We are wreaking havoc on Mother Earth, and all of the filth and stuff, we live right amongst it. I don't know if that will ever change. I think we have gone too far” (IP, 1. 7). He encourages teachers to provide space where students can explore the impact of mining for example.

I often talk about mines and what they do to the land. This is where we get our living from and they are depleting the water. Now they are talking about building a Tars Sands industry in Saskatchewan. I forget how many gallons of water they use to make one quart of oil. Once they put the water through, it can longer be used. We are just playing with the things we get from Mother Earth. It is really bad. I spoke one time at a church meeting about what people were doing to Mother Earth and I said, what are we going to leave our children and great grandchildren? (IP, 1. 7)

Teachers can use hot topic issues in relation to mining for example by introducing debates on the Uranium mining industry in Saskatchewan.

One of the worst discoveries is uranium. When they discovered it they started messing around with it. The stuff they don't use anymore is just as dangerous. We worked at this one lake and they brought some Elders in. The uranium was only eighteen inches below the ground. They asked why it is that the animals that feed on the grass above this uranium, nothing happens to them. The Elders told them they haven't disturbed it. They live right beside the uranium. But as soon as you start disturbing it, then the thing will come alive and that's what they're dealing with now. Sure it's another form of energy that we have, but you have to watch out how you use that energy. (IP, 1. 8)

Another hot topic area is researching First Nations perspectives and stories in relation to Global Warming. Many First Nations People live very close to the land and any changes that occur out of the usual patterns are noticed right away. The participant shared the following story on changes that have occurred as a result of global warming as an example.

I remember long ago when it got cold. The poplar trees would just split. That is how cold it was. We lived in a little mud house. There was no furnace, just a big heater and that was it. We enjoyed every bit of it. Nowadays, our winters are not severe anymore. I remember them old sleighs just creaking on that snow. But it doesn't do that anymore because Mother Earth is getting warm with Global Warming. I often talk about the polar caps melting and as they are melting, the diseases that were trapped in that ice for so many thousands of years are getting released. And now we are getting all kinds of diseases and they are having a heck of a time inoculating people. I think if you hear these kind of things from an Indian person it will mean more to the students than they would if they heard it from someone that has never lived in the community. (IP, 1. 7)

Science Camps and 'On the Land' Experiential Activities

A common theme that weaved throughout all of the interviews is the importance of connecting youth with the land through experiential excursions. Participants recommend that science teachers take students *out on the land* by using Science Camps and other types of Field Trips as an avenue to engage in experiential activities. In traditional times, learning First Nations Knowledge systems was usually done through engagement with the environment. Hands-on learning activities, thematic learning stations, and community resource people are key ingredients in planning science camps with a cultural emphasis.

Take them out in the wilderness where there is medicines and all kinds of plants. Take them out there with a couple of Elders, one male and one female. Have the Elders teach about plants and what they can be used for. There are certain plants that you cannot tell anybody. But a lot of the stuff you have out there can be used. There is medicine for sore eyes and even for cleansing oneself by using sage. Even the bark of a tree can be used for medicine. Some of these trappers in the north, they'll go out for about five or six months at a time, and when a guy gets sick out in the bush, he can't go and see a doctor, so naturally the herbs are there and that trapper has knowledge of that. That's the way these things are. (IP, 1. 9)

First Nations People do not separate knowledge in separate disciplines like Western Science and so the importance of integrating multiple subject areas when taking students on Field Trips. Students learn Western science concepts in addition to valuable knowledge of the natural world directly from First Nations People who act as resource people.

Observations of the Natural World

First Nations People often learned about the natural world through observation. Teachers can set up opportunities where students can learn active listening, observation, and traditional values such as patience and humility from the natural world. One participant shared the importance of having students observe the tiniest of the insects such as ants because they have something to teach us about life and values.

I used to deliberately make an effort to look for anthills when I was out attending ceremonies. People used to think I was crazy. But I like watching ants. They are so organized and they never squabble. I can sit for hours and just watch the ants work. Same thing with bees, they just know what they are doing. I think they are better than humans sometimes. The ants carry tiny white rocks into their nest, and these can be used for rattles in our ceremonies. (VW, 1. 2)

First Nations People often use ceremonies to become connected with the natural world as well as to seek knowledge and wisdom from the spirit world. There are stories of people being able to communicate with the animals through the vision quest ceremony for example. “We learned from the animals. The animals had a lot to teach us. You became aware of your surroundings. You appreciate the silence” (VW, 1. 3).

Today, it doesn’t have to be a vision quest. You can just go out into the bush and sit. You become aware of everything. Your senses open up, your smell, your hearing, and things you never noticed before, things we take for granted. You don’t need to go on a vision quest to learn from nature, just go out on the land, like on the prairies. You will probably learn something. (VW, p. 3)

Many of the participants talked about connecting students to the land starting from the early ages within families, within the school system, and through community-wide events. One participant expressed this sentiment in the following way.

They learn at a very young age. If you don’t teach them at home and especially if you live in the city, they will have no connection to the land whatsoever. You need to take the kids out once in awhile, whether it is cold, raining, or whatever. They will tell you all kinds of exciting things in one day that they didn’t know before. You see the expression on their faces. (VW, 1. 3)

It is important to teach students Western science as well as the value of respect for the natural world. By coming to understand that everything has a purpose, student will learn not to harm the environment.

The Four Elements: Water, Wind, Fire, Earth

One participant shared the importance of exploring the four elements of water, wind, fire and earth, as they are understood in Western science. First Nations believe in these four elements, with one addition, and that is the spirit that flows through all life. First Nations People used these five elements to heal themselves for example through the Sweat lodge ceremony.

First Nations People also personified their connection to each of these four elements. She said, “in our Dakota way, we have a water thing, we do a lot of ceremonies and prayers to the waters...it is a sacred thing...we pray and make offerings to the water spirit to keep the water pure for us living on Mother Earth to use” (VG, 1. 1). The participant continued to explain the personification of the elements using the wind as an example.

And the wind, a lot of times the environment cannot control the wind, it comes, and in our sacred, traditional way, we call it a sacred spirit. We pray to calm the winds when they are really starting to...and we watch...when it starts to do damage and beginning to destroy us then we have a spiritual ceremony and pray to the wind spirit to hold the wind back. (VG, 1. 1)

She continued her teachings of the four elements using fire as an example and ending with earth.

Fire is another very sacred thing to our people; we should not be fooling around with it or playing with fire because we realize that fire can be very dangerous. In that, the fire, we say in our traditional way that when a loved one is gone to the spirit world, we make a fire for their travel, to guide and help them to get where they need to go in a very spiritual, sacred way”. “Those are the four elements of nature and of course Mother Earth comes in because she is the provider for all of our needs as individuals, or as people living on Mother Earth. (VG, 1. 1)

From the foundational building blocks of the basic elements of life, students can expand their knowledge base of the natural world by exploring the traditional seasonal cycles of First Nations People.

Traditional Seasonal Cycles, Weather Patterns, Astronomy

One participant talked about focusing on seasonal cycles, weather patterns, and astronomy in school science. In traditional times, First Nations People used knowledge of the stars to navigate between camps as well as through land and river systems. In addition, understanding weather patterns of a certain place was critical to what may be expected when people travelled.

The Elders of the past, our forefathers studied everything, the moon, the sun, the sky, the clouds. They studied various forms and happenings. If there was going to be a change in the weather, they would forecast just by looking at how the sun traveled. They studied that, and they knew something was going to happen. There was a certain sign in the clouds or the sky and even at sunset. They knew what kind of day it was going to be. (TC, 1. 1)

Traditional astronomical knowledge was used to engage in seasonal activities at certain times of the year using particular technologies for survival. Astronomy was strongly linked to the spiritual orientation First Nations People have in relation to the natural world. One participant explains the connection between astronomy and spirituality in the following way:

From a traditional perspective, and as an Elder, everything that we do is from a traditional perspective, there is always a bit of science in it, but we don't look at it that way. An example is the study of the stars. Many, many years ago First Nations People lived by the stars and where certain stars were at certain times of the year. The Big Dipper, the Little Dipper, and the Milky Way were a very sacred, spiritual way of saying that when we leave Mother Earth, that is our road we travel to the Spirit World. Today, I guess you can combine that with the study of stars, or as you call it astronomy. (VG, 1. 1)

Prehistoric Animal Stories

One participant shared her experiences working side-by-side with science teachers who were focusing on prehistoric animals. She said this was a challenge, however, she remembered stories that her grandparents used to share about these sacred beings. The following is an excerpt of what she remembers.

Our people knew about prehistoric animals, the big winged ones. One of them did something wrong so the Creator made them shrink which became the birds we have today. They didn't follow the traditional way. They had to believe in their own sacred way to be walking on Mother Earth because she is sacred. So those were the stories I told the students when they studied Dinosaurs. There was a great punishment for these sacred things that roamed the earth and they all vanished. In our way, they say wherever they fell that is where they are today. Mother Earth has taken them back and we must never touch or disturb them. Right now the Archaeologists are doing just that. Our way is to leave them alone. They say, if you start taking things away from Mother Earth, those were hers so she took them back. When you dig them up and take them out, there will be all kinds of illnesses, changes, and Mother Earth can no longer protect us. In the midst of all that, we are going to be suffering. These were things that were said many years ago and today, they have all fallen into place. (VG, 1. 6)

Science teachers can introduce different perspectives on the rise and fall of prehistoric animals based on their own theories as well as stories shared by First Nations People.

LANGUAGES

First Nations People have their own words for the trees, grasses, water, moon, stars, sun, and other aspects of the natural world. Because all these are sacred, the language is also sacred. (VG, 1. 3)

- First Nations languages are inseparable from School Science
- Identifying, Naming, Classifying – eg. Traditional Plants
- Using Key Words, Phrases, Concepts in FN Languages
- First Nations languages and Place names

First Nations Languages in School Science

Many of the participants spoke about First Nations languages as being inseparable from school science. However, in many contexts, First Nations languages are taught as a separate subject de-contextualized from real life situations. In school science, First Nations languages are especially important in identifying, naming, and classifying animals and plants of a particular place.

I guess the role that language plays is in the naming of the plants. I had a young fellow come to my office this morning and I knew the name of the plants in Cree. However, I did not know the name of them using the scientific language. If students know the name of the plants in the Cree language, then they will know what the Elders are talking about. (IP, 1. 9)

The participant went on to state that First Nations languages are important in the naming of plants as well as when one is explaining how to mix them.

It's not so much that you know all of these plants. It is about knowing how to mix them. It's the mixture that will give you the doctoring. If you know how to mix them, then you have something. Then science could have that knowledge. Science already has a lot of our medicines, but they are not in the Cree name, or Saulteaux, or Dakota, or whatever. A lot of time people talk about bad medicine. It's the way you mix that medicine, the prayers that you put in there. A lot of people say there is bad medicine, but it's not like that. The Creator never put anything on earth that is bad. It's the way we make it. That's when it's bad. (IP, 1. 10)

The overall sentiment expressed by many of the participants is that First Nations languages are an inseparable aspect of passing on knowledge in First Nations cultures. More importantly, First Nations languages and words contain complex knowledge concepts related to the natural world.

The language is the memory of the people and it has all of the things that are important to the people. The integrity of any culture is really based in the language. It has tribal memory, and tribal history. The language is extremely important. If we analyze how we say things, we have a whole different way of thinking. For example in my Dakota language, we have a word for *child*, which translates to *a child carrying sacredness*. Now if you think of any society that can come up with a word like that for a child, then there is something in the thinking of that particular word which incorporates their experiences, observations, and the development of faculties that we all have that may be dormant. (KG, 1. 4)

One participant recommends that teachers use key words, phrases, and concepts in the First Nations language first followed by vocabulary in the English language (VG, 1. 3). Another participant spoke about how so much of the history is embedded in the language. She gave an example of place names in the traditional territories of First Nations People. Some of these *Places* are traditional ceremonial sites that have been replaced by pavement and highways. It is important to teach students about how their world has been re-named through the process of colonization and why it is important to begin the process of reclaiming our own concepts and stories of those *Places*.

Furthermore, there are different knowledge systems that are expressed in different ways. One participant explains this in the following way. She said, "I found out in the Dakota culture, there is a women's language. There is a way that women communicate that is different than men" (VW, 1, 9). The

ability to express and use these multiple perspectives for the social and collective well-being was the overall goal of traditional education among First Nations People.

SOCIAL AND COLLECTIVE WELL-BEING

Everything was for their families and they loved their children. That was one of the teachings with the various tribes that when you started having children, they were told that those children were not theirs, but on loan to them to look after with love and care as well as to provide for them to the best of your ability. That's why they went trapping, hunting, and gathering berries. That's why everything they did they always prayed. (TC, 1. 2)

- Collective Wellbeing as the Goal of School Science
- Spirituality, Sustainability, & Balance
- Traditional First Nations Values and School Science
- Respect as a Core Value – Guides Behaviour, Decisions, & Sustainable Ways of Being
- Promoting Elder and Youth Relationships

The overall goal of school science from First Nations perspectives is the social, political, economic and collective wellbeing of community members guided by a set of traditional values that have sustained them for centuries. Living healthy is about living in balance guided by a set of traditional values. School science curriculum units and activities must revolve around the mental, spiritual, emotional, and physical development of students while learning about healthy relationships within their families and communities.

According to one participant, “Spirituality and sustainability went hand in hand. For example, some people were given certain ceremonial knowledge and so this meant they were also given the privilege and authority to put up that Sundance Lodge so they could pray for life, for good clean health, and for the sustainability of the children” (TC, 1. 3).

The same participant shared the following story when he was asked the question in relation to how First Nations People survived before the Whiteman came.

The Creator provided everything for the Indian people. The Creator told them, ‘I will be up there. I will look after my Indians, and I will provide them whatever they need’. If they needed something for sickness, the Creator provided them with the knowledge. That is where all the various plants came in. For example, we have medicines for the back, heart, and the brain. That is why we still see many of our people practicing and this is good. But then again, we lost a lot too. A lot of our people forgot because somewhere along the line they became distracted. We were put in Residential Schools. That is where we lost a lot of our Elders. People lost their language. People used their language to communicate and pray to the Creator. (TC, 1. 5-6)

Traditional First Nations Values and School Science

Many of the participants spoke about infusing traditional values in school science. One participant said traditional values like respect are learned from grandparents, the culture, and the places in which people originate. He went on to state, “You need to know where you come from, and that’s one of things that you have to know” (IP, 1. 10). He said teachers spend a lot of time with children and so play an important role in passing on values that are important in the communities.

The thing that you do, when you send a child to school is that you are leaving it up to that teacher to be able to put all of things that we talk about, the values into that child. The thing that is taught to that child at that early age is the thing that he is going to do when he grows up. That’s why a long, long time ago, the old people would all of a sudden say that they want their grandson to come and live with them. We will teach him all of these things, the values. That kid will grow up to be like an old person. They will know all of these things. You see, when you send that child to school, that teacher is a babysitter, a mentor, they’re everything, and if you have Elders in there talking, then you have balance intervention. (IP, 1. 11)

One participant alluded to the notion that a person with traditional First Nations values may find working as a scientist to be problematic.

I guess an Indian person, or if a person had knowledge of our ways when they were young, they wouldn’t make a good scientist because a scientist has to work with little animals, injecting them with different kinds of stuff and making animals sick and seeing how it works. If we have our values, we would never do these things. We would never put something in an animal like that. It’s disheartening, but I guess they save a lot of lives, those little animals, the scientists use. (IP, 1. 11)

Traditional values reinforce First Nations worldviews. One fundamental value that kept coming up in the interviews is the need to reinforce respect for the natural world. One participant had this to say,

I think it is important to teach respect for everything we are part of, our Creation. Everything has a role to play. Everything that we do affects something somewhere. Everything that happens has an effect on something else. As people, we affect things by what we do, what we say, our actions, even what we think. We have to respect everything and everybody for what they are. Everything in Creation has an ability to do something that no other thing can do. That is their god given gift. We have the ability to do different kind of things. So respect and understanding of these things are important. (KG, 1. 4)

The value of respect is tied to survival and cooperation, which are still important today as they were in ancient times. He went on to explain, “The object of the exercise was survival of the group which means you could not reject anyone or throw anybody away because you needed everybody and the kind of uniqueness or individual ability to do things” (KG, 1. 4).

One participant explained that First Nations worldview, the concept of interrelatedness, and traditional values are inseparable aspects of school science. He explained this link in the following way.

Everything is related. Everything that they did was related to the family, community, and tribe. That is how they looked at everything. They had respect for everything. It was like that when they started using animals like dogs. They thanked the Creator for allowing them to have those animals so they could use them for their sustainability. They loved

animals. It was the same with horses. They were precious, sacred, and they didn't abuse them. It was believed that these animals agreed that they would come and be servants to work for the Indian people. Some of the Elders used to say that the horse gave up its spirit so they could come and help the Indian in all their ways of living. (TC, 1. 4)

Traditional values were used as a guide for all behaviour, decisions, and sustainable ways of being. Elders often taught young people to have respect for all animals because they were there for our use and in turn we humans would become a part of them.

They are there for a purpose and they're there so we can eat. They have given themselves up so that we can feed our children. That is why when we used to make a feast, we still have feasts, and we have Elders that pray thanking the animal for giving itself up so we could have this feast and so we can thank the Creator. They didn't waste the animal" (TC, 1. 5). "...If they were adopt the traditional values that we once had, we would have better communities then what we have now. There is no respect right now. There is no respect for tradition, spirituality, and anything pure. Even the leadership we have, there is no respect for them. The leadership has no respect for their community as well. The old Indians forecasted this. (TC, 1. 10)

Many of the participants spoke about the importance of connecting youth with Elders so they can learn their culture and traditional value system. Respect for self and others in the community is central to health and well-being. In his closing statement one of the participants had this to say.

They should find ways and means of gradually enticing these young people to come back. Let's get back on the right track. We're all off track right now. The Indian communities are all off track even our leadership. They're all off track. The leadership is too busy trying to fix them selves. They're not really concerned with wanting to fix what has to be fixed in the community. They ignore, but they see it, and they don't want to do anything about it. They need to focus on the youth, because they are our future. That is my philosophy is that we have things going on for our young people through sports, recreation, social development and everything because we've lost that now. (TC, 1. 11)

5.2 Learning Indigenous Science from Place: A Métis Perspective

Researcher's Prologue

The following constitutes a summary of a series of interviews with individuals from North West Saskatchewan. In respect of participant cultures, I wish to acknowledge that of the nine interview participants, six were Métis, two were First Nations and one was non-Aboriginal. It did not seem appropriate to remove the latter three sets of data from my analysis, but rather to acknowledge them as fellow northern residents with compatible views.

As a Métis woman, and former biology teacher, I was excited and honoured to be able to speak with residents from this area for the Learning Indigenous Science from Place research project. I had lived in North West Saskatchewan at one time and hold a deep respect for the people and the place.

In research, there is a historic attitude that the researcher should strive for 'objectivity', remaining unattached to the research and the researched. I hold no such position. I feel a tremendous accountability to the people who participated in this study, to the Métis community and to all Aboriginal Peoples. After spending many hours analyzing the interviews and my field notes, I realized how much I had not comprehended during the actual dialogues. The words on the pages seemed to grow in intensity and power over time. Voices of participants echoed through time helping me see important messages embedded in the text. I can only say a very humble 'thank you' to those who shared a part of themselves for this important work.

In this spirit, I offer my best interpretation of what I heard in the hope that our collective effort will help make a ripple of change in how we think about science education and what we do in future years for the sake of this planet and all the living things on it.

Yvonne Vizina

2008

Self

I would love to see my kids spend more time in the culture, especially now, my grandchildren. I would love to see them go canoeing and, you know, even doing science, do it out there, so they could get to feel who they are, what they are, where they come from. (NWS5, l.156)

... we signed a contract out of ethics... It's your ethical process in order to make peace with yourself and your boss and even your Creator. (NWS8, l.96)

They have to connect with the environment they're on. I know for a fact we will have some people who they'll make a connection to the Elders, some of them won't, and that's reality. But the ones that do, the ones that do kind appreciate the science...want to learn about science, all you have to do is open your windows, there it is. They're surrounded. But, at the same time in order for them to appreciate the science that they have and everything else, you know, I keep coming back to this. They got to have a strong spiritual self. So, you got to believe in something else. (NWS9, l.180)

Participants spoke about the role of self in relation to all other topics discussed throughout the interviews. None of the participants spoke about reaching a sense of fulfillment of self in terms of academic achievement. Participants spoke about experiential learning that provided opportunities to learn practical skills, developing personal relationships and spiritual understanding, carrying out of protocols as a measure of respect, caring for others and functioning as a part of cultural community.

One participant described the joy experienced by Elders in seeing youth having fun and being respectful to teachers while practicing traditional harvesting activities out on the land. He said it was an experience he would never forget, and doubted that any of the students would ever forget either. (NWS9, l.60) Participants talked about the impacts of loss of culture and language on community members. It is their hope that systemic change might bring their grandchildren into closer contact with traditional teachings. (NWS9, l.166; NWS5, l.156; NWS2, l.97; NWS1, l.106, l.228)

People

...it's not the teachers, it's not the administration, it's not the school divisions that are suffering, it's our kids losing out on all that knowledge that our Elders are able to pass on. And, yes, we are required to use the Elders once in a while, but not the way they should be used... (NWS9, l.60)

One of the things that I always see is ok, they say, well this is what science is, there it is, it's in the book, there is resources, etc., etc. But, they always, always more likely nine out of ten times forget to ask the people that are living in the area. There is so much information. There's so much, you know, there are so many people that could actually help them make it, make their life easier as a science teacher or anybody else, yeah. (NWS9, l.124)

With Indian Studies, why aren't the white people coming to learn more about Indian Studies? That's the same question they're asking regarding our people,

they say why aren't people coming to the science? (NWS5, l.176)

My kids are going to be all right, they're going to have jobs, they're going to have families, they're going to raise their families. They're going to be fine as human beings, but there's a part of them they'll never have which I have...to know how it is to feel to be able to grow up around your family, or to grow up around things that make you whole as an Aboriginal person, a Métis or First Nation. (NWS5, l.176)

I would say maybe it's safe for me to be here because there's no bad people come around to you. You're in a hidden place. Just like birds, when they build a nest in the bushes mostly behind the leaves so we can't see them. They're protected, nobody's going to hurt them. That's how I feel when I'm in the bush. (NWS4, l.233)

Participant discussion concerning people spanned a wide range of topics. Participants primarily talked about Elders and youth in relation to the interview questions. There was a general sense that Elders resident in a specific area may make themselves accessible to schools if respectful protocol is observed and trusting relationships are developed (NWS3, l.86). Some Elders may not have the confidence to put themselves forward to assist teachers, but over time that may change (NWS5, l.59). Participants commented that Elders have tremendous amounts of information that they are usually willing to share with young people. This information is not written down but is only accessible through oral tradition (NWS3, l.82).

