Assessing the Need for Culturally Responsive Science Curriculum:

Two Case Studies from British Columbia

by

Brian William Neill

B.Sc., University of Toronto, 1968
M.Sc., University of Toronto, 1971
M.Ed., University of Alberta, 1985

A Dissertation Submitted in Partial Fulfillment
of the Requirements for the Degree of

DOCTOR OF PHILOSOPHY

in the department of Curriculum and Instruction

Supervisory Committee

Assessing the Need for Culturally Responsive Science Curriculum:

Two Case Studies from British Columbia

by

Brian William Neill
B.Sc., University of Toronto, 1968
M.Sc., University of Toronto, 1971
M.Ed., University of Alberta, 1985

Supervisory Committee

Dr. Leslee Francis Pelton (Department of Curriculum and Instruction)
Supervisor

Dr. Todd Milford (Department of Curriculum and Instruction)
Departmental Member

Dr. John O. Anderson (Department of Educational Psychology and Leadership Studies)
Outside Member

Abstract

Supervisory Committee

Dr. Leslee Francis Pelton, Department of Curriculum and Instruction
Supervisor
Dr. Todd Milford, Department of Curriculum and Instruction
Departmental Member
Dr. John O. Anderson, Department of Educational Psychology and Leadership Studies
Outside Member

This inquiry began with a global question: Why are Aboriginal high school students underrepresented in the sciences? This led to the following series of questions: What is science? Is Aboriginal knowledge about nature and naturally occurring events science? What is science literacy? What are culturally responsive approaches to science education? The initial inquiry began as part of the Aboriginal Knowledge and Science Education Research Project, University of Victoria, British Columbia, Canada. Over time the inquiry morphed into two case studies. The first case study focused on a quantitative exploration to examine the current state of student performance in British Columbia secondary school science (Biology 12, Chemistry 12, and Physics 12), and mathematics (Principles of Mathematics 12). The examination of performance trends for over a decade confirmed the underperformance of Aboriginal students in secondary school sciences and mathematics when compared to non-Aboriginal students. The second case study sought to establish criteria, identify, and document a model project that incorporated the methods of western modern science (WMS) knowledge and ways of knowing represented by traditional ecological knowledge and wisdom (TEKW), local ecological knowledge (LEK), and indigenous knowledge (IK) in a local environment (place-based) and that was culturally responsive to students and faithful to science education principles. A model project was identified in British Columbia operating within the Heiltsuk First Nation territory by the Qqs (pronounced “kucks”) Projects Society. This project exemplified the *Te Kotahitanga Project* in Aotearoa/New Zealand by engaging student interns in science in place. Qqs partnered with a number of non-governmental organizations to develop the Supporting Emerging Aboriginal Stewards (SEAS) Initiative, whereby interns used WMS techniques to study their traditional territory in the Great Bear Rainforest. The SEAS project was deemed to make science more relevant for Aboriginal students, who may otherwise have rejected it because of a possible conflict with their cultural value systems and personal relevance.

There is a persistent tension between science espoused by WMS, and the wisdom and sacredness of indigenous knowledge and wisdom (IKW). Finally, recommendations are proposed for a Two-row Wampum Belt or a trans-systemic practice that would enable IKW and WMS knowledge to operate in a spirit of mutual cultural responsiveness, followed by recommendations for future study.

Table of Contents

List of Tables

List of Figures

Acknowledgments

I am grateful to my dissertation committee, Dr. Leslee Francis Pelton (Supervisor), Dr. John Anderson, and Dr. Todd Milford, all of whom have been extremely patient with this "life-long learner" … I am the richer for your guidance and collaboration. To my supervisor, Dr. Leslee Francis Pelton, I owe a special thanks for taking on the "supervisory role" when my initial supervisor left the university. This has been a journey "par excellence" for me.

A special thank you to The Right Honourable Paul Martin, PC, CC, for his timely response to my question: "What is your vision of Aboriginal Education in Canada?" I was certainly very honoured to engage in a personal phone conversation and to receive his speech "Confederation Today and Aboriginal Canada" that he delivered October 10, 2013, in Charlottetown, PEI. It was empowering to share common visions with him in such a personable manner.

I respectfully acknowledge the time and consideration that I have been given by the Heiltsuk First Nation, Chief Harvey Humchitt, Sr., (Wqivilba Wakas), and HIRMD Director, Kelly Brown, who not only provided me with insightful commentary, but also freely shared their understandings of life and where we are positioned as cultures.