Two participants commented that youth who have land-based experiences and knowledge achieve greater success in school on subjects related to science. These same students have an opportunity to be proud of their abilities or even be role models in field experiences (NWS9, l.146; NWS7, l.300). It was generally acknowledged by participants that youth are disconnected from learning traditional knowledge or from having any significant land-based experiences because these are not part of school curriculum.

Identity was an important concept discussed in relation to learning Indigenous science. Two participants commented that the artistic parts of culture such as music and dance are important, but it is the connection to the land and knowledge of the land that is deeply important and meaningful to Métis (NWS3, l.134; NWS8, l.48). One participant commented that for many kids, it is like they are 'starving for identity', looking for a 'way of being alive' as a result of urban lifestyle (NWS7, l.61). Another participant commented that our increasingly diverse mixed-blood heritages expose us to connections to many nations. It is difficult to discover what you connect to and feel comfortable with if the information and teachings of your own cultural history are not available to you. It becomes a search for identity that is fulfilled through spiritual and ancestral teachings (NWS6, l.90). Participants felt that there should be no problem with learning what is currently taught in school as well as Métis cultural land-based traditions (NWS4, l.261; NWS9, l.56). Participants acknowledged that the Residential School legacy of cultural oppression and concealment or shame of Aboriginal identity were still active barriers within education and learning (NWS1, l.41; NWS6, l.147; NWS2, l.188; NWS1, l.192; l.228; NWS5, l.51, l.59, l.75, l.91).

Spirituality was discussed within all the interview dialogues. No participant dismissed the importance of traditional spiritual beliefs as relevant and important in understanding Indigenous science. Some participants explained part of their understanding of spirituality was based on medicine wheel

teachings. Some participants explained part of their understanding of spirituality came directly from the land, but that it was acknowledged and accessed through protocols appropriate to their place. Some participants explained parts of their spiritual beliefs were based in Christianity and parts in traditional First Nations beliefs. One participant commented that in order for an educator to include spirituality in teaching, they must also practice those beliefs. Otherwise, students will not take the spiritual teachings seriously or simply ignore them. Similarly, education authorities must fully accept that spirituality is part of cultural knowledge, including land-based knowledge. The spiritual component cannot be left out of what is being taught to young people. Spirituality is connected to everything just as science is connected to everything. It would be senseless to ignore this truth, and more seriously, ignoring spiritual connections within science would not allow the development of the whole person as they are learning (NWS9, I.100, I.104). All participants commented that many barriers exist preventing the inclusion of traditional spiritual beliefs within the context of school curriculum.

A participant commented that teachers need to learn Indigenous science skills and knowledge along side of students. In some cases, it would be preferable to have teachers trained in advance especially if it involves field trips (NWS8, I.158). Participants commented that school systems and decision-makers who lacked understanding about the spiritual nature of Indigenous knowledge would be barriers to supporting teachers and students in this regard. In other cases, finances dictate the ability to include land-based knowledge (NWS3, I.114; NWS9, I.60; NWS6, I.119). Participants commented that it is important for Aboriginal leadership and community members to voice their feelings that they want traditional knowledge included in school curriculum. Teaching through cultural traditions is a meaningful method of providing education. Much of the current curriculum is not relevant to Aboriginal students so it is very difficult for the students to connect to the curriculum and be successful learners. It was felt that traditional knowledge is complete in itself and other kinds of science knowledge could compliment but should not replace traditional knowledge specific to place (NWS3, I.114, I.146; NWS8, I.27; I.52; NWS9, I.56).

The concept of *Place* was described geographically as the area of your home, community or political jurisdiction (NWS5, I.53). It was also described as where you are when you feel safe, at ease or comfortable with your surroundings. One participant described the northern boreal forest as a place where he felt protected (NWS4, I.233, I.253). Others described having a strong sense of place where the language is alive, the traditional way of living is alive and people actively practice culture and traditions of land-based activities (NWS7, I.57). Conversely, it was felt that people themselves deteriorate when they live in areas where the land is also not healthy and thriving. Urban environments force unnatural time scheduling, rigid flow of human activity, feel chaotic and generate a different energy than natural environments. Urban energy is not calmed, not soothing and is disruptive to feeling good (NWS6, I.32).

Land

You know, I can't jig, I can't play the fiddle, but I know a lot of stuff about how I'm here now, in terms of how to live off the lands, you know as a Métis. (NWS3, I.134)

It's really important. I don't know why they didn't do that anymore, they should have kept on doing it. It doesn't have to be just a [one] person that they take these kids out, it could be other people who takes the kids out for different things to learn different things, different ways, how to survive in the wild, like

fishing, trapping, building a cabin, or doing some hides, prepare hides, there's all kinds of different things that you can do out in the wild, out in the bush. And you have to take the kids right at the spot where you're doing that otherwise they won't know what you're talking about... (NWS4, l.197)

Participant discussion regarding the relationship of land to Métis People was very diverse and complex. One participant explained the importance of ethical interaction with the land. He described the need to carry out actions ethically, working for the best interests of all – not just you. He felt that the best way to do this is to ensure your actions are in line with those of the Creator. By working in this way, we would not see disastrous situations with oil spills or land decimated from mining or forestry operations. He explained that we have a responsibility to maintain connections to the land that already exist to help you live, not just exploit resources (NWS8, l.116). Another participant expanded on the need to work ethically by explaining that in traditional thought, every little thing has spirit. This includes water, trees and everything else we use. Recognizing the spiritual nature of the land helps people understand how to interact with the land, including the application of traditional protocols such as tobacco offerings, and allows them to form a holistic worldview (NWS9, l.108).

One participant described the enthusiasm of young people to learn about other cultures. He believes that science education should be structured to accommodate this type of natural curiosity. This would be possible by initiating a course of learning that begins with place, knowing self and place, then expanding out to incorporate diverse geographical areas in Saskatchewan like the flat lands outside the boreal forest area, learning in the four directions of north, south, east and west, and expanding to learn provincially and beyond. The indicators of learning that show meaningful understanding need to be linked to traditional value systems and skills such as cooperative living, traditional bush knowledge, respecting Elders and each other, survival skills, medicine plant knowledge, diverse ecosystems, protocols of place, respecting animal behaviour and cycles, spiritual ceremonies, traditional hunting, fishing and harvesting skills, traditional food processing skills, sharing and awareness of others needs (NWS9, l.108). This participant also felt that young people need to hear, see and experience that learning science is exciting and fulfilling. The study of science can easily be linked to cultural traditions and only a small part of the study of science needs to be learned from a book. Most of it can be learned from real life experiences in the environment around them (NWS9, l.56).

It was felt that Elders have the most important forms of knowledge needed by young people. The knowledge that Elders have about how to live and survive off the land has been passed down from generation to generation. Even today, traditional knowledge has to be learned by experience over a long period of time, it cannot really be notated in a book because of its complexity and shifting nature. One participant provided an example in knowing when it is safe to cross the ice on a local lake. This knowledge is impossible to write down because the answer is dependent on multiple factors that may take years to identify and consider when making the decision to cross the ice. This is about respecting the Earth and what one learns from it (NWS9, l.15).

The concept of *land* was not necessarily restricted to *land per se*. When participants began talking about *land* they also included discussion about water, sun, moon, clouds, rain and fire (NWS2, l.152; NWS1, l.262; NWS5, l.43; NWS3, 102; NWS4, l.209).

Participants acknowledge the challenge faced by educators in creating a science curriculum that could facilitate diverse geographic areas and cultures. It was felt that there would be a need to be very creative and ensure that all students had an opportunity to learn about their own place as well as the

places of others. This might be accomplished through visual aids or video to overcome distance issues (NWS9, I.39). One participant commented that in spite of the fact that people appear different and speak different languages that it does not mean we can't work together. If we can successfully work together in partnerships, we enhance the well being of this province, of Métis and the First Nations (NWS5, I.188).

Languages and Traditions

A culture is not only the language and all these other things, you know. Everything that you do, even how you talk to your Aboriginal brothers and sisters and your non-Aboriginal brothers and sisters, is part of the culture. You know, everything, how you look at the world around you, how you look at these things. (NWS8, I.108)

...science is not confined into one little spot of the province or one place, you know, we have to use science right across the whole province, the whole country, the whole world. (NWS8, I.43)

All the participants acknowledged the importance of language as an integral part of cultural identity. One participant explained that as a result of shame or desire to fit in with the non-Aboriginal population sometimes an individual will hide the fact that they can speak an Aboriginal language. This participant felt it illustrated how empty of self-worth an individual is if they are reduced to deliberately hiding their language. He explained that it became a responsibility of other Aboriginal language speakers to use their language at every opportunity, even if there was just one other speaker present (NWS3, I.150).

Some participants acknowledged their mother tongue as Michif, but said they just call it Cree (NWS3, I.158; NWS1, I.15, I.89; NWS2, I.73). One participant explained that during most of his life, the language was always referred to as Cree and it has only been in recent times that people have come to call the Cree mixed with French as Michif (NWS3, I.158). Other participants only ever referred to their language as Cree, and in some cases referred to them selves as Indian (NWS5, I.59; NWS4, I.128). This is important to note, as it draws attention to the common bond Métis individuals feel with Cree People and language. However, the lack of comfort, familiarity or knowledge to be able to identify one's own mother tongue may indicate the historic and continued oppression of Métis culture and language.

One participant indicated that it is up to Métis People to retain the culture, language, past and current traditions. This is challenging and also needs to take into account the need to thrive in today's economy. In his view, economic survival meant the survival of your family and took precedent over all other things (NWS5, I.59). Participants also noted that being proud of your culture and language and using it within society makes you personally, and the language, and the culture more proud and powerful (NWS3, I.160; NWS5, I.59). One participant felt that knowing their language would provide them with important bilingual skills for the future. He also felt that knowing multiple languages, as many from previous generations did, would be better than only having two languages. He felt that the *white-man* way of only having one language was insufficient to improved learning, relationship building, and teaching others (NWS4, I.128, I.137, I.149, I.157).

Participants agreed that learning an Aboriginal language must begin at home at an early age (NWS3, I.168, NWS5, I.156, NWS1, I.106). They felt that culture, values and Aboriginal languages should be part of all social programming and curriculum; to experience otherwise was to experience cultural

deprivation in the same manner that Residential Schools and foster homes encouraged cultural abandonment (NWS5, l.59, NWS4, l.177, NWS3, l.146). One participant also commented that trying to learn *the thought* [language and traditions] could begin with short periods of time in school, but must be continued outside the school in the home and out on the land otherwise it would not be successful (NWS4, l.177). Participants recognized that there is a need to have Aboriginal language speakers as teachers and support persons (NWS2, l.97, NWS5, l.59).

Discussion of cultural traditions was holistic and dynamic. Participants talked about traditions as being rooted in the need to survive (NWS3, l.43; NWS8, l.48). In times past, traditional knowledge was the means by which individuals coped with the hardships of their environment, developed value systems of sharing and helping each other, and taught next generations of people how to live in a similar way. One participant spoke about the extensive knowledge of Elders from the region. In one instance, these Elders were consulted in a series of interviews for regional environmental planning and the result was so successful that the project was used as a model for planning in other areas. The Elders spoke only from memory. They did not use any written references. Yet, the Elders were able to accurately recall nesting sites of birds, historic burial sites of Aboriginal and non-Aboriginal persons in the north, who trapped in what areas, what furs were abundant in specific areas, the routes of creeks and impact on larger water bodies, best methods of transportation and travel routes (NWS3, l.45). One participant acknowledged that although he lives in the north and does know some things about traditional life, he felt that what he knew did not even a fraction of what Elders from one generation back knew and understood about the land (NWS8, l.146). One participant expressed the importance of re-introducing traditional knowledge to adult and young generations of Métis to ensure it continues to be used, and is not lost (NWS3, l.102).

One participant noted that kids who avoid school, but attend at times when there are outdoor activities should be a message to us (NWS3, l.61). These students may not be successful at academics or book learning but they may have exceptional skills from living on the land with their grandparents and thrive when they have the opportunity to be leaders in this regard (NWS8, l.146). Some kids are not comfortable in the outdoors and want to have their technology along with them. This is not necessarily a bad thing but should be limited and could be negotiated with students and parents (NWS8, l.88). It is important to find ways that young people can have fun in the outdoors, and that it is not a negative experience. Young people will figure out the best way of solving problems and having fun doing it. These positive experiences create good memories carried throughout life (NWS3, l.102, NWS8, l.60, l.146, l.192; NWS7, l.27). Some of the participants felt that some of the math and history content currently taught in schools was simply inappropriate in that it replaced local knowledge that should have had priority (NWS3, l.114; NWS8, l.52).

Participants talked extensively about barriers to the integration of language and culture within society. They identified the transition away from traditional ways of knowing as a result of such things as the telephone, highways, power, other forms of technology and western education (NWS3, l.102; NWS8, l.52). No participant indicated that they would rather live without these things, but recognized the adverse impact they had on Métis language and traditions. Rather, participants talked about the need to continue to move forward, and, with the support of Aboriginal leadership and the broader Aboriginal communities, to insist on having Métis language and traditions incorporated into mainstream programming (NWS5, l.59; NWS3, l.102). In order to accomplish this, one participant explained that it is necessary to have school superintendents and teachers who are willing and able to do this. Racism from *educated* people was felt to be one of the biggest barriers to inclusion of Aboriginal traditional cultures (NWS3, l.114). Other barriers identified included educating highest level decision-makers within

education about the importance of including traditional knowledge, and similarly, undoing past oppression and convincing many Aboriginal Peoples also that sustaining their culture into the future is important. Political activity by Aboriginal leadership was seen as an important facet of making change.

Social Environment

We started this thing by signing a consent form and the idea of the consent is that you know you're being responsible to us and ... to your leaders. When they put the tobacco down they're just taking all the paperwork out of it and being responsible to who's most important, our Creator, and never mind all the paper and legal mumbo jumbo. You have to be responsible to the Creator. And, if it's sincere, then you're doing it right. But if you're putting tobacco down and you're not really caring about the things that you're taking from the earth, you'll know it and you'll carry that weight with you. It's kinda like a, I would imagine, it's a social stigma you would carry with you personally. You can't escape anything you do in this world. (NWS8, l.92)

They have to know what was here or what is here now, and it has to be into the school's curriculum, Métis, we are here. (NWS3, l.146)

The social environment of teachers, learners, communities and nations was described throughout participant interviews. Knowing the social environment, or place, was an important factor in knowing how to proceed with teaching and learning. One participant talked about the Canadian social environment with increasing numbers of diverse peoples emigrating from other countries, the rapid increase of the Métis population, and the need to ensure that school curriculum is helping all learners to know about this country from the perspective of the Métis (NWS3, l.146). One participant commented working for personal economic financial development, as opposed to personal social development, is insufficient for human beings. Deeper nourishment is required otherwise a person will never feel satisfied with their life (NWS8, l.176).

One participant commented that all social programming needs to take into account Métis culture and values. The interrelatedness of social development, economic development and well-being can be difficult for individuals to navigate. Often, individuals will distance themselves from Elder's teachings because they find them incompatible with economic or academic environments. Even Elders themselves will often be reluctant to participate in social programming, feeling that their knowledge is not valued since it has been neglected by society over such a long period of time. Yet, if we can overcome restrictive policy that limits Aboriginal Peoples participation, integration within systems can occur and we can succeed in learning from each other (NWS5, l.59).

There was recognition that school budgets create unnatural barriers between Elders and young people. Teachers wishing to invite Elders to help them teach in a variety of subject areas through storytelling and developing a sense of place within the learners may find themselves unable to have Elders come in because schools have not budgeted for this (NWS6, l.176). In a similar regard, one participant commented that even though there are numerous Aboriginal teachers graduating from post-secondary education they are not able to find employment in urban centres where the majority of Aboriginal youth reside. Increasing numbers of Aboriginal youth engaging in destructive social behaviour, including gang membership, is related to the absence of fostering healthy cultural identity. This participant inferred

resulting negative media backlash against the Aboriginal community did not take into consideration barriers experienced by Aboriginal educators in finding employment in urban settings (NWS7, l.61).

Physical Environment

Well, what I really think is it should be appreciation of the environment that you're in. Now, that could apply to the beautiful north here or the environment that is surrounded in the south. But, irregardless where you are, we tend to adjust ourselves to the environment that you're in. And that, I think, is one of the big things that we should, that Aboriginal science should, be at. Because, you know, we could talk about a lot of things, a lot of topics. But at the same time we have to give the students, we have to give the people, a chance to adjust to the environment that they're in and take advantage of using the people that have been here for generations and generations. (NWS9, l.124)

These are the things that I know. Wake up in the morning and make some tea and in the camp fire outside, it doesn't have to be inside. These are the things that I love doing, that I like doing, that's me. But, if you take people from that environment, through whatever it means, education, Residential School, whatever. We've lost because if you look back, if they have introduced and respected our culture, we wouldn't have lost it. I haven't lost it but my kids have to a certain degree. (NWS5, l.176)

Participants talked about the need for individuals to adapt to whatever physical or geographical environment they were living in by learning from Elder generations resident in that particular area (NWS9, l.124; NWS8, l.62, l.180). Two participants talked about the importance of knowing how to make transitions between northern and urban environments to ensure personal survival. These transitions include adapting to a fast urban pace of life and being aware of issues related to personal safety resulting from being among large groups of people and unfamiliar terrain (NWS3, l.27; NWS4, l.213, l.225). One participant described how important observational skills are in northern living when living in close proximity to the bush and wildlife. Consequently, developing observational skills can contribute to the development of spirituality, especially if science and other teachers are enjoying facilitating student interaction with the natural world (NWS9, l.166). It was also acknowledged that curriculum is not necessarily transferable among different geographical locations. The specific environment one is in will dictate what topics are relevant. But, this participant also described the concept of science as transcending physical life, and the study of life needing to acknowledge that. He believed it is important for educators and resource people to help young people understand there are other positive forces they can learn about, the importance and value of Elder's knowledge, and to view their whole environment and understand what is available to them. As well, educators have a responsibility and accountability to community members to ensure what they are teaching is meaningful and relevant (NWS9, l.180, l.192).

Economic Environment

Never mind personal social development, it's always about personal economic financial development, and that, as a person and a human being, that's not enough. You can't be happy living like that, you'll always be struggling to find something more. (NWS8, l.176)

I want to be a part of something in social development, economic development, the well being of our people, the well being of community, family. So, it's important not to be closed in, it's important to be open and to grow... It's not that we want to let go of our identity, it's just that we're saying we want to work with people that are developing... there's so many different things happening and yet we fall short of being a part of or benefiting from what's going on... (NWS5, l.53)

Participants acknowledged the importance of being able to make a living in order to support themselves and their families (NWS3, l.43; NWS5, l.53, l.91; NWS7, l.80; NWS6, l.82; l.183; NWS1, l.132). Yet, there remained a sense of understanding the need to retain a sense of balance with traditional value systems. One participant talked about commercial harvesting practices being an important traditional practice of his parent's lives. He was able to participate in this practice growing up (NWS3, l.43). Learning the traditional practices of commercial harvesting instilled values and knowledge were carried on into his adult life, even though he did not make a living doing the same kinds of activities that his father did. One participant described the unpreparedness of young people to make informed decisions about their future participation in mineral resource development as a direct result of short-comings in curriculum. The participant felt that school curriculum did not provide adequate opportunity to develop personal and cultural value systems. For this reason actions ultimately lead to environmental damage and individuals aimlessly seeking, and not finding, fulfillment through western type lifestyles (NWS8, l.176).

Another participant described the grief felt as a result of living in northern Saskatchewan and not being able to be out on the land because he could not afford the items needed to survive on the land. This participant felt a great connection to the land and wanted to include traditional practices within his life but felt powerless to overcome the economic barrier. As a result, alcohol became a destructive force in his life for some time (NWS7, l.80). One of the participants described a similar situation of the economic barrier to traditional land use, but was able to access family support to overcome this barrier. She described how she developed a real sense of who she was by spending time on the land with her father (NWS6, l.82). Two of the participants described the school economic environment as a barrier to learning traditional knowledge. Often there is insufficient funding to access equipment or to compensate Elders appropriately (NWS7, l.188; NWS6, l.119). Beyond school concerns, one participant described how traditional knowledge is taken from Elders by resource developers in consultation processes, but there is no reciprocal value returned to the Elders once the resource is developed (NWS7, l.190). Yet, it was understood that many Elders are supporting their children and grandchildren financially and no longer have a means of generating any revenue from the land. The Elders often participate in consultations and workshops as a means of supporting themselves (NWS6, l.210; NWS7, l.218). One participant commented that participation in the economy was extremely important for individuals, communities, and for Métis People. Participation in economic development activities would ensure personal survival for individuals and maximize opportunities for future generations of Métis that otherwise might be missed. This participant acknowledged that identity and traditional value systems are important, but different, factors in holistic personal development and holistic systemic or community development. He felt that holistic personal development was about healing and self-worth whereas holistic systemic or community development was about social development and the integration of various sectors such as economic, education, recreation and justice systems (NWS5, l.91).

Political Environment

...we are important and we want to be in the curriculum. (NWS3, l.146)

The idea of teaching and learning within a political environment was discussed as an important facet of education. Participant commented that Métis leadership and political rights provided an important way of demonstrating pride in your cultural identity. They felt that pressure from Aboriginal leadership and communities is needed to let others know that Aboriginal knowledge and culture are important and Aboriginal Peoples want it put into curriculum, books and systems (NWS1, l.228; NWS3, l.114, l.146, l.150, l.160). One participant expressed his concern that too often research studies were undertaken in northern Saskatchewan and never accomplished anything useful beyond just being another *study*. These past experiences over fifty years created a sense of apprehension in sharing opinions or knowledge by local community members (NWS9, l.19).

Spirituality

You know, I enjoy the environment. Now, if we can get our teachers, our science people, doesn't matter kind of, what subject your teaching, get them in that kind of environment where they enjoy going out to the bush, doing all these things, you know. Man, the kids are going to pick up on it and all that whole thing I just talked about, that's spirituality. Its how you perceive to see yourself in that situation, how you want to see yourself in your place... (NWS9, l.166)

Our society is becoming very materialistic and very greedy. There's no spiritual sense for the majority of people that exist on our planet today. The spiritual side is slowly depleting from the real sense of spirituality...But you know, this is it, we lack spiritually, it's lacking in the schools. There's no sense of spirituality in this school, maybe a little tiny portion, but we need to teach our kids, like I say, as soon as they hit the school, about their own spirituality. (NWS1, l.192)

The interview participants referred to spiritual beliefs as an integral part of living a balanced and harmonious life. Some of the participants talked about spirituality as being based in medicine wheel teachings (NWS5, l.67; NWS1, l.192; NWS9, l.100). One participant talked about spirituality as an intangible quality emerging from a connection with the land itself. There is a need to begin with even a small belief by the teacher that by going out onto the land, observing the land and using a holistic approach to teaching and learning they can be successful in their teaching. Teachers need to believe in their students and the things that students are capable of doing. This participant felt that if a teacher does not want to integrate land-based experiences a negative feeling is generated and it will impact the teacher, learners and also the Elders involved (NWS9, l.166). One participant held both Christian and traditional spiritual beliefs. This participant described a process of continuous learning and application of both belief systems, sometimes switching among belief systems and sometimes combining the belief systems to illustrate a point within the interview (NWS1, l.192). This participant also commented on being mocked by colleagues for openly displaying spirituality (NWS1, l.410). Another participant commented on the policy decision-makers only making a superficial effort to include spiritual beliefs in formal education (NWS9, l.104). There was no consensus on who should teach spirituality or where it should be taught. Some participants felt that it was inappropriate for teachers to attempt this (NWS9, l.104); others felt that it should be integrated into the school (NWS1, l.192). Participant comments showed that there is a general apprehension or uncertainty about including spirituality in education, yet all agreed that it is a key part of living in connection with culture and tradition.

Health

You can't learn everything from the book. The teachers are there to teach kids, they use books, but when you go out there in the bush it's totally different what you tell in the books and what you tell if they see that thing. It's different. (NWS4, l.426)

The land to me is rich with everything and if you don't have that than you see them just crumbling as people. (NWS6, l.32)

The participants talked about health care as originating with the health of the earth, learning how to use traditional medicines, living in a respectful way and passing on knowledge so that others can be healthy also. Participants expressed a wish for stereotypes to be broken down regarding teaching and learning traditional cultural practices within science education (NWS7, l.236; NWS8, l.88; NWS9, l.100). One participant shared stories about two Aboriginal women who were midwives in northern Saskatchewan. These women provided health care to hundreds of women in the region, delivering babies, providing traditional medicines and teaching correct use of medicines. There was also a willingness to teach the medicinal plant knowledge to others if proper protocols were respected and trusting relationships were developed. There was an understanding that some of the medicines were extremely dangerous, or lethal, and so only certain people would prove to have the skills necessary to work with medicinal plants (NWS3, l.86).

Participants commented that it is important to have many different forms of life and to understand biodiversity and knowledge diversity. Being too reliant upon one type of knowledge is similar to not honouring the diversity within ecosystems (NWS8, l.72; NWS9, l.180). Participants talked about their fear of pollution. One participant mentioned that northern Saskatchewan is becoming polluted and feared that polluted medicines would affect the Elders and children using them (NWS6, l.11; NWS8, l.76).

Following protocols was deemed to be a cornerstone of health care. For most participants, the first step in any protocol is to demonstrate respect (NWS3, l.82). It was also mentioned that when young people are taken out into the field to learn about medicines they need to understand that only the Elders should actually touch the plants as teachings are being shared (NWS8, l.88). If someone such as a teacher does not know about traditional spiritual teachings, approaching the situation respectfully will take them in the right direction. Including the opportunity for young people to learn spiritual beliefs is an important part of developing a holistic science education. However, the teacher must also practice what they are teaching kids. If the teacher is not following what they are teaching they won't feel good about themselves, and the kids will see that and not learn what is being taught (NWS9, l.176).

Health and healing were talked about as directly related to identity and respecting cultural practices. Participants described a healthy life as one that was connected to the Creator, the earth, your own spirituality, absence of blaming others, peacefulness and respectful interaction with other nations encountered throughout life (NWS1, l.192, l.394; NWS7, l.82). One participant commented that it is important to respect protocols but also to be considerate of all nations. Two participants spoke specifically about medicine wheel teachings and how they facilitate human development throughout life. This was considered to be essential to building a healthy life in learning about self, where you come from, what has happened in the past, establishing personal boundaries, how to build a perspective to

feeling good about yourself and building respect and trust (NWS5, l.67; NWS1, l.394). Other participants talked about learning how to have a healthy life by being out on the land learning medicines and traditional skills (NWS4, l.342, l.402; NWS6, l.32, NWS7, l.236). One participant commented that young children should participate full time in traditional activities for a whole year in order to establish a base for future participation in cultural activities (NWS5, l.176).

Balance

One element that's missing to balance their lives is spirituality. It's not there. So how can they know what's right and wrong, if they don't have no sense of spirituality? Even us as individuals, if I don't have God in my life...I wouldn't be balanced. I'd be off balance because there's some element that's missing. Because you have to look at yourself on your physical, emotional, spiritual and mental. If you can't balance your life that way, there's something wrong, you don't survive. (NWS1, l.204)

A lot of people have different perspectives of medicine. The medicine wheel has these different colors. But each community has their different colors. But a medicine to me is when you have a headache, you take a pill. A medicine wheel in regards to what you want is a medicine to be able to correct you or work with you, to understand you, what hurts you and why is it that you can't get away from this hurt. (NWS5, l.67)

Throughout the interviews with Métis participants, the importance of having a balanced life was spoken about both directly and indirectly. Since the dialogue was focused on the education of Métis youth, participants began with responding in that regard but extended their comments to include youth and adults generally. Participants expressed a wish that their children and grandchildren would have balanced lives (NWS5, l.69; NWS4, l.253-259; NWS1, l.216). The dynamics of living a balanced life emerged in a number of different ways. One participant felt that respecting the choices youth make is very important, even if those choices lead them away from the fragile threads parents are able to provide to culture and tradition. The premise of the medicine wheel teachings infers choice but one has to find it themselves. It is difficult for young people and adults to have the things contemporary life offers and remain connected to traditions (NWS5, l.69). One participant felt that Métis youth need to be exposed to traditional teaching of life on the land by others in the community. This would provide a model that would encourage them to stay in their local northern community and not get involved with people who would have a negative influence on them. This participant felt that this was really the only way that Métis youth should be taught (NWS4, l.253). One participant felt that the absence of spirituality in the lives of youth was the most disruptive factor in having a balanced life. The participant felt that having a balanced life meant inclusion of the domains of the medicine wheel teachings including mental, physical, spiritual and emotional aspects of self-development. Respecting this balance would ensure personal survival (NWS1, l.204).

Harmony

Over hundreds and hundreds of years, a lot of our people, not only here in this region, but all over the north...wherever Indigenous people are they lived in harmony with their environment that they were in. The funny thing about it, if I

was to go ask the Elders around here about it...like when do you...cross the ice, all those other things, all those factors coming in, they would sit there and laugh at me. Because, over the years they've learned this is passed on from generation to generation; how to live and survive off the land, the things that they have to do for them in order for them to go from one season to the other. It's just something that we know. It's not things that's written down, you know '3:45 on a Friday - this is a good time to cross the ice'. All those things. They have that respect with the earth, with Mother Nature and environment. So they know and it has been taught to them over the years. (NWS9, l.15)

I don't personally believe that people in the north are really being considered with respect to education or science, because they [youth] can't make the connections that are provided or presented in curriculum to their everyday life. (NWS8, l.27)

Understanding the concept of harmony was spoken about by interview participants as a matter of demonstrating an understanding and respect for the environment, protocols and traditions practiced by previous generations of local people. One participant explained how taking young people out onto the land provides the opportunity for them to learn traditional teachings from local Elders of the protocols of offering tobacco, the life cycles of animals, harvesting knowledge and other things individual learners may wonder about during the course of the experience on the land (NWS9, l.88). One participant explained that trust and respect are part of protocol and that Elders will observe you in order to decide whether you have gained their confidence and trust. Only after a trust relationship is formed the Elders may teach you what they know about certain things. If the Elder is uncertain, they may ask someone else about you, or ask someone to find out more about you (NWS3, l.82-86). This infers that the protocol of trust-building extends beyond the people directly within the teacher-learner relationship to include others within the spheres of the teacher's life and the learner's life. Other participants talked about various forms of respect that have been absent from the education system and society in general. One participant commented that it is important for teachers to show respect for all nations of people by thinking critically about how they assess students. The teacher needs to know where the student came from and something about the student's culture in order not to make inappropriate assessments about the student's abilities (NWS5, l.67-91). The same participant commented that if the *system* can enhance the confidence of Aboriginal Peoples, there will be a greater respect for the *system* by Aboriginal Peoples (NWS5, l.168). All of the interview participants talked about the current generation of youth lacking the traditional knowledge which would contribute to harmonious relationships with others and with the natural world. Participants structured their stories and comments around traditional teachings they learned from grandparents, and acknowledged that many adults and most youth no longer live these teachings, or even know the teachings, as a result of the disconnection from first-hand experiences on the land and to the traditional teachers.

Values

If you do assessment based on a culture, the values, the identity, you have a totally different curriculum. (NWS5, l.91)

...that whole idea is nothing new to the people in northern Saskatchewan or for the Aboriginal People for that matter. Because we had... to use that for a long,

long time, since as far back as anybody can remember and anything is recorded. The final outcome is, you know, going back into the whole idea about traditional values and those kinds of things. Those had to be used in order for you, and the things and the process of getting there is what they call the indicators now. (NWS9, l. 88)

The participants did not attempt to define the concept of values. Rather, throughout the course of the interview process, participants described stories, personal experiences and their own understanding of lifelong learning in relation to place, culture and traditions. Each participant had a unique set of experiences that formed their own value system, but also acknowledged throughout their stories where contemporary life created divergences from traditional Métis life on a trapline, use of original languages, social and economic well-being of individuals and families, and respect for Elders, traditional medicinal knowledge, animals and harvesting practices (NWS5, l.47, l.55; NWS3, l.86, l.134; NWS7, l.12, NWS4, l.128). In this regard, the participants spoke from common understandings of cultural practices even though they were from different communities, were different ages, genders, and had no knowledge of what other participants said. One participant questioned how much Métis culture and values universities are carrying to be able to teach university students, including Aboriginal university students (NWS5, l.59).

Additional Concepts of Importance to Métis

Teaching

Throughout the interviews, participants talked about *teaching* as a means of cultural retention and transmission. For example, Elders teach, teachers teach, parents teach, we teach each other, etc. and by teaching others we learn also (NWS5, l.115; NWS3, l.152). When we lose the parental ability to teach through traditional activities it is a sacrifice for children's opportunity for career (NWS5, l. 156). Learning through teaching is a concept that is not necessarily explicitly depicted on the Métis Holistic Lifelong Learning Model.

Pedagogy

There's a continuum of teaching/learning, where learning with the most impact is doing is out there doing camps or doing other experiential things with Elders and traditional land users. If you can't do that, the next best thing is to have Elders in to teach directly through their stories. If you can't have that then telling stories that you've heard from Elders. Finally, if you can't do that, then you're sort of just stuck with book stuff (NWS8, l.150). It is also important to recognize that if you are out on the land, trying to teach too many learners at once will be unsuccessful. The learners need to be close to the teacher and to what is being shown otherwise they will not get the full information and lose interest (NWS4, l.201).

Traditional Activities

There are many science concepts and technical skills that can be learned from traditional activities. For example, canoeing, hunting, camping and fishing are activities that most young people would enjoy. Educators could identify the physics, chemistry, biological, geological or other science concepts or skills that students could learn. Methods of learning should be **fun** as well as educational. Methods of

learning should be appropriate to culture and place. For example, construction of a Métis-style sled could be used in teaching structure and design (NWS3, l.134; NWS4, l.60; l.92; NWS8, l.62).

Intergenerational Learning

Elders could also be teaching adults together with the young people learning traditional skills or knowledge. Many adults do not have the language or traditional knowledge (NWS3, l.152).

Story

The use of story is very important as a teaching tool. Teacher stories, Elder stories and student stories are all important. Stories can be funny but teach very serious lessons about your own culture, the cultures of others and culture-clashes (NWS9, l.166). Attention should be paid to the use of metaphor in story. In one story told, the role of mother within a family unit is shown as a metaphor for mother earth. If mother is not happy everyone suffers. If mother is happy everyone is happy (NWS9, l.192).

Oral Tradition

Stories were told about the remarkable memory that traditional land users had. Detailed descriptions of events, places, transportation routes and historical information were all held in memory. Even years later, traditional land users are able to recall the information (NWS3, l.49).

Adapting Technology

One participant felt that contemporary technology should be used to preserve traditional knowledge. Elders could be video taped demonstrating something so new generations of people could learn some things (NWS9, l.68). One participant felt that parents need to spend more time with their children to intervene and regulate the types of programming viewed by their children (NWS4, l.285).

Assessment & Self-Reflection

Traditional forms of assessment were based on readiness of the child as determined by the parents or other relatives. The child also had a role in assessment in knowing their own skill level or limitations in relation to practical tasks. For example, using a firearm at a young age was an appropriate way to learn hunting skills. Safety skills were learned along side of the practical activity (NWS3, l.67, l.69). Teaching traditional activities would provide a means of encouraging successful learning of other subjects as well such as math and language arts (NWS9, l.146; NWS6, l.127; NWS7, l.272). Currently, with tests and indicators, educators require instant evaluation. With learning traditional knowledge, it spans lifetimes and so the whole scale is different. A person goes through phases of learning not specifically time related, but readiness related. There is no shame in being older and learning something that somebody younger might know. It's wherever you are. Some people talk about that as place. For example you're at a certain place in your life where you're ready to learn this or that and maybe a year earlier you weren't ready (NWS9, l.146). Assessment also requires consideration of how the learner's family is structured and how it has evolved (NWS5, l.140).

Multiple Ways of Knowing

Understanding a variety of systems and the benefits and consequences of each is an important part of making good decisions. For example, heavy reliance on western science in mining or harvesting may

result in depletion of resources that we cannot recover from. This is a way of understanding stress on systems and what happens when they break down (NWS8, l.72). Another way of thinking about this concept is how women and men use available knowledge. One participant expressed that his wife felt it was very important for women to have the same skills that men have in order to ensure the survival of their families. In the event of the death of a husband, or at times of being alone, a woman has to be able to fend for herself and her children (NWS4, l.277, l.326).

Goals of Science

Some participants suggested we need to ask *what the goals of science are* and *whose science has what goals*. They believe that since the word science is a western word, it drags you in that direction. Further, it was felt that key goals of western science are military application, commercialization, profit generation, industry, consumerism, capitalism. Some participants described the goals of an Indigenous science as about connecting the generations and learning your culture and history (NWS8, l.112; NWS9, l.124). Another participant described science as the family, a sense of belonging, survival, knowing who you are, what you are, where you come from (NWS5, l.127).

Curriculum

Although goals of science curriculum can remain common, we need additional research into how holistic Aboriginal science curriculum can be customized to place. We need to consider what happens when it's implemented in urban centres, the north or in rural Saskatchewan. There needs to be more dialogue about the concept of learning from place. Subsequently, we need to consider how a customized curriculum can be shared with other learners outside the area so they can learn those things too. Kids need to love learning about science from a rich and exciting curriculum. Educators who love science should be role models in this regard for students (NWS9, l.88, l.90, l.146). **Inappropriate or irrelevant curriculum** that ultimately contributes to student failure does not serve anyone's needs. For example, trying to evaluate students on curriculum that is not northern specific is frustrating and time-consuming for the teacher and does not facilitate reaching objectives of curriculum, evaluation or students (NWS8, l.176).

Time

Teachers are bound by time factors and cannot always include the kinds of traditional teachings they would like to include. Collecting resources over a few years becomes a critical element in teaching in areas where there are limited resources available (NWS9, l.192). Students also need adequate time to observe and practice what they have learned. If teachers are impatient the learner will lose interest and give up. As well, if a learner is not interested they will become a distraction to those who do want to learn (NWS4, l.108; l.116). Teaching and learning a language is also influenced by time. Including it in curriculum once weekly is not enough. A person cannot learn that way (NWS4, l.173).

Recovering from Grief and Loss

Recovery is part of health, but stories of grief and loss, including the loss of traditional knowledge within families, was of significant impact that participants took time to describe the permeation of those experiences throughout their lives (NWS1, l.7; NWS3, l.69; NWS5, l.91, l.115; NWS7, l.72; NWS9, l.146). Recognizing the source of pain is important in making choices for the future, connecting to cultural

sources of healing and motivation to change aspects of your life through reconciliation (NWS5, l.184; NWS4, l.52).

Humour

There were wonderful moments of humour shared during some of the interviews. Although it is extremely difficult to cite a situation where the interviewer and participant(s) erupted into laughter over the double meaning of a response, good-natured teasing, uncertainty of responses, a good rant or other exchanges, the act of sharing laughter brings a richness and warmth to the discussion that brings it to life. The use of humour was not something talked about specifically, but it was a part of all participant interviews. In talking about childhood pastimes, one participant commented, “Ah, we used to have a big tv, oh a big one. My dad bought it for twenty-two muskrats” (NWS4, l.293; l.480).

5.3 Learning Indigenous Science from Place: Pre-Service Teacher Perspectives

LACK OF RESOURCES AND MATERIALS

One of the most common challenges identified by participants in implementing First Nations content in school science is the lack of community-based resources, materials, and general information.

There are a lot of teachers who are non-Aboriginal and so I think they struggle with this because they don't have a lot of knowledge in that area. There are no resources and textbooks. You could call in an Elder, but that is not always easy to do. So it would be very good to document the teachings and practices so that it is available to all teachers. (H, S, 1. 1)

While taking the kids out on the land is important, schools need the equipment for the teachers to be able to do this. "It is really hard to find the resources. Let's say I am from the north and I want to teach in the old ways with animals or whatever. You need the resources like boats and canoes. Where would you get the money to buy these? Someone needs to be in charge of that" (M, S, 1. 2). This participant went on to state, "There is a need for books. Especially when you are incorporating storytelling in your lessons. I notice that a lot of the books and stories are from years ago and we need a lot more than what we have" (M, S, 1. 3).

ELDER INVOLVEMENT IN SCHOOL SCIENCE

A common strategy shared by the participants is the importance of Elders perspectives in school science. "One of the supports, that teachers need is more stories from Elders. There are so many Elders out there who haven't had a voice. If we each get a story from an Elder about something that we actually learned growing up that we didn't realize we were taught. It would be nice to bring that out" (M, S, 1. 3). She said, "If you don't feel comfortable teaching a particular aspect of Indigenous knowledge, then one strategy is to bring in an Elder" (M, S, 1. 12).

SPIRITUALITY IN SCHOOL SCIENCE

Spirituality is an inseparable aspect of Indigenous cultures. While Indigenous knowledge systems are diverse and complex, it is difficult for teachers to incorporate those aspects that have a heavy emphasis on spirituality. "I think a lot of Aboriginal teachings have a spiritual component. It's a real difficult area to get into especially in the Catholic schools where they have their own beliefs on Christianity. And in the Public school system, just how do you incorporate that without offending anyone who has different beliefs" (H, S, 1. 2). One of the fears many teachers face is the issue of non-native people passing on Indigenous knowledge. Some community members may also struggle with this issue particularly if teachers are not from that particular culture (H, S, 1. 11).

INCORPORATING A BALANCE OF ACADEMIC AND FUN ACTIVITIES

Learning standard Western science has often been perceived as a serious academic pursuit with a lot of rigorous mental learning. Rigorous mental learning was also very important for Indigenous Peoples, but there was always balance with fun, humour, and laughter. In contemporary times, many students are often turned away from going into sciences because there is no fun in memorizing a lifeless body of facts

and where there is too much emphasis on rote memory learning. In this story, one of the participants talked about being in a conference where they were required to develop a fun activity in science.

One of the professionals who was in the room had a temper tantrum in the room. That person said, 'I don't know why you people insist that science is fun, science is not fun, science is hard work and you never get anywhere if you just think you are have there to have fun'. And so she had this meltdown in the room and she packed up her stuff and walked out. That's too bad I thought, because science can be fun. (M, S, 1. 12)

EXPERIENTIAL STRATEGIES - 'OUT-ON-THE-LAND' EXCURSIONS

One key strategy identified by the participants is to facilitate experiences where students can have sustained content with the natural world. This can be achieved by taking students to traditional trap lines, fish camps, and other significant places where they can learn about how people interacted with the environment. One participant said,

The formal method of in-classroom teaching comes from the Western world thought. Most textbooks are written from a male perspective. However, traditional knowledge comes from being outdoors and interacting with the environment in an informal way. Teachers need a lot of background information as well as knowledge of these locations where teaching can take place. Students can experience first hand about trapping, fishing, and where the animals are. It is difficult to bring some of those type of things into the classroom. (R, S, 1. 2)

Despite the fact that preserving and passing on First Nations cultures and languages is an important part of self-determination efforts in communities, many schools in Saskatchewan continue to offer cultural and language programs as *options* rather than a mandatory aspect of overall teaching. One participant stated,

Some schools up north offer Cree programs and students have a choice whether or not they want to take these courses. In the Cree language program for example, students learn about the background of certain places. This should be mandatory. It's weird because some communities live right next door to a river or places where people hunt and fish. There are a lot young people who do not know anything about this knowledge and so much of it is being lost. This is a part of science too, and this is their history. (M, S, 1. 2)

One of the participants shared the following about providing opportunities for students to bond with the natural world,

Going on a nature walk just kind of slowed down life for a moment and we just stopped and listened to the different sounds of nature and smelled all the different smells. All your senses just got wrapped up in it. And so I think it is important to do that with your students because they learn to develop a relationship with nature. They develop a respect for nature. I think this is key because of all the pollution. We have a big job ahead of us in fixing our environment with what we have done to it. (H, S, 1. 5)

Other participants talked about using Outdoor education as an avenue to learn school science and a respect for the land.

I think going out on Outdoor Education field trips and taking the time to do a cultural camp would very beneficial and I would like to incorporate that in my teaching when I am out there teaching in the future. It would be good if we had Ghost River Rediscovery

Program here in Saskatchewan. Just to allow youth the opportunity to rediscover the past way of living. (H, S, 1. 7)

I think it is important as educators to teach all people respect for the land because I think we are all at fault. What we are doing that's destructive to the land. We all need to take ownership and responsibility, not only as Aboriginal people, but all of us humans. (J, S, 1. 14)

TEACHING SCHOOL SCIENCE THROUGH OTHER SUBJECT AREAS

One common strategy identified by the participants is to use other subject areas as a vehicle to teach school science. In her story, one participant talked about her experiences in a Physical Education methods class that she took. Everyone chose an activity in the gym. However, she wanted to do something in the outdoors and so she took her students out on the land. The actual walking and hiking was the physical aspect of the lesson. In addition, she incorporated traditional plants in her lesson where students learned to identify what grew in the area. Students were also able to plant trees and at the end of the walk they learned how to build a fire (M, S, 1. 3).

SHARING KNOWLEDGE OF OTHER INDIGENOUS CULTURES

Incorporating the perspectives of other Indigenous cultures around the world has the potential to expand and enhance the scientific knowledge base of students. One of the participants stated,

We live in such a materialistic world right now where everybody is always in such a rush. We need to bring back that simplicity. I think it is important to show videos on how other cultural groups of people throughout the world live. You know like Africa and other tribal groups. Students can learn about how they lived off the land. It is important for students to understand that they are connected to other people around the world. Creator did not create everything for us. We need to get back to that way of thinking, living, and knowing. (H, S, 1. 4)

TRADITIONAL PLANTS AND MEDICINES

A common strategy identified by the participants is to focus on traditional plants and medicines. One of the teachers talked about her experiences in developing a *Learning Centre* on Aboriginal Uses of Medicinal Plants. She used common plants like dandelions and different types of herbal teas that students could relate to. Because there was relevance in what they were learning, the students were very interesting in learning more (V, S, 1. 4).

Another participant stated, "I am interested in learning and teaching traditional medicines. My grandmother was a Medicine Woman and my kid's grandfather was also a Medicine Man. I remember using bear grease. My son also had eczema and my mother made cream out of spruce gum. I am interested in teaching children how to look for different bush roots" (J, S, 1. 6).

TRADITIONAL SEASONAL CYCLES AND CULTURAL EVENTS

Cultural events based on the traditional seasonal cycles are an important avenue where students can learn about Indigenous knowledge and traditional technologies used for survival. One of the participants shared the following, "Fall goose hunts and spring trapping excursions were natural seasonal activities that people engaged in long time ago. Some schools hold weeklong cultural events where students can also learn basket making, beading, storytelling, and feasts (M, S, 1. 7).

This same participant stated the following, “I learned how to make dry meat at a cultural camp. A friend of mind from one of the northern communities taught me. Where else would I learn how to do that? You have to go up north. I used to have a neighbour ... who smoked fish in his smoke house” (M, S, 1. 8).

TRAPPERS AND FISHERMEN IN SCHOOL SCIENCE

Trappers and fishermen were identified as valuable resource people that can be brought into the science classroom to speak to students. They have a rich knowledge base because they have to know a little about everything to survive off the land.

People that you can invite to the school are fishermen and trappers. They can explain to us what kind of traps they use or the kinds of animals they hunt. They are like Elders showing trapping or what they do on a day-to-day basis on the trap line, how they travel, how they catch a beaver. It would be good to teach the whole process of trapping beaver right down to the drying and stretching of the pelt. (N, S, 1. 8)

TRADITIONAL STORIES OF THE NATURAL WORLD

The way in which Aboriginal knowledge is sequenced in the overall science lesson is an important consideration to make. For example, stories are one method that science teachers can use right at the beginning of the day to introduce for example the worldviews of Indigenous Peoples and their relationships with the natural world. Learning Western scientific concepts would then follow. Students learn these stories still have validity today as they explore the underlying hidden messages and core teachings. One of the participants in the interview reflected on the importance of teachers having confidence in the way they work with stories in the classroom. “She was really confident in those legends. She could share with students how rocks are perceived as being alive. For me, I would be too worried that my students would not give those legends any value. They would think I was wacky. So I think the way she did it, the confidence in what she was teaching was really important and it made a big difference” (H, S, 1. 11).

EVALUATION AND ABORIGINAL CONTENT

Fear of science in general was identified as one of the barriers that students often face and so there is a need to re-instill a sense of natural curiosity and interaction with the natural world using Aboriginal methods. In the following passage, the participant struggles with incorporating Aboriginal knowledge and links this challenge with questions about evaluation that end up linking back to how science is defined (‘from place’-author emphasis).

I don’t think there has been a lot of success in science in general. I think people have a fear of science as they do with math. It is sort of a male dominated thing. Anyone that is naturally curious about something and they find out it is science, they just back away from it. Incorporating Aboriginal knowledge is about natural curiosity and interaction with the world. How do you assess that? You can only look at, how do you assess the change in a person’s eyes when they discover something for the first time or catch their first fish, or you know, how do you put that on paper? How do you bring that into the classroom? That’s where we need the definition of science I guess. (C, S, 1. 10)

Constructivist and critical approaches to teaching science were mentioned as a possible doorway for science teachers to bring Indigenous knowledge systems.

She uses constructivism in her science classroom which is really good. You provide opportunities for students to construct their own meaning of what they are learning in science. It takes the maleness out of science. Students are allowed to discover on their own what it means and so I guess you just have people reflect and write about they learned. That is just as effective as anything else. (H, S, 1. 11)

ENVIRONMENTAL CONTAMINATION

Environmental contamination is an important area of focus for school science. One of the participants talked about concentrating on water for example. The participant said,

No one owns the river. I can paddle up stream and down stream and I am on the edge of the world. What bothers me is what is being dumped into that river. We need to also know learn about environmental laws. I know when I am drinking water out of this river next to my community that I am drinking out of the Saskatchewan River here ... I know I am not going to go and dump something into it that is going to pollute it and it will also head down stream and hit someone else's drinking supply. It really angers me because people just don't seem to think beyond their living rooms and televisions. They are sitting there unconnected to the land and really don't realize what they are doing, how it's manifested as a corporate entity. I will never know. The more technology we have, the farther away we get from nature and from realizing our own footsteps and the impact we have. (M, S, 1. 13)

One of the participants shared an activity that they did on land use. The river was used as an example. Students were divided up into groups. They were each given a sheet of paper. "We all had a little section of the river that we could do whatever we wanted within our little group. Some of us beautified it, some of us industrialized it; it was a perfect model of what is actually occurring in the world. We put the river together. Each piece of paper represented a plot along the river, like a river lot" (M, S, 1. 14).

RECYCLING AND SCHOOL SCIENCE

Community-wide recycling and ways of conserving energy were mentioned as important topics to cover in school science. One of the participants talked about the lack of recycling programs in many communities.

Up north there is not a lot that you can do for recycling. Everything goes to the dump. There are no recycling facilities in the north. What do you do and how do you teach that? My cousin from northern Manitoba came to visit me last summer. She would take a half hour shower and she would wash the dishes while the water was running. I asked her if they practiced conserving water, and she said no. They don't have a clue what is going on even if they see it on T.V. They think it is only for the white and not for Aboriginal people. (H, S, 1. 5)

5.4 Learning Indigenous Science from Place: Teacher Perspectives

LACK OF KNOWLEDGE OF FIRST NATIONS PERSPECTIVES

I think some teachers don't have the knowledge or are afraid to approach science from a First Nations perspective. They don't know the protocols. They don't want to try. They don't know how to approach elders. However, I find that schools are always asking. (S, SPS, 1. 1)

Lack of knowledge of First Nations perspectives was cited as a big problem for many teachers. One participant stated the following,

I am always surprised when teachers are required to teach First Nations content, they are always concerned with protocol and they are concerned about not being able to teach it properly. However, we never seem to be too concerned when we are teaching Chinese content, African content, and whole bunch of other different cultures. It just seems that when it comes to First Nations content that all of sudden there is a discomfort level. And that sort of bothers me. (M, SPS, 1. 1)

Teachers with First Nations heritage also struggle with incorporating cultural content. Quite often people overlook the diversity that exists within First Nations communities and expect all First Nations teachers to be *cultural experts*. One of the participants shared the following

I was not raised with a lot of culture and history. The first time I was really exposed to it, was during my internship. I was asked to teach this big huge unit on heritage and about First Nations and Métis People. And really, that in its' self was kind of an act of racism. But I did get through it in my internship and I did a really good job of it and then I started learning more. (M, SPS, 1. 1)

The participant went on to state, "I think a lot of people are racist and they don't realize that they are being racist. I had this one person ask me if I had any *moccasin thread*. This same person asked me a month later if I knew how to *hand weave* a Métis sash. I finally said to her, you know I am Cree, not Métis. Why are you always assuming that I know all of this Indian stuff?" (M, SPS, 1. 5). Similarly another participant validated this response in the following way,

I've been through that too. It almost seems like, when other people realize you are a Cree person, or you are a Cree teacher, or a Cree cultural teacher, you are suppose to have all of that knowledge. Like you are supposed to carry around your suitcase of Cree culture and knowledge. They come up to you and ask you all sorts of crazy things. I had a teacher who came up and said, 'I need to present this Tobacco can you come and present it for me?' And I said 'no'. 'If you have Tobacco, you can present it yourself'. It is just respectful to do it yourself because you are the one requesting help from the Elder. (S,SPS, 1. 5)

LACK OF RESOURCES AND MATERIALS

One of the common responses from the participants was a lack of resources and materials in relation to incorporating First Nations and Métis perspectives in school science.

The biggest barrier in my first year of teaching was the lack of resources. They were spread out all over the place. Our school had nothing. Even our culture teacher, she was expected to do the culture program for the first time. It was being piloted and she was just all over the place. She

had nothing to go from. So this was one of my biggest barriers. Even my involvement with ... grade six we were required to integrate Indigenous knowledge in the science curriculum. The biggest challenge was that we all had to do things from scratch. There were not a whole lot of resources out there. We were also not given a list of resources. (M, SPS, 1. 2)

One participant talked about creating a digital repository where materials and resources can be stored for easy access by teachers. “Basically the idea is to bring together the information, have a place to store it, and it is always being edited and always being changed. If you are not comfortable with what is there, you can have place where you can work on it some more. You can see what other teachers are doing (L, SPS, 1. 17).

The participant spoke about the need to create a guide called *Aboriginal content delivery for dummies* where teachers can learn about frequently asked questions. Or it could be a showcase for ‘everything that you wanted to know about Indians but were afraid to ask’ or ‘everything that you wanted to know about elders’ (L, SPS, 1. 18).

ELDER INVOLVEMENT IN CURRICULUM DEVELOPMENT

It always leads back to the Elders that have Indigenous knowledge. And it doesn't have to be Elders; it can be people who have been brought up by Elders.
(S, SPS, 1. 16)

All of the participants talked about the importance of Elder involvement in the development of science curriculum. One of the participants describes her experiences in a developmental science program. Each teacher in a group was required to pick a unit they would concentrate on during the year. They were required to learn about the protocols in approaching Elders in the community. “First of all, we sat down with the Elders and talked with them about two or three times. And then we brainstormed as a group. And then we went out and tried to integrate it” (M, SPS, 1. 2).

PARENTAL RESISTANCE TO ABORIGINAL CONTENT

Even though science teachers are required to incorporate First Nations and Métis content, they are often required to defend what they teach in the classroom. This takes a lot of energy and time away from teachers who could better spend their energies implementing and testing out new ideas that will enhance the scientific consciousness of students.

I picked space and the students just loved the activities that we did. But before I taught it, and after I taught it, the parents were coming in and asking, ‘what are you doing? What are you teaching, what does this have to with our student culture, why are you teaching First Nations this and that?’ I am tired of having to defend incorporating First Nations content in the classroom. I think if it comes from the top down, it makes a difference. I look to the provincial Ministry to send me the rationale and philosophy and why we are doing what we are doing and then I just give that to the parents. (M, SPS, 1. 2)

While there is resistance from some parents, there are also many other parents who are non-Aboriginal who believe First Nations and Métis content is important. “There are a lot of people who appreciate it. I had one of these parents she was my psychologist years ago. She thought it was just great and there was a lot of appreciative parents, like parents who are teachers as well. But then there was a lot of other parents that were just on the other side of the coin” (M, SPS, 1. 3). One participant shared a story about

how German people are fascinated with Aboriginal culture (S, SPS, 1. 21). Parental resistance is linked to a general lack of understanding of Aboriginal history and culture. “Even in First Nations communities, there is denial of the impact of Residential Schools and how traditional knowledge ways were lost through these institutions” (S, SPS, 1. 3). One participant talked about parents wanting to know how their children were being evaluated. “My main issue in incorporating Indigenous knowledge last year was that parents and children wanted to know how they were being evaluated. They wanted something concrete. They wanted to see an actual measurement” (M, SPS, 1. 23).

SYSTEMIC CHANGES TO SUPPORT ABORIGINAL CONTENT

Participants in the focus group identified a general lack of systemic support in relation to incorporating Aboriginal content. Not only are there a low number of Aboriginal educators working in the provincial education ministry, there is also a critical need for more Aboriginal science teachers. The turnover rate of Aboriginal consultants is high and there is no consistency in delivery of content. Even when there are supports like cultural teachers, these people often get shifted around where they are moved from classroom to classroom and school to school. “I think First Nations teachers in our division have been very proactive to no end and with not a lot of results. Our system has not really done a lot to make sure that First Nations People are being successful. There is no hiring policy to hire more First Nations People” (M, SPS, 1. 6). “We even share all of our material. I was so exhausted that I applied for leave because I felt like the program was not being taken seriously” (S, SPS, 1. 6).

Another participant talked about the need to work closely with a local cultural centre in the province. “We need to develop relationships so that we are not trying to do it ourselves but work with the arms of the FSIN [Federation of Saskatchewan Indian Nations] that have been commissioned. This is their job. We don’t need to reinvent it. We just need to increase their capacity as well” (J, SPS, 1. 19).

RELEVANCE TO LOCAL COMMUNITIES

One of the common strategies identified by the participants is to focus on relevance. The idea is for teachers to make connections between science and the communities and cultures of First Nations and Métis learners. One of the participants stated,

You have to make it relevant for them. Use anecdotes and stories about Aboriginal cultures. Bring in talks about traditional medicines. Study adaptation and succession where you can pull in talks about relationships with animals and plants. The minute you make a connection with their culture, they listen more, and then they have things to say. They ask questions and that’s the big thing with us is developing questioning skills. Since most of my students are going into the scientific fields, our main goal is try to create a life long interest in science and hopefully when they have their own children, they will be able to pass on the passion. But you need to be interested in collecting that knowledge on your subject matter yourself. So, even if the resources are out there, you have to be interested in finding it and not just having it on a piece of paper, like not just having the unit, you have to know it. And that’s difficult for me, because I have to look at a whole range of units and I have to find a body of knowledge that I can pull out when kids ask questions. So it is about developing a broad body of personal academic knowledge. (L, SPS, 1. 4)

ABORIGINAL LANGUAGES

Aboriginal People have names for everything in the universe including the land, animals, and plants. (S, SPS, 1. 11)

One of the issues identified by the participants was the diversity of First Nations languages spoken by students in the public school system and the general lack of materials and resources that reflect this diversity. "In our school one of the problems that we keep on coming up against is that that majority of materials are Cree centered. We seem to be getting more and more kids who grew up in Dene speaking areas" (L, SPS, 1, p. 7). Another participant talked about learning the language in order to reach students. "I had to kind of learn a little bit of Dene to incorporate it. At least identify the alphabet so that they can become interested in it. So I used to create little activities for them. I am teaching them how to respect another person's language" (S, SPS, 1. 7). Another participant talked about the limited impact of language immersion programs. A lot of times these programs are located far from the central area of the city where there is a majority of First Nations language speakers. When the children go out for recess after having done Cree lessons for example, they are conversing in the English language (S, SPS, 1. 8). This same participant talked about the importance of First Nations language immersion programs for parents as many have lost their languages through the Residential School system.

INCORPORATING ABORIGINAL PERSPECTIVES IN SCHOOL SCIENCE

You need to think what is around you. How people lived long time ago. (S, SPS, 1. 13)

It is important to know about natural time, and the same with seasonal time. There was a time of the season where you can hunt. There is a time where the animals were bearing their young. And there is a time when they are getting fat. So they knew when to go out and hunt. (S, SPS, 1. 15)

I think teamwork is important. Elders, teachers, parents, and children should be involved in planning a curriculum. I think they call it a generative classroom. It's like creating a garment where everyone is involved and collaborating. We come together. We can add other team members as we see fit. We learn from each other and we learn the interests of the students and what works for them. (S, SPS, 1. 17)

There is the core curriculum that you have to teach and there is the adaptation. There is room to adapt any kind of Aboriginal content and I think more teachers need to know that. Yeah, it's your job to incorporate wherever you can and it is also your job to educate yourself on what you don't know. (S, SPS, 1. 26)

One participant shared the follow strategy in relation to incorporating Aboriginal perspectives in school science.

In my grade six classroom room we did a space unit. We talked about the moon and the moon cycles. We explored the story of creation of the moon from an Aboriginal perspective. And then I had my class create an English/Cree calendar and so they had all of the months in Cree, like the hatching moon and the eagle moon. I had them insert clip art of actual animals in the computer. I

had them plot the stars and do a story. We also did birch bark biting to make stars. I integrated a lot of art. (M, SPS, 1. 12)

Another participant shared the following example of how she connected students to *Place*. “In my grade eight classroom we did mapping and location of *Place* names. I had them explore a map of Saskatchewan and locate all of the Cree names of *Places*. Even some streets and apartments have Cree names. They were really interested in finding out the origins of those names and it took us a month to do this project” (S, SPS, 1. 13).

In summary, the participants in the study talked about incorporating the following focus areas that they deemed important to First Nations contexts: Climate Change (L, SPS, 1. 9); Seasonal Cycles, Weather patterns and Forecasting, Animal & Plant Cycles (S, SPS, 1. 10); Using creation stories and making comparisons with stories from other cultures (S, SPS, 1. 14); Using Talking Circles (S, SPS, 1. 15); Using Traditional Seasonal Calendars as a guide (M, SPS, 1, 11); Elder teachings of the natural world for each calendar month (S, SPS, 1. 15); Diseases of Acculturation such as Diabetes (L, SPS, 1. 9); Obesity and Nutrition (L, SPS, 1. 9); Traditional diet (S, SPS, 1. 11); Germ Warfare (L, SPS, 1. 10); Astronomy & Stories (L, SPS, 1.10); Comparing Greek and Aboriginal constellations (M, SPS, 1. 12); Ethnobotany and Medicines (L, SPS, 1. 10); *Place* names, origin of those names, and the stories behind the names (S, SPS, 1. 13).

5.5 Discussion of Findings

The information emerging from the First Nations, Métis, pre-service teacher and service teacher interviews provided a wealth of data to illustrate current thoughts about Learning Indigenous science in relation to *Place* and the role of Indigenous science in contemporary science education. In bringing together this study as members of the research team, we knew we faced a daunting task not only in developing research questions and interview questions that could provide meaningful data to begin this exploration of Learning Indigenous science in relation to *Place*, but in presenting the findings to a diverse audience of scholars, education administrators and technicians, teachers and Aboriginal community members in a way that was helpful to their lives within their unique particular contexts.

The research team recognized early in discussions dating back to 2005 that the largely unexplored scholarly area of Indigenous science, coupled with increasing pressure on educators to include Aboriginal content in all school subject areas, might result in greater than normal expectations placed on this research to produce *recipe* formulas for inclusion of Indigenous science concepts in school curriculum. As researchers, we found it necessary to resist the temptation to try to respond with absolutes in a positivistic manner, but to remain true to the dynamic changing holistic nature of Indigenous science.

Using the Clue Structure system of analysis provided a means of examining participant commentary within the frameworks of the Holistic Lifelong Learning Models put forward by First Nations and Métis communities in 2007. Information on the Models can be found in Section 4.1 Holistic Lifelong Learning Models of this report. Although the Models were drafted about learning in general, the research team saw this as an opportunity to test how the outcomes of interviews about Indigenous science might appear in relation to the Models. If the messages of holistic learning, as depicted on the Models, were the beginning of a tangible illustration of the important features of learning, we believed the results of the Indigenous science study might be able to be mapped in the same manner.

For example, imagine if you will, one of the Models, First Nations or Métis, as colour image flat on a table. Next, imagine the data emerging from the comparable First Nations or Métis interviews as a transparent image superimposed onto the base Model. We should be able to see if the same concepts emerged from the interviews, what was said about the concepts in order to help bring meaning to them, what additional concepts emerged and what established concepts might have been missing from the interview data.

The research team found the themes depicted in the Holistic Lifelong Learning Models did indeed emerge from within the interview data specifically concerning learning Indigenous science in relation to Place even though the participants were not provided with the Models for the interviews. The research team also found that a number of other concepts came out of the interview data that could be considered for future iterations of the Models as new primary concepts, or as data that supports existing concepts on secondary or tertiary levels as sub-concepts or indicators. Future research on the Holistic Lifelong Learning Models would be necessary to bring a detailed analysis to that consideration.

The research team also recognized that there are very significant sensitivities around analyzing data that is tested against cultural worldviews as expressed by members of the cultural communities themselves in the creation of the Holistic Lifelong Learning Models. Worldviews cannot be re-manufactured with research in the way that theories can be tweaked, discarded or recreated. Rather, worldviews exist and as researchers we try to understand the parts and the whole, and in this case perhaps, how we might better understand Aboriginal perspectives of in relation to provincially developed and delivered science curriculum.

The literature selected to help contextualize this research brings forward a picture of the history of Aboriginal education in Canada, the contemporary status of Aboriginal education in Saskatchewan, an overview of the concept of Indigenous science and some of the discourse regarding Indigenous science education. The literature review, Holistic Lifelong Learning Models and interview data provide a triangulation of evidence that can help educators and educational authorities build new perspectives of science education that are culturally sensitive, culturally relevant and inclusive of the areas of learning expressed as integral parts of First Nations and Métis learning experiences.

Aboriginal teachers and pre-service teachers participating in this study provided valuable insight into the challenges they, and all teachers, face in integrating First Nations and Métis content into curriculum in general. The responses fielded from the service and pre-service teachers do not fit into the concepts illustrated on the Holistic Lifelong Learning Models. In this case, interview questions focused on an inquiry different from that used for other Aboriginal community members. As expected, the data reveals that most of the service and pre-service teachers feel that they personally do not have the traditional knowledge required to adequately integrate Indigenous science into curriculum in a meaningful way. Perspectives shared by the teachers and pre-service teachers bring a sense of what the impediments to integration of Indigenous science are, where they are occurring and where they are likely to continue to occur. The interview data shows that without a concerted systemic effort ranging from community participation to government policy the status quo is unlikely to change.

5.6 Summary of Research Findings and Conclusions

The purpose of this research study was to investigate how educators and education systems might take up *place-based* Indigenous science and apply it within the established school science curriculum. To do

this, five central questions were developed by members of the *Indigenous Knowledge in the School Science Curriculum Committee* in the construction of a collaborative research proposal.

The following is a summary list of research findings based on key thematic categories that emerged from the study. These findings are compared with the Holistic Lifelong Learning Models for First Nations and Métis using the Clue Structure approach to analysis described in Section 4 Data Analysis.

More specifically, the summary list of the findings emerging from the interviews and focus groups are provided for First Nations, Métis, pre-service teachers and service teacher participant groups. The findings are presented first according to themes illustrated on the relevant Holistic Lifelong Learning Models (Appendix 1 and 2).

First Nations and Métis Lifelong Learning Model Themes

(Extracted from the ABLKC / CCL June 2007 models)

Métis	First Nations
Self	Self
People	Ancestors; Family; Nations and Other Nations; Community; Clan
Land	Natural World
Physical Environment	
Languages and Tradition	Languages
Sources of Knowledge and Knowing	Traditions & Ceremonies
Social Environment	Social
Economic Environment	Economic
Political Environment	Political
Spirituality	Spiritual and Culture
Health Care	Collective Well-Being
Balance and Harmony	

First Nations and Métis Lifelong Learning Additional Themes

(Extracted from interviews)

Métis	First Nations
	The Land & Place as Teacher
Values	Holistic Worldview
Teaching	Traditional Values
Pedagogy	Seasonal Cycles
Traditional Activities	Elder Involvement & Elder Helpers
Intergenerational Learning	Traditional Protocols & Ethics
Story	Traditional Technologies
Oral Tradition	Experiential & Hands-On Learning
Adapting Technology	Stories & Storytelling
Assessment & Self-Reflection	Orators and Oral Speaking Skills
Multiple Ways of Knowing	Trapline & Fish Camp Excursions
Goals of Science	Traditional Plants & Animals
Curriculum	Women's Ways of Knowing

	Dreams, Visions, & Intuition
Time	Intellectual Property Rights
Recovering from Grief and Loss	Feasts & Community Gatherings
Humour	Humour & Fun Activities

Pre-Service and Serving Teacher's Themes

(Extracted from interviews)

Pre-service Teachers	Teachers
Lack of Resources and Materials	Lack of Knowledge of First Nations Perspectives
Elder Involvement in School Science*	Lack of Resources and Materials
Spirituality in School Science*	Elder Involvement in Curriculum Development
Incorporating a Balance of Academic & Fun Activities	Parental Resistance to Aboriginal Content
Experiential Strategies – <i>Out-On-The-Land</i> Excursions	Systemic Changes to Support Aboriginal Content
Teaching School Science Through Other Subject Areas	Relevance to Local Communities
Sharing Knowledge of Other Indigenous Cultures	Aboriginal Languages*
Traditional Plants and Medicines	Incorporating Aboriginal Perspectives in School Science
Traditional Seasonal Cycles and Cultural Events	Student research projects on TEK
Trappers and Fishermen in School Science	Preservation of First Nations Knowledge Systems
Traditional Stories of the Natural World	
Evaluation and Aboriginal Content	
Environmental Contamination	
Recycling and School Science	

* These themes are depicted on either the First Nations or Métis Holistic Lifelong Learning Model

5.7 Research Questions

What is a First Nations perspective [of learning Indigenous science from place] for the purposes of curriculum development in Saskatchewan?

Despite decades of policies calling for cultural and language content inclusion in all subject areas in Canada's reserve schools, the responses of participants in this study clearly shows that incorporating First Nations perspectives in school science remains a unique challenge for educators in Saskatchewan.

Throughout the interviews, the overall responses captured a real need for more in depth research at the grassroots community level. This study involved a sparse, but indeed a good representative sample of a moving glimpse that captures what schools are doing, to meet the needs of First Nations students in science education. The goal of this research was not about coming up with a universal *one-size fits all* approach to incorporating First Nations culture content as this is something that is highly contested by many scholars who work with Indigenous populations around the world.

First Nations perspectives emerge from a particular place that gives voice and form to a particular culture, worldview, language, values, beliefs, and knowledge systems. In Saskatchewan, there are five major First Nations cultural groups that include the Cree, Dene, Saulteaux, Dakota, and Assiniboine. It became clear in this study that geographical distance, time, and travel to 70 plus reserve communities within the province is a daunting task that could easily be relegated to a multi-year research project. Although there were participants from these groups, more community-based research is needed to fully capture the essence of their perspectives in relation to cultural and linguistic content inclusion in school science.

From this research we highlight the incredible advances that have been made in the area of First Nations education since the Indian Control of Indian Education policy was introduced in the early 1970s. Indeed many provinces and school divisions advocate and support the visions of First Nations communities in ensuring their perspectives are foundational to any curriculum that is developed in their traditional territories. This study is meant to build on the strengths of this momentum. After listening to all of the participants, the research team felt that further dialogue is needed within the province about science education in First Nations schools. More importantly and without a question, adequate resources are needed to enhance, develop, and implement broad educational frameworks that will allow for the development of science curriculum that is line with each community context based on their unique cultural traditions. The results of the study offer broad ideas, key focus areas, suggestions, examples, and recommendations that are meant to guide science teachers, university teacher education programs, policy makers, school administrators, and others who are responsible for curriculum in First Nations populations.

The research team commends those people who came forward to participate and most especially the Elders who provided their words of wisdom and knowledge expertise. The results of this final report represent all these voices, our dialogues, our stories, our challenges, and our visions for science education in Saskatchewan. The process of coming together and interacting with educators who work directly in some way with First Nations schools was the right step to take as it stimulated a lot of discussion and knowledge exchange. It must be noted that some of the learning that took place during the process of the individual and group interviews deserves a passing comment as it can never be captured in words. The research team was enriched in profound ways and at many levels. We strongly

believe this study is a landmark contribution to the literature base on Indigenous science education with a focus on First Nations and Métis perspectives in Saskatchewan.

What is a Métis perspective [of learning Indigenous science from place] for the purposes of curriculum development in Saskatchewan?

Métis describe teaching and learning Indigenous science as a process; a holistic endeavour experienced in close concert with the land with traditional land users and Elders who can impart cultural values, knowledge, and language particular to a place. Métis believe science studied in isolation from natural surroundings provides only limited information; rather it should be that which constitutes how we know a particular place, as well as the world around us, and make decisions about our personal relationships with, and responsibilities to, the natural world from a cultural perspective. The idea of teaching or learning science as something separate from the rest of life is inadequate. Indigenous knowledge, and Indigenous science, is holistic in nature encompassing the fullness of human knowledge, belief, and experience.

The literature review in this report outlining the history of Aboriginal education in Canada irrefutably illustrates the unfortunate attitude toward Indigenous knowledge held by public governing authorities in Canada. Within the past few generations, we have seen the widespread implementation of Residential Schools, and punitive actions against Métis and First Nations Peoples when they resisted oppressive government policies. Now, as then, Indigenous knowledge, and subsequently indigenous science, is seen by most members of the public as something quaint and interesting, but certainly not something that is going to help you get ahead in this world, make money or build a respectable career in a contemporary labour market. The burden to recover from decisions of the past is going to take a collective effort from all members of society today, Aboriginal and non-Aboriginal alike.

Saskatchewan's 1995 Indian and Métis Action Plan indicated a need to address forms of evaluation, governance, teachers and administrators, external relationships and communication. The RCAP report produced in 1996 described in detail the dysfunction of relationships between Aboriginal Peoples and the state, but also described practical strategies to begin a process of inclusive policy-making. Specifically, RCAP outlined the need to address issues of Aboriginal identity, inclusion of Elders, and long-term methods of developing intergenerational means of transmitting culture and language. There is significant research and documentation describing systemic changes that education requires to adequately represent First Nations and Métis perspectives in Saskatchewan education systems. What remains to be done is actualizing these perspectives for learners in the form of enhanced curriculum and supporting resources.

Throughout the Métis community participant interviews, the concept of identity emerged a number of times as a root without which other areas of learning cannot flourish. Whether acknowledging specifically Métis identity, ancestral Cree or Dene roots, or generally giving equitable acknowledgement to all Aboriginal Nations, interview participants felt strongly that children in schools are not given the opportunity to learn ancestral knowledge about the land in a way that is culturally authentic. In the absence of access to their own ancestral knowledge in schools, Métis children lose their sense of identity today to much the same extent the literature illustrates the historic impact of Residential Schools on generations of Aboriginal Peoples' identities. Participants felt issues forcing concealment of Aboriginal identity, politicization of curriculum, and economic and labour force needs are all contributing forces against inclusion of Indigenous science in school curriculum. Most interview participants were nothing short of astonished to be asked for their views on the matter of Indigenous

science at all. Participants felt that there would be no meaningful inclusion of Indigenous science in school curriculum until the historical and contemporary mitigating factors mentioned previously are acknowledged and addressed within school systems. Participants felt only then might there be an opportunity to share Métis traditional teachings with children, educators and other community members.

Addressing social, political or spiritual issues within the context of a discussion about ‘science’ was not problematic for Métis interview participants. These topics emerged as natural parts of their responses to questions and within the stories shared. The interview discussions about Indigenous science were predominantly discussions about process and context, rather than an effort to identify a set of facts or traditional practices dismembered from the larger cultural context within which that knowledge resides. Earning the trust of traditional knowledge-holders was seen to be paramount. Indeed, overcoming the impact of certain emotional conditions on learning, such as dealing with personal and community grief and loss, were seen to be important and natural parts of Indigenous science education. Métis interview participants acknowledged that Indigenous science must be learned through land-based experiences in collaboration with experienced traditional land users. Interview participants often described the extensive traditional knowledge held by their mentors and recognized that acquiring a comparable scope of knowledge would have required long-term consistent interaction with these mentors. The current disconnection between learner and land, learner and community, and learner and culture will be challenging to create meaningful, holistic Indigenous science education.

Saskatchewan’s Ministry of Education has laid the groundwork through policy for inclusion of First Nations and Métis perspectives in all facets of education, including science education. This is a good start. However, perhaps more than any other targeted subject area, science education faces greater challenges because it is farther behind in curriculum and resource development that can facilitate Métis perspectives. Some of these challenges are described by pre-service teachers, service teachers, and Métis interview participants. The challenges are not insurmountable, but will require innovative thinking, an in-depth understanding of Métis perspectives of science, and a willingness to challenge the status quo and improve science curriculum currently delivered in Saskatchewan education systems. At governance and administrative levels provincially and within schools, a focused effort can be made to develop new forms of programming that is supportive of culturally appropriate forms of assessment, such as those described in the interview summaries, reports supplementing the Holistic Lifelong Learning Models and the contents of the RCAP report describing traditional forms of education. These would include such things as inclusion of holistic views of education and the natural world, the understanding that we are an integral part of the natural world, non-coercive education, opportunities for learning through observation, teaching by example, non-interference in the learning process, learning in natural settings, and non-regimented / institutionalized programming. Concepts such as bravery, courage, kindness, sharing, survival, knowing animal behaviour, moral lessons and values constitute important qualities learned through traditional forms of Aboriginal education.

How can learning from place help to create a foundation for a science curriculum that is contextualized to place and to the people of the place?

Aboriginal Peoples in Saskatchewan are a people of Place. Despite the cultural diversity, it is the land that is considered the first teacher, the first philosopher, the ultimate giver of life and nourishment. Every aspect of Aboriginal Peoples’ cultures is about fostering and reinforcing a spiritual worldview orientation and strong connection to the land through the use of traditional value systems that guide all

thinking, behaviour, and life decisions. Aboriginal knowledge systems are deeply rooted within the soil of which the metaphoric trees in the Holistic Models derive their nutrients from and, as such, have much to contribute in the current efforts to develop school science with a focus on the environment and sustainable ways of being.

In order to develop school science with a holistic focus grounded in earth-based philosophies, it must be relevant and meaningful for all students that share and live out their lives from the foundation of Place and from each Aboriginal community of a particular Place. Underneath every city, town, and village lies the traditional territories of Aboriginal Peoples who lived out their lives in particular ways using particular knowledge systems to survive. Learning, understanding, and celebrating the perspectives of the original Peoples who have long occupied this sacred landscape called Canada will enrich all students and teachers regardless of cultural background. Section 2.4 Theories of Ecological Education explains, “developing an intimate knowledge of the environment sustaining us can help us personally to discover a sense of place and, with it, all the responsibilities we hold in ensuring the continued health of a particular place” (p. 44). During the course of this study, interview participants described the need for learners to forge a connection to the natural world to avoid making choices that will result in irreparable harm to the environment. Learning Indigenous science in relation to Place makes good sense not only for Aboriginal learners, but all Canadian learners.

Contextualizing school science from a foundation of Place requires Aboriginal community involvement in the visioning, planning, development, implementation, and evaluation of curriculum. Each community will require an educational infrastructure supporting the development and articulation of Place-based ontologies, epistemologies, methodologies, and pedagogies that underlie school science practice. All participants in this study indicate a great need for more supportive resources, up-to date examples, and the documentation and sharing of best practices that will allow teachers to invest their energies in teaching and connecting with students. The development of printed materials in line with Saskatchewan cultural contexts is a step in the right direction. However, it is the Place - the communities and the individuals who comprise those communities who are the ultimate sources of information about traditional knowledge systems that complement, animate, and bring to life to any curriculum or resource that is offered in school science.

How can these perspectives and learning from place inform teachers of the processes and content needed in science curriculum?

The results of the *Learning Indigenous Science from Place* research project will help teachers understand the historical context of the separation of Aboriginal Peoples from cultural knowledge systems and how rebuilding science education within a holistic framework can support the inclusion of Indigenous knowledge. Rethinking how contemporary science education is delivered can lead to learners who are more personally engaged in the material, build broader foundations for understanding material and are able to enjoy the process of discovery.

Across Canada, provincial governments and First Nations governments are working diligently to create policies and practices supportive of Aboriginal content and perspectives in school curriculum. Foundational research emerging from Aboriginal governments, post-secondary institutions, Royal Commissions, provincial/territorial/federal governments and others have provided evidence demonstrating the importance of appropriate school content for Aboriginal Peoples based on cultural identity and values. Researchers have also provided evidence illustrating issues and challenges artificially created as a result of school systems devoid of cultural content and supports as well as the

impact of those systems which have actively worked to destroy Aboriginal cultural identity. While there remains a great deal of improvement work to do in school systems, much has been accomplished such as the creation of more culturally sensitive administrative structures, institutional support of Aboriginal educator training, revision of curriculum to be more inclusive and encouraging Aboriginal content and resource use within classrooms.

Teachers, in turn, find themselves personally and professionally charged with the enormous task of integrating Indigenous science into school curriculum. To begin to develop an effective pedagogy inclusive of First Nations and Métis perspectives in school science curriculum, teachers need to understand and build their own awareness of the history of First Nations and Métis Peoples. Teachers need to learn from the perspectives of First Nations and Métis Peoples as well as from Western Eurocentric perspectives. Learning from place, then, can become meaningful to educators when there is a greater understanding of history in general and the impacts historical events have had on Aboriginal and non-Aboriginal groups of people in specific places. It is important to understand historical contexts to increase teacher knowledge professionally and to assist in setting appropriate and achievable goals for inclusion of First Nations and Métis perspectives in school science curriculum.

An important insight educators will gain in becoming appropriately informed on historical contexts, is that the call for inclusion of First Nations and Métis perspectives in education originated with First Nations and Métis communities. A cyclical pattern of 'call' and 'response' is seen to move from Aboriginal communities through governments, school administrations, teachers, and learners. For teachers, armed with at least some background knowledge and understanding of historical contexts, a return to First Nations and Métis community members for support should be seen as a natural and complete rotation of the cycle.

As identified in the literature review and the interview data, place has multiple meanings. Learning from place means educators and learners should be learning multiple perspectives about multiple topics. Given this daunting task, it is essential for teachers to start by knowing general information about the larger historical and philosophical frameworks of their inquiry before moving into the more detailed content. In essence, there is no one-size-fits-all solution to the question. This does not mean that there are no solutions; it simply means that teachers can draw on information coming from the historical and philosophical contexts of Aboriginal education, information provided by their administrations and the expertise of local resource persons such as traditional land users and Elders. For example, if place is defined as including all of Canada's land base it will provide a different set of content than if it is defined as regional area, local area, river system or other geographic area. Diverse meanings of place provide teachers with a variety of options for content.

For teachers and learners, exposure to traditional knowledge will come at varying degrees and from a variety of learning opportunities. Teachers with little or no background in Aboriginal education should position themselves as learners along with students. Having the skills and supports to arrange learning opportunities from Aboriginal resource people is a strength that teachers can bring to planning and achieving goals they set for the integration of traditional knowledge into curriculum. Just as teachers can build their own background knowledge from reading or attending professional development workshops before embarking on development of processes and content for integration of traditional knowledge in science curriculum, teachers can assist students to build background knowledge that will help them interact directly with traditional land users and Elders. Teachers should not try to position themselves as experts in the area of traditional knowledge or simulate spiritual activities, but rather,

guide the learning experience as a combination of school-based learning linked with community-based knowledge.

Assessment processes need to evolve from purely quantitative data collection and associated rubrics to qualitative processes which take into account holistic learning. It will not be easy. In fact, this may be one of the most challenging tasks facing teachers. It will be important to draw on research supporting assessment of Aboriginal learners and form advisory networks of educators skilled in contemporary and traditional ideologies of assessment to implement new measures that support success in science education. Achieving assessment with a balanced approach can be done with research, collaboration and community involvement. Having teachers and education systems ask questions related to what the purpose of science is and how it can improve our lives based on a holistic paradigm is essential to the process. Limiting assessment to goals based only on compartmentalized knowledge does not provide learners with the broad-based thinking and experiences they will need in the future.

Building relationships with Aboriginal community members is an important step teachers need to take in Learning Indigenous science in relation to Place. Understanding basic information relating to Aboriginal identity will assist in this regard. Referring respectfully to First Nations People, specific Nations' original names, Métis People, Inuit People or collectively as Aboriginal Peoples will lead to recognition that there are distinct cultures and languages. Diversity also exists within groups of People. Language dialects may vary from region to region just as cultural practices and protocols to access traditional knowledge will vary from region to region and even among individuals. Knowing some standards will be helpful for teachers, but it is always wise to ask the person(s) you are building a relationship with what their expectations are, or seek advice from another resource person beforehand if possible.

It is important for teachers to know that not all Aboriginal individuals will have all the answers to their questions. Aboriginal communities are based on collective strength with a variety of individuals having skills and abilities that vary from other individuals. Traditionally, young people would learn from the adults and Elders within their community building their own expertise based on inherent gifts they were born with, acquired by rites of passage, or from shared experiences. Aboriginal children who are not exposed to traditional teachings have been removed from these cycles of learning. Indeed, parents or care-givers of children may also be included in the learning experiences creating a supportive learning experience. Teachers can help facilitate reconnection to culture through effective relationship-building with a variety of Aboriginal resource persons.

The literature review of this document provides an orientation to the complexity of the concept of place. The multi-dimensional, relational, experiential, local, and land-based aspects of place give particular contexts that have both unique and common elements. Spirituality provides connectivity and is important to understanding both philosophical and pragmatic elements. Spiritual teachings should only ever be obtained from Aboriginal persons acknowledged within their particular community as having the right to impart these teachings. Place ebbs and flows; it is dynamic and organic, rooted in the cultural traditions of a particular People. For example, identity is intimately connected to place and might be thought of as the fertile soil from which living things grow, thrive and regenerate. While seeds may blow to new areas, they may not thrive if it is too different from the original source, or they may form new communities that begin as fragile groups and can be strengthened given the right conditions. The source community will continue to thrive unless it becomes so thin that it can no longer sustain itself. Reconnecting young Aboriginal learners, and all learners, to traditional knowledge will assist in helping understand our living connections to place and the people of a place.

One of the most important things that a teacher will need to include in achieving meaningful inclusion of traditional knowledge in science education is to provide land-based experiences together with Aboriginal traditional land users and Elders. Being able to provide these kinds of experiences will take most teachers some time to build their own capacity to do so. Since traditional knowledge is holistic and considers all knowledge and action linked, specific science concepts can already be considered as existing within a holistic paradigm. The challenge will be for teachers to learn how these concepts relate to traditional teachings. Whether the topic at hand is studying the night sky, electricity, magnetic force or genetics, providing learners with multiple ways of knowing will support divergent thinking, sustainable choices, ethical behaviour and success in science experiences.

Sharing resources, outlines and guides that are locally developed will be essential. The electronic age provides many opportunities to collaborate and share lesson plans, unit plans or just ideas-in-development regarding Indigenous science. Establishing a website for sharing is a good recommended start, although it is important to ensure that inappropriate content is not put into circulation. This may require a resource person(s) to monitor postings. A multi-level system which has publically posted material as well as material vetted through formal processes may be advisable. Traditional land users and Elders are not always readily available and teachers will be faced with the challenge of not having access to these resource people they require on demand. It will be imperative for teachers, schools and systems to plan collaboratively for effective access to traditional land users and Elders. Some teachers may have already proven themselves effective at accessing traditional land users and Elders. These teachers or similarly skilled community members may be key people to include in larger planning processes, professional development activities and facilitation of group outings for land-based experiences.

What supports or processes are needed for educators and systems to engage authentically in Indigenous science?

Building on knowledge of the past is a key concept in Indigenous science. It is also a key concept in education in general. History, social studies, music, math and all subject areas, including science, build on knowledge and experiences of the past. Business systems that have good corporate memory thrive and avoid errors of the past. School systems must also evolve and build successes by learning from past mistakes. Historic attempts to eliminate cultural aspects of humanity in education have shown that superficial successes in that regard have only served to disguise trauma and much deeper social wounds of those subjected to the experiences. Yet, there remains resistance from non-Aboriginal, and even some Aboriginal individuals, who believe in maintaining the status quo supporting commercial purposes of science and science education.

Post-secondary institutions, especially teacher education programs offered in universities, need to be offering teacher education programming in Aboriginal languages for teachers to develop these skills. Language programming offered in k-12 school systems will only be effective when it becomes an integral part of the education process. Having curriculum materials, including science curriculum materials, developed in Aboriginal languages will support fluency and intergenerational language learning.

Building a science curriculum that is supportive of Learning Indigenous science in relation to Place will not be successful without the support of school administrations, Aboriginal and non-Aboriginal communities, curriculum developers and teachers themselves. Educating teachers about their own attitudes and behaviour will be difficult, and sometimes unpleasant, but has been part of the teaching process currently shouldered by Aboriginal teachers. Professional development for all teachers would

help to increase the knowledge base of teachers lacking a background in anti-racist education, Aboriginal education, cultures and histories. Demonstrating the importance of holistic thinking in science education based on research, evidence and best practices is necessary to provide the ideological support needed for all groups.

Further developing educational policy and legislation supporting Indigenous ways of knowing will provide a framework for supporting content and activities that comprise part of all education rather than add-on activities that are minimalist or serve to reinforce stereotypes of Aboriginal Peoples. This requires a willingness of governing authorities to provide adequate financial and human resources supporting policy and legislation as well as capacity-building in teacher and local communities to implement plans. It also requires openness by school systems to explore issues of local relevance and importance to Aboriginal Peoples. Education systems can support the formation of groups of Aboriginal teachers to address teaching certain issues of concern to First Nations and Métis communities. Similarly, there is a need to respect the political Aboriginal organizations and work in harmony with their systems and affiliated educational and cultural organizations, building on capacity which already exists including knowledge, processes and established protocols. Teachers expressed a need for support to explore roots of science and roots of religion, how the spiritual practices and beliefs of another culture is expressed as their science and a means of using observation to make meaning in their lives, and the beliefs that guide how Aboriginal Peoples live. Teachers also believe there is a need to learn from what other provinces are doing successfully and ultimately create teacher exchange programs so new ways of thinking can be shared.

Resources and materials emerged as a critical need expressed by educators for use in guiding the integration of Indigenous knowledge in science curriculum. To accomplish this, there would need to be support to have Elders and other Indigenous knowledge holders assist teachers with traditional teaching of science, protocols and the traditional processes of learning. Forging respectful and trusting relationships with Elders takes time. While some Elders are experienced in working within a school environment or with large numbers of students, others are not. Trappers and fishermen, for example, may have extensive knowledge of life on the land, but inexperienced in working with schools. As well, the diversity within Aboriginal Nations, such as Cree, Dakota, Dene, or Métis means a greater need to learn from individuals who can share what they know. As a support to school systems and individual educators, having cultural liaison personnel available to go out and meet with traditional land users or Elders is necessary to take the time needed to honour traditional protocols properly and effectively.

Any development of resources and materials requires financial support. Acquiring traditional resources, such as canoes or other technology will also require an investment in the human capacity-building to ensure safety. Cultural camps can be a great benefit to teachers and learners. A variety of activities can be done, relationships developed and fun experiences out on the land can be used to teach and learn Indigenous science. Hosting camps in places where traditional activities are still practiced will serve to provide real experiences, and perhaps, encourage the development of camps in other places. These larger events can help to raise the comfort level of participants in engaging in activities outside the classroom, while drawing on collective strengths of the group. Electronic technology, such as the Internet, can link learners to remote sites to talk with traditional land users from other regions of Canada. Videos can supplement learning experiences.

Teachers believe developing a process that begins with professional development and learning directly from the Elders, having teachers write units and practice in the classroom, coming back together to

demonstrate what was done; compiling the new units and materials and completing the cycle with knowledge exchange among teachers will effectively replace ad hoc processes that currently exist. New evaluation processes appropriate for Indigenous science can be built based on established research and collective effort of multiple educators rather than leaving teachers to try to do this in isolation. Collaboration in such a focused manner also provides an opportunity to develop safe and respectful spaces, sometimes known as 'ethical spaces' where Aboriginal community members can interact with educators within school systems in order to learn from each other. Another key result of this process resides in the creation of resources and materials that can be shared among educators. Teachers felt the development of a web portal where resources could be posted was suggested as the most efficient method of sharing. The website might also be able to serve as a host to field teacher questions, or have a 'frequently asked questions' page regarding protocols for teachers learning basic information.

School systems need to have adequate numbers of people working in central positions to coordinate material and resources needed by teachers to include Aboriginal content. Proactive planning will help ensure individuals who are employed in these roles do not become overwhelmed and inadvertently end up creating bottlenecks within the process. School librarians and other support personnel need to be included in professional development activities related to Aboriginal education in order to assist teachers effectively with locating appropriate resources.

To engage authentically in Indigenous science teachers need to be interested in what they are doing in order to teach it effectively. Encouraging colleagues to incorporate Aboriginal content and enjoy the process is important. Formation of generative curriculum and generative classrooms was a goal indicated by teachers interviewed. Teachers need to know about the history of many people in order to incorporate into their teaching; not just the Aboriginal Peoples in Canada, but all people. Some teachers felt it helps to demonstrate similarities with human cultures when teaching about plants and animals and the differences; when cultural differences and connections are talked about the students are much more interested. Teaching about relationships and parallels in nature is helpful to high school students so they will be encouraged to learn more, or to encourage students who are already parents to teach their own children about these things. Having good questioning skills and a good academic base of knowledge is important in encouraging students to develop these skills for themselves. When addressing sensitive subjects such as racism, having guest speakers can be helpful.

In order to engage authentically in Indigenous science, there is a need for support from principals, education systems, other teachers and from students. The holistic nature of Indigenous science means that it is not only specific content is learned, but the context of why it is important to learn including social and ethical considerations. The inclusion of spirituality and relationships all impact on how we think about science and the decisions we make with the knowledge we learn. Learning about recycling should lead to discussions about populations, pollution, environmental contamination, and health issues. Coming up with creative solutions can also include learning about simpler lifestyle choices, reducing consumption, and other environmentally friendly strategies. It is the integration of deeper Aboriginal community perspectives and exposure to traditions and ceremonies that can help learners understand the holistic paradigm. Encouraging the use of Aboriginal languages at home and school can help to reinforce the preservation of worldviews different from Western Eurocentric worldviews. Using original Aboriginal languages is essential in understanding traditional uses of plants and animals, health, healing and wellness. All of these perspectives can contribute to inspiring learners to explore careers in scientific disciplines that they may not have previously considered. Conversely, Learning Indigenous

science in relation to Place can also encourage learners to participate in more community-based activities that will lead them to healthier lifestyles and cultural connectivity.

6. RECOMMENDATIONS

6.1 A Holistic Paradigm

The traditional knowledge of Indigenous Peoples differs from region to region and is grounded in the particular environment and culture from which it has emerged. Traditional knowledge has emerged over time and changes over time. All time is part of Indigenous Peoples history and has contributed to Indigenous epistemologies. Battiste & Henderson (2000) provide insights in this regard,

From the beginning, the forces of the ecologies in which we live have taught Indigenous peoples a proper kinship order and have taught us how to have nourishing relationships with our ecosystems. The ecologies in which we live are more to us than settings or places; they are more than homelands or promised homelands. These ecologies do not surround Indigenous peoples; we are an integral part of them and we inherently belong to them. The ecologies are alive with the enduring processes of creation itself. As Indigenous peoples, we invest the ecologies with deep respect, and from them we unfold our structure of Indigenous life and thought. (p. 9)

Defining traditional knowledge for use in Eurocentric scientific paradigms is difficult. The oral nature, intangible aspects and holistic views of traditional knowledge are not easily understood, or accepted, within foreign scientific paradigms. That is, Eurocentric scientific paradigms search for *finalities*, for tangible evidence, for definitions and for non-contradictory qualities. Without these qualities, Eurocentric scientific paradigms cannot accept or process other kinds of information. This results in the hegemony of Eurocentric science paradigms being of little value in framing or understanding traditional knowledge. The challenge remains for Eurocentric scientists to expand their repertoire of a single exclusive model of scientific inquiry to include new paradigms that respect the intangible, intuitive and shifting nature of other kinds of knowledges, including Indigenous traditional knowledge.

Facing enormous global environmental crises in this millennium, governments and science communities are recognizing that irreversible environmental damage has placed continued human existence at risk. Yet, even Eurocentric science, embedded within Western ideology and hegemonic practices of capitalism and consumerism, has been powerless to avert pending disaster by providing sufficient solutions based on its own paradigms. In 2002, Simon Brascoupe, Director of the Aboriginal Affairs Directorate of Environment Canada, explained,

Science and technology are fundamentally limited in their scope and ability to solve the current environmental crisis. Their linear approach is juxtaposed to the holistic interpretations of Indigenous Peoples who seek to maintain a delicate balance between the physical, emotional, mental, and spiritual. Consumerism, which is the soul that feeds present day neo-liberal regimes, contrasts with the spiritual connection to the land that is at the heart of Indigenous People's philosophies and traditional practices. For the industrial world, there are many obstacles that cloud sustainable development and sustainable decisions. (Brascoupe, 2002, p. 29)

Cajete (1994, 1999) has written extensively about Indigenous science education. Perspectives on ecology, personal spiritual development, traditional philosophies, mythology, artistic visioning, relationships, and curricula are offered to help understand the complexities of Indigenous ecological education and formulate a framework for educators to work within. Cajete conveys methodologies for transformational education, drawing on Tewa teachings and similar philosophies from other Indigenous Nations. Cajete (1994) says, "This transformation is a dynamic creative process that brings anything but peace of mind, tranquility, and harmonious adaptation. The exploration of self, and relationships to

inner and outer entities, require a tearing apart to create a new order and higher level of consciousness” (p. 210).

Personal transformation through spiritual development is necessary to achieve a completeness in life. The educational pedagogies employed to facilitate personal transformation need to be grounded in ecological awareness and connection. Cajete believes, “a contemporary application of Indian education must integrate the orientation of economic survival and ecological sustainability if it is to serve the needs of Indian people living in contemporary times” (Cajete, 1994, p. 216).

Hampton (1995) describes a redefinition of Indian education in terms of a six-directional framework, incorporating traditional teachings of north, south, east, west, spirit and earth. Combined, the framework is intended to demonstrate a pattern for organizing thought about how we exist in the universe. Hampton believes it is important to recognize each direction’s set of complex meanings, feelings, relationships and movements are dynamic, as is Indian education. Examining past and current forms of Indian education is the beginning of a process to construct models and theories of education which will result in successful education for Indigenous students.

Klug & Whitfield (2003) detail concepts of culturally responsive pedagogy for American Indian Children. Pedagogy includes concepts of how we decide what will be taught, what is taught, when and how we teach. Ismat (1994) is cited in describing culturally responsive curriculum capitalizes on students’ cultural backgrounds rather than overriding or negating them; is good for all students; is integrated and interdisciplinary; is authentic and child centered, connected to children’s real lives; develops critical thinking skills; incorporates cooperative learning and whole language strategies; is supported by staff development; and is part of a coordinated, building-wide strategy (p. 151). Klug & Whitfield (2003) describe the need to incorporate traditional languages and knowledge within existing curriculum, and to draw on cognitive psychologist’s research on constructivist approaches to teaching and learning, which rely on students’ abilities to create knowledge based on their experiences (pp. 167-175).

Ultimately, in actualizing Indigenous educational processes and goals outlined by writers such as Cajete (1994, 1999), Hampton (1995), Ermine (1995), Klug & Whitfield (2003), and others, Canadian education systems will need to create new forms of educational institutions which are grounded in Indigenous traditional knowledge and values, but can facilitate the development of Western scientific academic disciplines as well. Indigenous science education must be seen to be more than a process of discovering remedies to deal with ecological damages and environmental crises worldwide. Indigenous science education must take its rightful place as the vehicle to produce ecologically aware citizens and a healthy global environment. Educators, researchers, policy-makers and community members can examine various forms of Indigenous education in an effort to ascertain common characteristics and philosophies, but the primary focus must be to integrate local knowledge systems into school science curricula.

6.2 Strategies to Enhance Indigenous Science in Curriculum

- Relationship-building (schools, post-secondary institutions, community, government, industry)
- Respecting protocols (discovering protocols of place & honouring them)
- Teacher skill-building (including school support for teacher release time)
- Community-based curriculum development (Frameworks: Ontology, epistemology, methodologies, and pedagogies)
- Adequate Funding Resources to support curriculum goals
- Teacher and student as learners
- Appropriate knowledge dissemination and storage
- Respecting wisdom of Elders and traditional land users
- Respecting ceremony as the domain of Aboriginal Peoples
- Respecting and supporting First Nations and Métis spiritual belief systems
- Seeking holistic understanding from First Nations and Métis perspectives (valuing diverse knowledge systems)
- Promoting intellectual understanding
- Encouraging affective learning
- Experiencing the natural world (inclusion of practical land-based experiences)
- Facilitating parental control and involvement in education (NIB, 1972)
- Encouraging self-development of individuals and systems

6.3 Recommendations for Further Research

- Additional research is needed specifically for the purpose of obtaining Aboriginal Peoples perspectives in science education
- Additional research is needed in how to best train pre-service and practicing teachers on how to successfully integrate Aboriginal perspectives into their normal teaching practices.
- Additional research is needed in understanding linkages between Indigenous Science, Place and Urban Aboriginal students
- Additional research is needed to investigate how science teachers follow curriculum guidelines to include Indigenous science, or how science teachers include Indigenous science in the absence of culturally sensitive curriculum guidelines
- Additional research is needed to investigate the complexity of teaching science to Aboriginal students (pedagogy) and systemic barriers that impede progress of teachers and students
- Additional research is needed to investigate if, and how, teachers understand the cultural nature of the western science they teach (pedagogy)
- Additional research and development is needed for a broader collaboration of science educators and Aboriginal communities across Canada
- Additional research and development is needed for a shared forum for Indigenous science – website, database, on-line modules, resources

BIBLIOGRAPHY

- Adelson, N. (2000). *Being alive well: Health and the politics of Cree well-being*. Toronto, Canada: University of Toronto Press.
- Aikenhead, G. (2006a). Towards Decolonizing the Pan-Canadian Science Framework. *Canadian Journal of Science, Mathematics, & Technology Education*, 6 (4) (October 2006), 387-399.
- Aikenhead, G. (2006b). *Science Education for Everyday Life: Evidence-Based Practice*. London, Ontario: The Althouse Press.
- Aikenhead, G. (2002). Cross-Cultural Science Teaching: Rekindling Traditions for Aboriginal Students. *Canadian Journal of Science, Mathematics and Technology Education*, 2, 287-304.
- Aikenhead, G. (2001). Integrating Western and Aboriginal Sciences: Cross-Cultural Science Teaching. *Research in Science Education*, 31, 337-355.
- Aikenhead, G. (1999). Cross-Cultural Science Education: A Cognitive Explanation of a Cultural Phenomenon. *Journal of Research in Science Teaching*, 36 (3), 269-287.
- Aikenhead, G. (1997). Towards a First Nations Cross-Cultural Science and Technology Curriculum. *Science Education*, 81(2).
- Aikenhead, G., & Huntley, B. (1999). Teachers' views on Aboriginal students learning Western and Aboriginal science. *Canadian Journal for Native Education*, 23, 159-175.
- Aikenhead, G., & Ogawa, M. (2007). Indigenous Knowledge and Science Revisited. *Cultural Studies of Science Education* 2(3).
- Alaska Native Science Commission, ANSC website, Key Issues: Traditional Knowledge <http://www.nativescience.org/issues/tk.htm> Retrieved February 13, 2008.
- Allan, N., & Crawley, F. (1998). Voices from the Bridge: Worldview Conflicts of Kickapoo Students of Science. *Journal of Research in Science Teaching*, 35, 2, 111-132.
- Assembly of First Nations [AFN]. (2007a). *Indian Residential Schools Unit*. Retrieved November 2007 <http://www.afn.ca/residentialschools/history.html#>
- Assembly of First Nations [AFN], First Nations Information Governance Committee. (2007b). *The First Nations Regional Longitudinal Health Survey (RHS) Code of Research Ethics*. Ottawa.
- Assembly of First Nations [AFN]. (1994). Breaking the silence: An interpretive study of Residential School impact and healing as illustrated by the stories of First Nations individuals. Ottawa, Canada: First Nations Health Commission.
- Assembly of First Nations. (n.d.). *Description of the AFN*. Retrieved June 12, 2008, from Assembly of First Nations: <http://www.afn.ca/article.asp?id=58>

- Association of Canadian Universities for Northern Studies. (2003). *Ethical Principles for the Conduct of Research in the North*. Ottawa. Retrieved December 2007
<http://www.acuns.ca/EthicsEnglishmarch2003.pdf>
- Barman, J., Hebert, Y., & McCaskill, D. (Eds.). (1987). *Indian Education in Canada: Volume 2 - The Challenge*. Vancouver: University of British Columbia Press.
- Barman J., Hebert, Y., & McCaskill, D. (Eds.). (1986). *Indian Education in Canada: Volume 1 - The Legacy*. Vancouver: University of British Columbia Press.
- Barman, J., Hebert, Y., & McCaskill, D. (1986). The Legacy of the Past: An Overview. In Barman J., Hebert, Y., & McCaskill, D. (Eds.), *Indian Education in Canada: Volume 1 - The Legacy*. Vancouver: University of British Columbia Press.
- Barron, F. (1997). *Walking in Indian Moccasins: The Native Policies of Tommy Douglas and the CCF*. Vancouver: University of British Columbia Press.
- Basso, K. (1996). *Wisdom Sits in Place: Landscape and Language Among the Western Apache*. Albuquerque: University of New Mexico Press.
- Bastien, B. (2004). *Blackfoot Ways of Knowing: The Worldview of the Siksikaitsitapi*. Calgary: University of Calgary Press.
- 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.
- Battiste, M. (2000). *Reclaiming Indigenous Voice and Vision*. Vancouver: UBC Press.
- Battiste, M. (1998, May). *Decolonizing the university: Ethical guidelines for research involving Indigenous populations*. Plenary Address presented to Canadian Society for the Study of Education, 25th Annual Conference. Ottawa, Ontario.
- Battiste, M. (2008). Animation Theme Bundle 2: Comprehending and Nourishing the Learning Spirit. Retrieved July 23, 2008 from
<http://www.cclcca.ca/CCL/AboutCCL/KnowledgeCentres/AboriginalLearning/Themes/AnimationThemeBundle2.htm?Language=EN>
- Battiste, M., & Barman, J. (1995). *First Nations Education in Canada: The Circle Unfolds*. Vancouver: University of British Columbia Press.
- Battiste, M., & Henderson, Sakej Youngblood. (2000). *Protecting Indigenous Knowledge and Heritage: A Global Challenge*. Saskatoon: Purich Press.
- Brandenburg, A., & Carroll, M. (1995). Your place or mine? The effect of place creation on environmental values and landscape meanings. *Society and Natural Resources*, 8, 381-398.
- Brandt, C. (2004). A Thirst for Justice in the Arid Southwest. *Educational Studies* 36 (1).
- Brascoupe, S. (2002). The end of sustainability. *Biodiversity Journal of Life on Earth*.

- Brascoupe, S., & Endemann, K. (1999). *Intellectual Property and Aboriginal People: A Working Paper*. Ottawa: Strategic Research and Analysis Directorate, INAC, and Intellectual Policy Directorate, Industry Canada, Fall 1999.
- Brightman, R. (1989). Acaohkiwina and Acimowina: Traditional narratives of the Rock Cree Indians. Hull, Quebec: Canadian Museum of Civilization.
- Brown, B. (1987). Territoriality. In D. Stokols & I. Altman (Eds.), *Handbook of Environmental Psychology* (505-531). New York: John Wiley & Sons.
- Bull, L. (1991). Indian Residential Schooling: A native perspective. *Canadian Journal of Native Education*, 18 (Supplement), 3-63.
- Cajete, G. (1999). *Igniting the spark: an indigenous science education model*. Skyland, NC: Kivaki Press.
- Cajete, G. (2000a). Indigenous knowledge: The Pueblo metaphor of Indigenous education. In M. Battiste (Ed.), *Reclaiming Indigenous voice and vision* (pp. 181-191). Vancouver, BC: University of British Columbia Press.
- Cajete, G. (2000b). *Native Science: Natural Laws of Interdependence*. Santa Fe, New Mexico: Clear Light Publishers.
- Cajete, G. (1999). *A people's ecology: Explorations in sustainable living*. Santa Fe, NM: Clear Light Publishers.
- Cajete, G. (1994). *Look to the Mountain: An Ecology of Indigenous Education*. Skyland, NC: Kivaki Press.
- Cajete, G. (1988). Motivating American Indian Students in Science and Math. *ERIC Digest*. [Eric Document Identifier #296812, publication date 1988-01-00].
- Cajete, G. (1986). *Science: A Native American Perspective: A Culturally Based Science Education Curriculum*. Unpublished doctoral dissertation, International College, Los Angeles.
- Canadian Council on Learning [CCL]. (2007a). Animation Theme Bundle 1: Learning from Place <http://www.cclcca.ca/CCL/AboutCCL/KnowledgeCentres/AboriginalLearning/Themes/AnimationThemeBundle1.htm>. Retrieved November 28, 2007.
- Canadian Council on Learning [CCL]. (2007b). Holistic Lifelong Learning Models. <http://www.cclcca.ca/CCL/Reports/RedefiningSuccessInAboriginalLearning/RedefiningSuccessModels.htm>. Retrieved February 2008.
- Canadian Institute of Health Research [CIHR]. (2005). *Guidelines for Health Research Involving Aboriginal Peoples (Draft, 2005)*. Ottawa: CIHR Ethics Office.
- Canadian Institutes of Health Research, Natural Sciences and Engineering Research Council of Canada, Social Sciences and Humanities Research Council of Canada [TPCS]. (2005 [1998]). *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans*. Ottawa: Interagency Secretariat on Research Ethics, Public Works and Government Services Canada.

- Cape Breton University website, Institute for Integrative Science and Health, msit.cbu.ca, Retrieved February 3, 2008.
- Cariboo Tribal Council. (1991). Faith misplaced: Lasting effects of abuse in a First Nations community. *Canadian Journal of Native Education*, 18(2), 161-198.
- Carlson, K. (2001). *A Stó:lō Coast Salish Historical Atlas*. Vancouver: Douglas & McIntyre.
- Casey, E. (1996). How to Get from Space to Place in a Fairly Short Stretch of Time: Phenomenological Prolegomena. In Feld, Steven and Keith Basso., (eds.). *Senses of Place* (pp. 13-52). Santa Fe, New Mexico: School of American Research Press.
- Chinn, P. (2007). Decolonizing Methodologies and Indigenous Knowledge: The Role of Culture, Place, and Personal Experience in Professional Development. *Journal of Research in Science Teaching*, 44(9), 1247-1268.
- Christie, M. (1991). Aboriginal Science for the Ecologically Sustainable Future. *Australian Science Teachers Journal*, 37(1), 26-31.
- Cobern, W. (1996). Worlview theory and conceptual change in science education. *Science Education*, 80, 579-610.
- Colorado, P. (1988). Bridging native and western science. *Convergence*, 21(2.3).
- Cruikshank, J. (2005). *Do Glaciers Listen? Local Knowledge, Colonial Encounters, and Social Imagination*. Vancouver: UBC Press.
- Daes, Erica-Irene. (1994). *Preliminary Report of the Special Rapporteur: Protection of the Heritage of Indigenous Peoples*. E/CN.4/Sub.2/1995/26. Sub-Commission on Prevention of Discrimination and Protection of Minorities, Commission on Human Rights, UNESCO.
- Deloria, Vine Jr. (1995). *Red Earth, White Lies*. New York: Scribner.
- Deloria, Vine Jr. and Wildcat, D. (2001). *Power and Place: Indian Education in America*. Golden, Colorado: Fulcrum Publishers.
- Department of Justice. (n.d.). *Constitution Act 1982*. Retrieved June 11, 2008, from Constitution Acts 1867 to 1982: http://laws.justice.gc.ca/en/const/annex_e.html
- Ermine, W. (1995). Aboriginal Epistemology. In M. Battiste and J. Barman (eds.), *First Nations Education in Canada: The Circle Unfolds* (pp. 101-112). Vancouver: UBC Press.
- Feld, S., & Basso, K. (Eds.). (1996). *Senses of Place*. Santa Fe, New Mexico: School of American Research Press.
- Fixico, D. (1998). Ethics and Responsibilities in Writing American Indian History. In D. Mihesuah (Ed.), *Natives and Academics: Researching and Writing About American Indians* (pp. 84-99). Nebraska: University of Nebraska Press.

- Fletcher, C. (2003). Community-based participatory research relationships with Aboriginal communities in Canada: An overview of context and process. *Journal of Aboriginal and Indigenous Community Health*, 1(1), 27-60.
- Garrouette, E. (1999). American Indian Science Education: The Second Step. *American Indian Culture and Research Journal*, 23(4), 91-114.
- George, J. (1999). Indigenous Knowledge as a Component of the School Curriculum. In L.M. Semali & J.L.Kincheloe (Eds.). *What is Indigenous Knowledge? Voices from the Academy* (pp. 79-94). New York: Falmer Press.
- Geertz, C. (1996). Afterword. In Feld, S., & Basso, K. (eds.). *Senses of Place* (pp. 259-262). Santa Fe, New Mexico: School of American Research Press.
- Goulet, Jean-Guy. (1998). *Ways of Knowing: Experience, Knowledge, and Power among the Dene Tha*. Vancouver: UBC Press.
- Goulet, L. (2005). *Creating Culturally Meaningful Learning Environments: Teacher Actions to Engage Aboriginal Students in Learning*. PhD dissertation. Regina, Canada: University of Regina.
- Government of Saskatchewan. (2007). *First Nations and Métis Education Branch*. Retrieved June 12, 2008, from Government of Saskatchewan: <http://www.learning.gov.sk.ca/First-Nations-Métis-Education>
- Gresko, J. (1986). Creating Little Dominions Within the Dominion: Early Catholic Indian Schools in Saskatchewan and British Columbia. In Barman, J., Hebert, Y., & McCaskill, D. (eds.). *Indian Education in Canada: Volume 1 - The Legacy* (pp. 88-109). Vancouver: University of British Columbia Press.
- Gruenewald, D. (2003a). The Best of Both Worlds: A Critical Pedagogy of Place. *Educational Researcher*, 32, 3-12.
- Gruenewald, D. (2003b). Foundations of Place: A Multidisciplinary Framework for Place-Conscious Education. *American Educational Research Journal*, 40, 619-654.
- Haig-Brown, C. (1988). *Resistance & renewal: Surviving the Indian Residential School*. Vancouver, Canada: Tillacum Library.
- Hammond, L., & Brandt, C. (2004). Science and Cultural process: Defining an Anthropological Approach to Science Education. *Studies in Science Education*, 40, 1-47.
- Hampton, E. (1995). Towards a redefinition of indian education. In M. Battiste, & J. Barman, *First nations education in canada: the circle unfolds* (pp. 5-46). Vancouver: UBC Press.
- Harding, S. (2006). *Science and Social Inequality: Feminist and Postcolonial Issues*. Chicago, Illinois: University of Illinois Press.
- Hare, J., & Barman, J. (1998). Aboriginal Education: Is There a Way Ahead? in David Long and Olive Patricia Dickason, eds. *Visions of the Heart: Canadian Aboriginal Issues, 2nd Editio*n (pp. 331-359)n. Scarborough ON, Thomson Nelson.

- Harris, H. (2002). Coyote Goes to School: The Paradox of Indigenous Higher Education. *Canadian Journal of Native Education*, 26 (2), 187-196.
- Henderson, Sákéj. (2000). Ayukpachi: Empowering Aboriginal Thought. In M. Battiste (Ed.), *Reclaiming Indigenous Voice and Vision* (pp. 248-278). Vancouver, BC: UBC Press.
- Indigenous Knowledge in the School Science Curriculum Committee. (2007). 2007-2008 Work Plan. Saskatoon.
- Indigenous Peoples' Health Research Centre. (2004). The Ethics of Research Involving Indigenous Peoples. Saskatoon SK: Author. <http://www.iphrc.ca/text/Ethics%20Review%20IPHRC.pdf> Retrieved February 2008.
- Ing, R. (1991). The effects of Residential School on native child-rearing practices. *Canadian Journal of Native Education*, 18 (Supplement), 67-116.
- International Labour Organization. (1989, June 27). *Convention (No. 169) concerning Indigenous and Tribal Peoples*. Retrieved June 12, 2008, from Office of the High Commissioner for Human Rights: <http://www.unhchr.ch/html/menu3/b/62.htm>
- International Society of Ethnobiology [ISE]. (2006). *Code of Ethics*. General Assembly of the International Society of Ethnobiology, 10th International Congress of Ethnobiology, Chiang Rai, Thailand, 8 November 2006. Retrieved December 2007 at http://ise.arts.ubc.ca/_common/docs/ISECodeofEthics2006_000.pdf
- Inuit Circumpolar Conference. (1992). *Principles and Elements for a Comprehensive Arctic Policy*. Alaska, Greenland, Canada: Author.
- Inuit Tapiirit Kanatami. (n.d.). *About ITK*. Retrieved June 12, 2008, from Inuit Tapiirit Kanatami: <http://www.itk.ca/corporate/index.html#2>
- Jaine, L. (ed.) (1993). *Residential Schools: The Stolen Years*. Saskatoon, SK: University of Saskatchewan Extension Press.
- Jegede, O.J. (1995). Collateral Learning and the Eco-Cultural Paradigm in Science and Mathematics Education in Africa. *Studies in Science Education*, 25, 97-137.
- Johnson, M. (1992). *Lore: Capturing Traditional Environmental Knowledge*. Hay River, NWT, Canada: University of Calgary, 1992.
- Johnston, B. (1988). *Indian school days*. Toronto, Canada: Key Porter Books Ltd.
- Kawagley, A. O. (1995). *A Yupiaq Worldview: A Pathway to Ecology and Spirit*. Prospect Heights, IL: Waveland Press, Inc.
- Kawagley, A.O. (1990). Yup'ik Ways of Knowing. *Canadian Journal of Native Education*, 17(2), 5-17.
- Kawagley, A.O., & Barnhardt, R. (1999). Education Indigenous to Place: Western Science Meets Native Reality. In G. Smith, & D. Williams (Eds.). *Ecological Education in Action: On Weaving Education, Culture, and the Environment* (117-140). New York, NY: State University of New York Press.

- Kawagley, A.O., Norris-Tull, D., & Norris-Tull, R.A. (1998). The Indigenous Worldview of Yupiaq Culture: Its Scientific Nature and Relevance to the Practice and Teaching of Science. *Journal of Research in Science Teaching*, 35, 133-144.
- Kawagley, O. (2000). Identity-creating Camps. *Sharing Our Pathways*, 5(2), 4-5.
- Kirkness, V. and Selkirk-Bowman, S. (1992). *First Nations and Schools: Triumphs and Struggles*. Toronto, Ontario: Canadian Education Association.
- Knudtson, P., & Suzuki, D. (1992). *Wisdom of the Elders*. Toronto, Ontario: Stoddart Publishing Company.
- Korpela, K.M. (1989). Place-identity as a Product of Environmental Self-Regulation. *Journal of Environmental Psychology*, 9, 241-256.
- Lemke, J. (2001). Articulating communities: Sociocultural perspectives on science education. *Journal of Research in Science Teaching*, 38, 296-316.
- Lipka, J. (1990). Integrating Cultural Form and Content in on Yup'ik Eskimo Classroom. *Canadian Journal of Native Education*, 17(2), 18-32.
- Little Bear, L. (2000). Jagged Worldviews Colliding. In M. Battiste (Ed.), *Reclaiming Indigenous Voice and vision* (77-85). Vancouver, BC: UBC Press.
- Lussier, A., & Sealey, D. (Eds.). (1980). *The Other Natives: The Métis, Volume 3*. Winnipeg: Manitoba Métis Federation Press.
- MacIvor, M. (1995). Redefining Science Education for Native Studies. In M. Battiste and J. Barman, (eds.), *First Nations Education in Canada: The Circle Unfolds* (pp. 73-98). Vancouver: UBC Press.
- MacLeod, R. (1981). Introduction: On the Advancement of Science. In R. MacLeod & P. Collins (Eds.), *The Parliament of Science* (pp. 17-42). Northwood, England: Science Reviews.
- Maddock, M. (1981). Science Education: An Anthropological Viewpoint. *Studies in Science Education*, 8, 1-26.
- McGregor, D. (1994). An evaluation of traditional environmental knowledge from an Aboriginal perspective. Unpublished research paper. Toronto: Faculty of Forestry, University of Toronto.
- McGregor, D. (1995). Aboriginal knowledge and western science: A clash of worldviews, paradigms, and methods. Unpublished research paper. Toronto: Department of Anthropology, University of Toronto.
- McGregor, D. (1995). Sources, transmission, and control of natural knowledge systems in Aboriginal communities. Unpublished research paper. Toronto: Department of History, University of Toronto.
- McGregor, D. (1999). Indigenous knowledge in Canada: Shifting paradigms and the influence of First Nations advocates. In Veeman, T., B. Purdy, F. Salkie, and G. Larkin, Science and Practice: Sustaining the boreal forest. Proceedings of the 1999 Sustainable.

- McGregor, D. (2000). The state of Traditional Ecological Knowledge research in Canada: A critique of theory and practice. In Laliberte, et al. (Eds.), *Expressions in Canadian Native Studies* (pp. 436-458). Saskatoon, Canada: University of Saskatchewan Extension Press.
- McKay, A., & McKay, B. (1986). Education as a total way of life. In Barman, J., Hebert, Y., & McCaskill, D. (Eds.). *Indian Education in Canada: Volume 1 - The Legacy*. Vancouver: University of British Columbia Press.
- McKinley, E. (1996). Towards an Indigenous Science Curriculum. *Research in Science Education*, 85, 74-76.
- McKinley, E. (2005). Locating the Global: Culture, Language, and Science Education for Indigenous Students. *International Journal of Science Education*, 27, 227-241.
- McKinley, E., McPherson W., & Bell, B. (1992). Language, Culture and Science Education. *International Journal of Science Education*, 14, 579-595.
- Messenger, P., (Ed.). (1989). *The Ethics of Collecting Cultural Property: Whose Culture? Whose Property?* Albuquerque: University of New Mexico Press.
- Métis National Council. (n.d.). *Who are the Métis?* Retrieved June 12, 2008, from Métis National Council: <http://www.metisnation.ca/who/index.html>
- Michell, H. (2008). *Pâkîtinâsôwîn: Tobacco Offerings in Exchange for Stories and The Ethic of Reciprocity in First Nations Research*. Unpublished paper.
- Michell, H. (2007). Nîhîthawâk Ithîniwak, Nîhîthawâtîsîwin and Science Education: An Exploratory Narrative Study Examining Indigenous-based Science Education in K-12 Classrooms from the Perspectives of Teachers in Woodlands Cree Community Contexts. PhD Dissertation: University of Regina.
- Michell, H. (2005). Nehithawak of Reindeer Lake, Canada: Worldview, Epistemology and Relationships with the Natural World. *The Australian Journal of Indigenous Education*, 34, 33-43.
- Miller, J. (1996). *Shinkwauk's Vision: A History of Native Residential Schools*. Toronto: University of Toronto Press.
- Milloy, J. (1999). *A National Crime: The Canadian Government and the Residential School System 1879 to 1986*. Manitoba: University of Manitoba Press.
- Nadasdy, P. (1999). The Politics of TEK: Power and the 'Integration' of Knowledge. *Arctic Anthropology*, 36(1-2), 1-18.
- National Indian Brotherhood [NIB]. (1972). *Indian Control of Indian Education*. (1972). Ottawa: Author.
- National Indian Brotherhood [NIB]. (1988). *Traditions and Education: Towards A Vision of our Future — A Declaration of First Nations Jurisdiction over Education*. Ottawa: National Indian Brotherhood, Assembly of First Nations.

- Nicholas, A. (2001). Canada's Colonial Mission: The Great White Bird. In K. Binda, & S. Calliou (Eds.), *Aboriginal Education in Canada: A Study in Decolonization* (pp. 9-33). Mississauga, Ontario: Canadian Educators' Press.
- Nieto, S. (2002). *Language, Culture, and Teaching: Critical Perspectives for a New Century*. Mahwah, New Jersey: Lawrence Erlbaum publishers.
- O'Loughlin, M. (1992). Rethinking Science Education: Beyond Piagetian Constructivism Toward a Sociocultural Model of Teaching and Learning. *Journal of Research in Science Teaching*, 29: 791-820.
- Ogawa, M. (1995). Science Education in a Multi-Science Perspective. *Science Education*, 79, 583-593.
- Orr, D. (1992). *Ecological literacy: education and the transition to a postmodern world*. Albany, NY: State University of New York Press.
- Ovando, C. (1988). Teaching Science to the Native American Student. In J. Rehner (Ed.), *Teaching the Indian Child: A Bilingual/multicultural Approach*. Billings MT: Eastern Montana College.
- Pomeroy, D. (1994). Science Education and Cultural Diversity: Mapping the Field. *Studies in Science Education*, 24, 49-73.
- Proshansky, H. (1978). The City and Self-identity. *Environment and Behavior*, 10, 147-169.
- Proshansky, H., Fabian, A., & Kaminoff, R. (1983). Place-identity: Physical World Socialization of the Self. *Journal of Environmental Psychology*, 3, 57-83.
- Racette, S. (2006). Métis Education. In *The Encyclopedia of Saskatchewan*. Regina: Canadian Plains Research Centre, University of Regina.
- Royal Commission on Aboriginal People [RCAP]. (1996). *Report of the Royal Commission on Aboriginal People*. Ottawa: Canada Communication Group – Publishing.
- Riggs, E. (2004). Field-Based Education and Indigenous Knowledge: Essential Components of Geoscience Education for Native American Communities. *Science Education* 89, 2 (March 2005), 296-313.
- Ritchie, S., & Butler, J. (1990). Aboriginal Studies and the Science Curriculum: Affective Outcomes from a Curriculum Intervention. *Research in Science Education*, 20, 249-354.
- Russell, C., Bell, A., & Fawcett, L. (2000). Navigating the waters of canadian environmental education. In T. Goldstein, & D. Selby, *Weaving connections: Educating for peace, social and environmental justice* (pp. 196-217). Toronto: Sumach Press.
- Sable, T. (2005). *Emerging Identities: A Proposed Model for an Interactive Science Curriculum for First Nations Students*. PhD Dissertation, University of New Brunswick.
- Sainte-Marie, B. (2000). *Science: Through Native American Eyes*. Kapaa, HI: Cradleboard Teaching Project. Retrieved April 6, 2002, from www.cradleboard.org.

- Saskatchewan Education. (1984). Directions, The five year action plan for native curriculum development. Regina, SK: Author.
- Saskatchewan Education. (1984). Five year action plan for Native curriculum development. Regina, SK: Author.
- Saskatchewan Education. (1995a). Diverse voices: Selecting equitable resources for Indian and Métis education. Regina SK: Author.
- Saskatchewan Education. (1995b). Indian and Métis education advisory committee: Action plan 1995. Regina, SK: Author.
- Saskatchewan Education. (1995c). Indian and Métis education policy from kindergarten to grade 12. Regina, SK: Author.
- Saskatchewan Education. (2000a). Aboriginal education provincial advisory committee: Action plan 2000-2005. Regina SK: Author.
- Saskatchewan Education. (2000b). Core curriculum: Principals, time allocations, and credit policy. Regina SK: Author.
- Saskatchewan Education. (2003). Building partnerships: First Nations and Métis peoples and the provincial education system. Regina, SK. Author.
- Saskatchewan Education. (2005). Aboriginal education provincial advisory committee: Priorities report 2005-2007. Regina SK: Author.
- Saskatchewan Learning. (2005). Science 10 curriculum guide. Regina, SK. Author.
- Schnarch, B. (2004). Ownership, Control, Access, and Possession (OCAP) or Self-Determination Applied to Research: A Critical Analysis of Contemporary First Nations Research and Some Options for First Nations Communities. First Nations Centre: National Aboriginal Health Organization.
- Scott, C. (1996). Science for the West, Myth for the Rest? In Laura Nader (Ed.), *Naked Science: Anthropological Inquiry into Boundaries, Power, and Knowledge* (pp. 69-86). New York: Routledge.
- Sealey, D. (1980). Education of the Manitoba Métis. In Lussier, Antoine S. and Sealey, D. Bruce (Eds.), *The Other Natives: The Métis, Volume 3*. Winnipeg: Manitoba Métis Federation Press.
- Semalim, L., & Kincheloe, J.L. (1999). *What is Indigenous Knowledge: Voices from the Academy*. New York: Falmer Press.
- Siggins, M. (2005). *Bitter embrace: White society's assault on the Woodland Cree*. Toronto, Canada: McClelland & Stewart Ltd.
- Smith, G., & Williams, D. (1999). *Ecological education in action: on weaving education, culture, and the environment*. Albany, NY: State University of New York Press.

- Snively, G., & Corsiglia, J. (2001). Discovering Indigenous Science: Implications for Science Education. *Science Education*, 85, 6-34.
- Snively, G. (1990). Traditional Native Indian beliefs, Cultural Values, and Science Instruction. *Canadian Journal of Native Education*, 17, 44-59.
- Snow, Chief John. (1977). *The Mountains are our Sacred Places*. Toronto: Samuel Stevens.
- Sobel, D. (2004). *Place-based Education: Connecting Classrooms and Communities*. Great Barrington, MA: The Orion Society.
- Sobel, D. (1998). *Mapmaking with Children: Sense-of-place Education for the Elementary Years*. Portsmouth NH: Heinemann.
- Society for the Advancement of Excellence in Education. (2005). *Moving Forward in Aboriginal Education: Proceedings of a National Policy Roundtable*. Concordia University.
- St. Denis, V. (2002). Exploring the Socio-cultural Production of Aboriginal Identities: Implications for Education. PhD Dissertation. Stanford University.
- St. Denis, V., Bouvier, R., Battiste, M. (1998). *Okiskinhamakewak – Aboriginal Teachers in Saskatchewan's Publicly Funded Schools: Responding to the Flux*. Regina SK: Saskatchewan Education.
- Steele, F. (1981). *The Sense of Place*. Boston, CBI Publishing.
- Stephens, S. (2000). *Handbook for Culturally Responsive Science Curriculum*. Fairbanks, Alaska: Alaska Native Knowledge Network.
- Stokols, D., & Shumaker, S.A. (1981). People in Places: A Transactional View of Settings. In J.H. Harvey (Ed.), *Cognition, Social Behavior, and the Environment*: p. 441-488. Hillsdale, NJ: L. Erlbaum.
- Stringer, E. (1999). *Action Research, 2nd Edition*. London: Sage Publications.
- Sutherland, D., & Tays, N. (2004, April). *Incorporating Indigenous Culture into School Science*. Paper presented at the annual meeting of the National Association for Research in Science Teaching, Vancouver.
- Smith, L. (2002 [1999]). *Decolonizing Methodologies: Research and Indigenous Peoples*. London: Zed Books Ltd.
- United Nations, Sub-Commission on the Promotion and Protection of Human Rights. (2000). Report of the Seminar on the Draft Principles and Guidelines for the Protection of the Heritage of Indigenous People: Human Rights of Indigenous Peoples. Geneva: Author.
- United Nations Education, Scientific and Cultural Organization. (2002). *UNESCO Universal Declaration on Cultural Diversity*. Retrieved June 2008, from UNESCO:
http://www.unesco.org/education/imld_2002/universal_decla.shtml#1

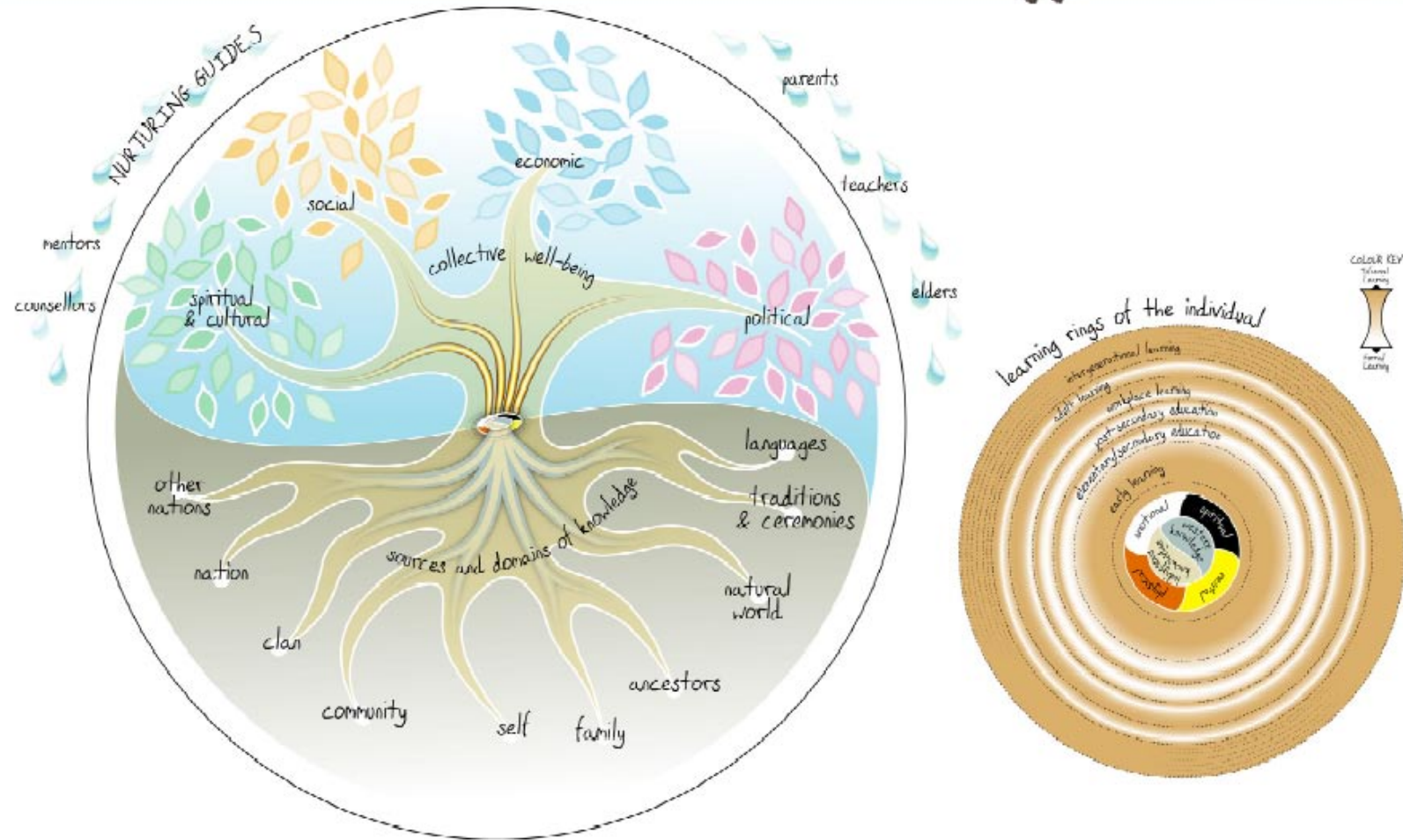
- United Nations Educational, Scientific and Cultural Organization. (n.d.). *Education for Sustainable Development*. Retrieved July 2008, from United Nations Educational, Scientific and Cultural Organization: http://portal.unesco.org/education/en/ev.php-URL_ID=27234&URL_DO=DO_TOPIC&URL_SECTION=201.html
- Urión, C. (1999). Changing Academic Discourse about Native Education: Using Two Pairs of Eyes. *Canadian Journal of Native Education*, 23, 6-15.
- Villeneuve, J. (1996). Fanning The Teacher Fire: An Exploration Of Factors That Contribute To Teacher Success In First Nation Communities. Master's Thesis: University of British Columbia.
- Waldram, J. (1997). Traditional Knowledge Systems: The Recognition of Indigenous History and Science. *Saskatchewan Indian Federated College Journal*, 2(2), 115-24.
- Wiessner, S., & Battiste, M. (2000). The 2000 Revision of the United Nations Draft Principles and Guidelines on the Protection of the Heritage of Indigenous People. *St. Thomas Law Review*, 13 (1), 383-390.
- Williams, D., & Stewart, S.I. (1998). Sense of Place: An Elusive Concept that is finding a Home in Ecosystem Management. *Journal of Forestry*, 96, 18-23.
- Williams, D., Patterson, M., Roggenbuck, J., & Watson, E. (1992). Beyond the Commodity Metaphor: Examining Emotional and Symbolic Attachment to Place. *Leisure Sciences*, 14, 29-46.

APPENDICES

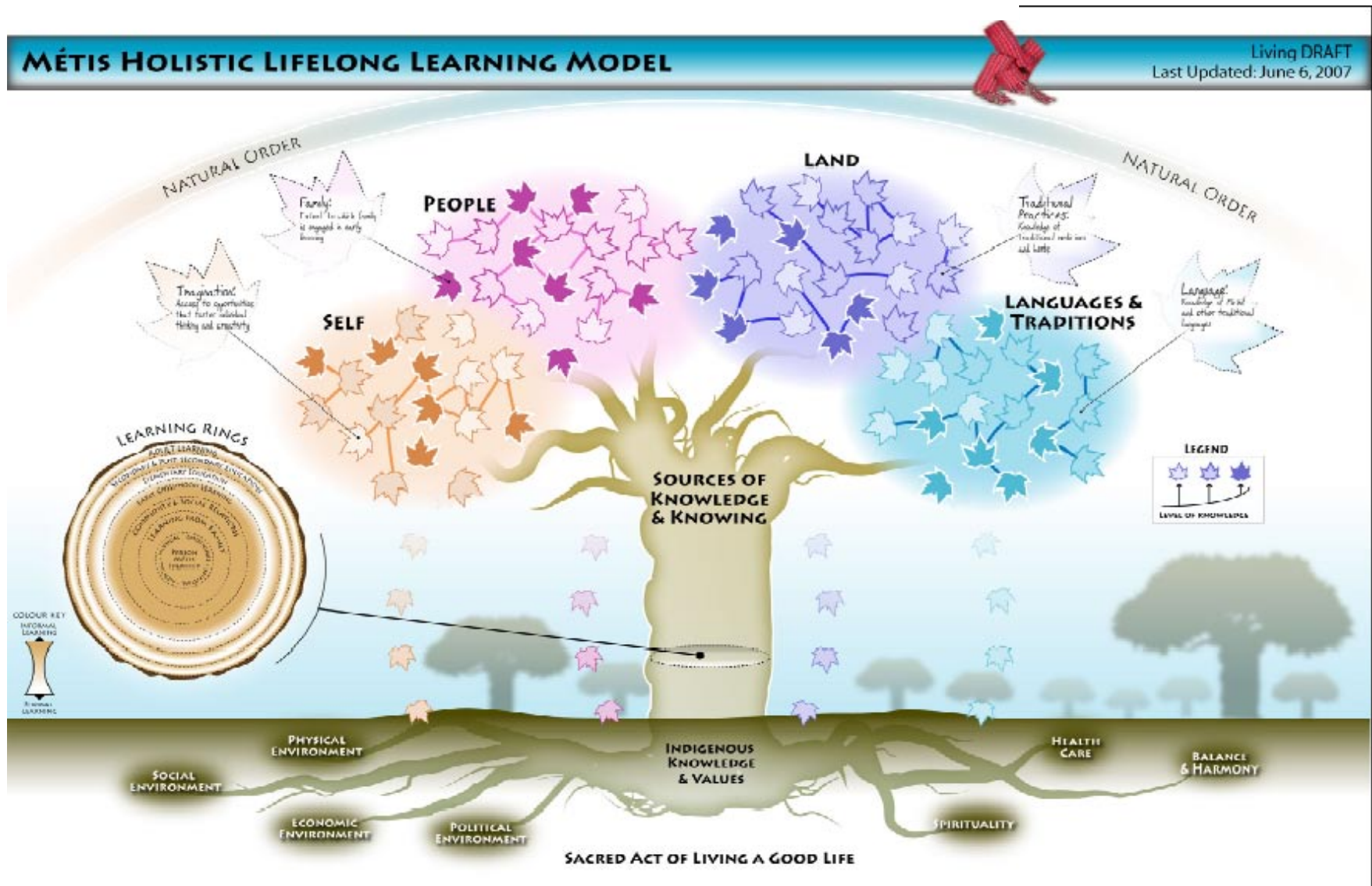
Appendix 1: First Nations Holistic Lifelong Learning Model

First Nations Holistic Lifelong Learning Model

Living DRAFT
Last Updated: June 6, 2007



Appendix 2: Métis Holistic Lifelong Learning Model



Appendix 3: Indigenous Science and Western Science: Similarities and Differences

In what follows, three comparisons are reviewed and/or adapted to provide some insight into the differences and similarities between Indigenous and Western knowledge/science. The first comparison is borrowed from Stephens (2000) and examines the similarities between Indigenous and Western science. The second comparison is adapted from Kawagley and Barnhardt (1999) and focuses on the similarities and differences between the Indigenous and Western scientific worldviews. And the last comparison is borrowed from the Alaska Native Science Commission website <http://www.nativescience.org/issues/tk.htm>.

Stephens (2000) identifies commonalities between Indigenous science and Western science in the following four areas: Organizing principles, habits of mind, skills and procedures, and knowledge.

Organizing principles include: the common notion that the universe is unified and that the body of knowledge is essentially stable but subject to modification.

Habits of mind include: common notions of honesty, inquisitiveness, perseverance, and open-mindedness.

Skills and procedures common to both models of inquiry include: empirical observations in natural settings, pattern recognition, and verification through repetition, inference and prediction.

Knowledge common to both models of inquiry include: plant and animal behaviors; cycles; habit needs; interdependence; properties of objects and materials; position and motion of objects; cycles and changes in earth and sky. (p. 11)

The commonalities above offer a starting point for curriculum development that honours both Western science and Indigenous science. However, because Indigenous and Western worldviews and values differ, the interpretation of nature differs, and thus the knowledge/science content of each system is not easily translatable.

The following comparison has been adapted from a comparison provided by Kawagley and Barnhardt (1999). They can serve as a first step towards understanding and celebrating cultural difference. Comparing worldviews can be a way of illuminating and rejecting the positivist Western science paradigm as the only way of knowing. More importantly, the comparisons serve as a point of clarity that positivist Western science thinkers may want to think about. As with most dichotomous comparisons, they can be challenged as partly accurate and useful. The first statement in each comparison is based on Indigenous worldview (IW). The second statement is based on the predominant worldview of Western science (WS):

Indigenous Science Worldview	Western Science Worldview
<p>Spirituality is embedded in all elements of the cosmos;</p> <p>Humans have responsibility for maintaining a harmonious relationship with the natural world;</p> <p>Natural resources are viewed as gifts; Need for reciprocity between human and natural worlds;</p> <p>Spiritual practice honors Nature on a daily basis;</p> <p>Wisdom and ethics are derived from direct experience with the natural world;</p> <p>Universe is made up dynamic, ever-changing natural forces;</p> <p>Universe is viewed as a holistic, integrative system with a unifying life force;</p> <p>Time is circular with natural cycles that sustain all life;</p> <p>Nature will always possess unfathomable mysteries;</p> <p>Human thought, feelings, and words are inextricably bound to all other aspects of the universe;</p> <p>Human role is to participate in the orderly designs of nature;</p> <p>Respect for Elders is based on their compassion and reconciliation of outer- and inner- directed knowledge;</p> <p>Sense of empathy and kinship with other forms of life;</p> <p>View proper human relationship with nature as a continuous two-way, transactional dialogue</p>	<p>Spirituality is centered in a single Supreme Being;</p> <p>Humans exercise dominion over nature to use it for personal and economic gain;</p> <p>Natural resources are available for unilateral human exploitation;</p> <p>Spiritual practices are intermittent and set apart from daily life;</p> <p>Human reason transcends the natural world and can produce insights independently;</p> <p>Universe is made up of an array of static physical objects;</p> <p>Universe is compartmentalized in dualistic forms and reduced to progressively smaller conceptual parts;</p> <p>Time is linear chronology of “human progress”;</p> <p>Nature is completely decipherable to the rational human mind;</p> <p>Human thought, feeling, and words are formed apart from the surrounding world;</p> <p>Human role is dissect, analyze, and manipulate nature for own ends;</p> <p>Respect for others is based on material achievement and chronological old age;</p> <p>Sense of separateness from and superiority over other forms of life;</p> <p>View relationship of humans to nature as a one-way, hierarchical imperative.</p>

The following two charts appear on the Alaska Native Science Commission (ANSC) website. They note,

Too often, traditional knowledge is incorrectly made parallel only to science. Science is but a small part of non-indigenous knowledge. Similarly, to suggest that traditional knowledge is only the equivalent of science is to diminish incorrectly the strength and breadth of traditional knowledge...while it is not appropriate to compare scientific and traditional knowledge as equivalents, The use of traditional knowledge in scientific knowledge in science means that the two knowledge bases will be in contact with each other as practitioners attempt to weave the two together.

Comparisons between traditional and scientific knowledge styles

Indigenous Knowledge	Scientific Knowledge
assumed to be the truth	assumed to be a best approximation
sacred and secular together	secular only
teaching through storytelling	didactic
learning by doing and experiencing	learning by formal education
oral or visual	written
integrated, based on a whole system	analytical, based on subsets of the whole
Intuitive	model- or hypothesis-based
Holistic	reductionist
Subjective	objective
Experiential	positivist

ANSC, n.d. <http://www.nativescience.org/issues/tk.htm>

Comparisons between traditional and scientific knowledge in use

Indigenous Knowledge	Scientific Knowledge
lengthy acquisition	rapid acquisition
long-term wisdom	short-term prediction
powerful prediction in local areas	powerful predictability in natural principles
weak in predictive principles in distant areas	weak in local areas of knowledge
models based on cycles	linear modelling as first approximation
explanations based on examples, anecdotes, parables	explanations bases on hypothesis, theories, laws
Classification: a mix of ecological and use non-hierachical differentiation includes everything natural and supernatural	Classification: based on phylogenic relationships hierarchical differentiation excludes the supernatural

ANSC, n.d. <http://www.nativescience.org/issues/tk.htm>

Appendix 4: Promising Practices Database

The following *promising practices* are arranged in three sections: promising practices in inclusive curriculum design (including units, lessons, etc.), promising practices in pedagogy/methodology, and promising practices in systemic initiatives.

A. **PROMISING PRACTICES IN INCLUSIVE CURRICULUM DESIGN (UNITS, LESSONS, ETC.)**

1) **Forests for the Future (Tsimshian territory, BC)**

Social studies and science curriculum

The Forests for the Future social studies curriculum focuses on four unit plans that incorporate Indigenous and scientific knowledge to meet the ecological needs of the local community. The curriculum incorporates the traditional ecological knowledge of Gitxaala Elders. <http://www.ecoknow.ca/>

2) **Rekindling Traditions (Northern Saskatchewan, Canada)**

6 Cross-cultural science and technology units

Guided by the writings of Dr. Greg Cajete and other First Nations educators, six teachers across northern Saskatchewan and Dr. Glen S. Aikenhead developed six cross-cultural science and technology teaching units (complete with lesson plans). The project involved the communities bringing First Nations science into the science classroom. They also wrote a teacher guide for the whole project and another document to tell our stories about involving people in the communities (our challenges, successes, and advice). The units give students access to Western science and technology without requiring them to adopt the worldview endemic to Western science. <http://www.usask.ca/education/ccstu/>

3) **Manitoba Education, Citizenship and Youth**

Title: Incorporating Aboriginal Perspectives: A Theme-Based Curricular Approach (Resource Materials and Templates)

This workshop package offers selected instructional strategies for specific grade and content areas. It is designed to assist teachers as they build Aboriginal Perspectives into curricula http://www.edu.gov.mb.ca/k12/docs/policy/abpersp/ab_persp.pdf

To assist Manitoba educators in incorporating Aboriginal Perspectives, Native Studies documents have been developed and published, such as:

- Native Studies Early Years (K- 4) A Teacher's Resource Book
- Native Studies Middle Years (Grades 5 - 8) A Teacher's Resource Book Framework, and
- Native Studies Senior Years (S1 - S4) A Teacher's Resource Book Framework

Most recently Integrating Aboriginal Perspectives into Curricula: A Resource for Curriculum Developers, Teachers and Administrators has been distributed to schools to assist in the process.

Cultural Concepts are organized according to grade level:

Grade 2	Cooperation and Respect;
Grade 5	Knowing Our Place
Senior 2	Water and Collective-Decision Making

Science units exist for each grade level/cultural theme.

<http://www.edu.gov.mb.ca/k12/abedu/perspectives/resources.html>

4) The Alaska Native Knowledge Network

ANKN is a systemic initiative that has endorsed and developed curricula

The Alaska Native Knowledge Network is a resource for information related to Alaska Native knowledge systems and ways of knowing. It has a searchable curriculum database, sample science units, copies of Alan Dick's science books, AISES Handbooks, links to multiple related sources and much, much more:

- Dick, A. (2003) *Resources for Native Science Camps, Projects and Fairs*. Fairbanks, Alaska: Alaska Native Knowledge Network
- Dick, A. (1999) *Village Science, Teacher and Student Editions*. Fairbanks, Alaska: Alaska Native Knowledge Network
- Dick, A. (1998) *Northern Science or Alaskans are Never Stuck, Teacher and Student Editions*. Fairbanks, Alaska: Alaska Native Knowledge Network
- Matthews, D. (2003) *Unangam Hitnisangin/Unangam Hitnisangis/Aleut Plants: a Region-Based Plant Curriculum for Grades 4-6*. Edited by B. Carlson.

<http://www.ankn.uaf.edu/unangam>

ANKN culturally responsive science units

The Alaska Native Knowledge Network website contains 21 culturally responsive units that can be applied to any locale. The website states that more units will be available soon.

<http://www.ankn.uaf.edu/curriculum/units>

5) The Kormilda Science Project: An Indigenous Perspective on the Earth Sciences (Read, 2002)

In Australia, national policies explicitly support Aboriginal versions of school science (see Michie, 2002; Purdie et al., 2000). This support inspired a non-Aboriginal science educator to collaborate closely with three different Aboriginal family groups across Australia to produce a high school textbook, *The Kormilda Science Project: An Indigenous Perspective on the Earth Sciences* (see Read,

2002). *The Kormilda Science Project* is a rare example of a textbook that respectfully integrates Indigenous science with Western science.

6) Native Access to Engineering Program

The Native Access to Engineering Program has been producing curriculum since 1998. Each topical set consists of a newsletter, worksheet and teacher's guide.

Curriculum units include: Geomatics, Ocean Engineering, Nutrition, Building Engineering, Water, Geology, Biomedical Eng., Energy, Structures, Simple machines, Environment, Communications, Chemical, Construction, Flight, Materials, Measurement, Space, Agriculture, Mining, Forestry, Computer, Transportation, Sound, Light.

<http://www.nativeaccess.com>

7) Practising the Law of Circular Interaction (Saskatchewan Indian Cultural Centre, 1993)

Indigenous ecology curriculum

Practising the Law of Circular Interaction was born out of the efforts of Aboriginal participants to transform a Western science ecology curriculum into an Indigenous ecology curriculum. The differences in epistemology, ontology, and axiology between the two knowledge systems were found to be so discordant that they necessitated a fresh independent start (This example reinforces the idea that curricula developed in one cultural context/community is not necessarily transferable to another).

<http://www.sicc.sk.ca/>

8) Cradleboard Core Curriculum

The Cradleboard Teaching Project has created a library of fifteen text-based volumes of core curriculum based in Native American culture. Seven of these are already available as interactive online units. One is available to the public at the Cradleboard Store as our main fundraising vehicle. The others exist as traditional school-type print and graphics curriculum units, waiting to be re-created as interactive multimedia units as time and project funding allows. Cradleboard Core Curriculum is available in five subject areas at three grade levels [elementary, middle years, secondary].

www.cradleboard.org

B. Promising Practices in Pedagogy/Methodology

9) Authentic Language learning/Instruction: Māori schools in Aotearoa, NZ

McKinley et al. (1992) enriched the idea of integration when they argued for students to learn both Indigenous and Western sciences in a student's Aboriginal language. This led to research into translating the Aotearoa New Zealand science curriculum into the Māori language (McKinley, 1996) and to research into the effect of non-Indo European languages on student learning" (Aikenhead, 2006b, 125).

Aotearoa New Zealand enjoys an enhanced science curriculum. A Māori version of their country's science curriculum came about through negotiations between Elders of the Māori nation and science educators (McKinley, 1996; Stewart, 2005). This Māori version, called "pūtaiao," was recognized by the country's ministry of education for a network of Māori language schools and Māori bilingual and immersion classrooms in elementary and high schools, including grade 12 (McKinley, 2005; McKinley, Stewart, & Richards, 2004). "As an Indigenous science, pūtaiao offers the opportunity to develop a uniquely local critical science education curriculum" (Stewart, 2005, p. 866). Teacher candidates are being educated to produce lesson plans to fit pūtaiao (Barker, 2004).

It is clear from the Aotearoa New Zealand and Australian experiences that when Indigenous knowledge is recognized as foundational to school science, appropriate curricula, teacher education programs and instructional materials can ensue.

10) Student Engagement Through Technology (Digital Cameras) and Mentoring

The use of digital cameras in Aboriginal student education emerged as a theme in effective practices. *Traditional Pathways to Health* is a research project developed through collaborative efforts between University of Victoria researchers, and Aboriginal teachers and students from two school districts. The project enables Aboriginal youth at three high schools in Victoria to use digital video to highlight their own positive activities, culture, and traditions as important dimensions of their lives that help to keep them well (see Riecken, et. al., 2006). The following are three examples of schools that have utilized and found the project to be successful:

- Career and Personal Planning (CAPP) at Victoria High School (BC) has a course option for Aboriginal students that focuses on making connections with Elders and other Aboriginal role models.
- The Westshore Center for Learning and Training (BC) has developed a separate First Nations graduation program with a strong cultural focus that engages adult and youth learners with Aboriginal artists, poets, dancers, and writers.
- In First Nations Leadership 11 at Esquimalt High (BC), the philosophy of the course is the belief that First Nations values and beliefs are essential to the understanding of self and others as leaders.

Mentoring has been employed successfully in the areas of Aboriginal women's health (see Banister & Begoray, 2006), success coaches (see Costa, 2006), pre-service teachers' working with students (see McCluskey, Baker & McCluskey, 2005).

C. Promising Practices in Systemic Initiatives

11) Aboriginal Knowledge and Science Education Research Project

The *Aboriginal Knowledge and Science Education Research Project* was developed by the Aboriginal Education Enhancements Branch of the Ministry of Education and the University of Victoria. The principal goals of the project are to:

"...enable Aboriginal students to be successful in science and related programs at the middle and secondary school levels; to encourage Aboriginal students to consider science-related

occupations; and to provide a meaningful context that will enable curriculum developers at a later phase to develop culturally appropriate science curriculum materials and programs for Aboriginal students” (Snively & Williams, 2006, 242 – 243).

12) **Aboriginal Learning Knowledge Centre**

The Aboriginal Learning Knowledge Centre was created by the Canadian Council on Learning as a national initiative supporting the development of effective solutions to challenges faced by First Nations, Métis and Inuit learners. The Aboriginal Learning Knowledge Centre has a Consortium and a National Advisory Committee of more than 100 organizations and individuals from across the country working together to create a path for the improvement of Aboriginal learning in Canada. A Steering Committee made up of volunteer members of the Consortium and National Advisory Committee provide direction to the Aboriginal Learning Knowledge Centre. The Co-Lead Organizations for the Aboriginal Learning Knowledge Centre are the [Aboriginal Education Research Centre](#) at the University of Saskatchewan and the [First Nations Adult and Higher Education Consortium](#) in Calgary, Alberta.

<http://www.ccl-cca.ca/CCL/AboutCCL/KnowledgeCentres/AboriginalLearning/AboriginalLearningHome/?Language=EN>