I further acknowledge the immense help and co-operation of Jessie Housty, Director of Traditional Ecological Knowledge at Qqs Projects Society and Heiltsuk Tribal Councillor, and Diana Chan, Pacific Wild's Science Field Co-ordinator, for the use of the SEAS Initiative summer internship student blogs that began in 2010. I am indebted to Elder Angela Mason who generously gave her knowledge and time, providing a needed dimension to the study, and her willingness to be my co-presenter at the 2013 CSSE Congress in Victoria.

To my wife Rose Mary, I am sorry for the concerts, runs, paddles missed, but above all I am so appreciative and aware of your sacrifices on my behalf. To my family and friends, I thank you for your understanding and support.

I would also like to thank Mr. Pat McCrea, Ministry of Education for the Province of British Columbia, now working in the Open Government and Community Partnerships Division: Business Intelligence Unit. His willing help accessing performance data was very much appreciated.

Finally, but by no means least, I would like to thank Dr. Larry D. Yore, University Distinguished Professor Emeritus, for his mentorship, encouragement, support, wisdom, and guidance throughout this creative dissertation process; and Shari Yore for her editorial expertise and patience in shaping the final document.

Dedication

Marion Wright, July 9, 1963—January 16, 2012

This photo was given to me by Marion and permission for its use was granted by Chief Tony Hunt, December 2013.

Marion and I began the doctoral program together in September 2006. We were not only classmates but also very good friends who collaborated on many assignments that were part of our program. Marion gave me many valuable insights into her rich cultural roots, the first being, “Hemens laxenguyulas” [Our ancestors are behind us in everything we do]. To me, this powerful message is never far from my own thinking today. Marion taught me about colours and directions; we would both smile a smile of understanding when we would wear “red” on an important “presentation day” for a particular course. Marion was proud of her Kwaguilth and Métis heritage, a heritage that she easily shared with me. My sadness at her passing is balanced by the love I feel for all we shared when we were together. Our last communication was a joyful one, as I related my experiences in Aotearoa where I gained a greater understanding of Māori culture, a culture that shares many common struggles with First Nations. The joy for me was finding and photographing a commemorative pole carved in 1990 by her Uncle Tony Hunt in Rotorua, NZ on behalf of the Government of Canada. Marion, you remain with me and I

feel that you are “still behind me” in my writing and understanding of First Nations culture.

Marion received recognition for her tireless work in teaching her cultural roots and enabling others to carry on this important task. I therefore add the following to this dedication to her work by Dan Maclennan (*Courier-Islander*, May 9, 2012).

> **Cedar tree honours Marion Wright**
>
> An Aboriginal Education pioneer was remembered Monday during ceremonies marking the official opening of the First Nations Gathering Place at the North Island College (NIC) campus in Campbell River
>
> A western red cedar tree was planted next to the new big house in tribute to Marion Wright (July 9, 1963 – January 16, 2012), college instructor and NIC’s first coordinator of Aboriginal Education.
>
> “Marion was the first NIC employee to co-create a vision for Aboriginal Education at NIC,” said family member George Hunt Jr., who presided over the tree planting. “As was her way, she brought many people together for deep discussions to discover what needed to be done, and then she did it.”
>
> Read more:
> http://www.canada.com/Cedar+tree+honours+Marion+Wright/6590194/story.html

Thank you, my friend!

Chapter 1
Introduction to the Study

The study began with a global question: Why are Aboriginal high school students in British Columbia (BC) underrepresented in the sciences? This led to other fundamentally related questions: What is science? Is Aboriginal knowledge about nature and naturally occurring events science? What is science literacy? What are culturally responsive approaches to science education? The initial inquiry began as part of an Aboriginal Knowledge and Science Research Project at the University of Victoria, BC, Canada. Over time, the inquiry metamorphosed into two case studies. The first case study focused on a quantitative exploration, using BC Ministry of Education (MoE) data to examine the current state of student performance in secondary school sciences (i.e., Biology 12, Chemistry 12, and Physics 12) and mathematics (Principles of Mathematics 12). The second case study, a qualitative exploration, sought to identify and document a model project in BC that incorporated the methods of western modern science (WMS) and the knowledge or "ways of knowing" represented by traditional ecological knowledge and wisdom (TEKW), local ecological knowledge (LEK), and indigenous knowledge and wisdom (IKW) in a local environment (place-based) that was culturally responsive to students and faithful to science education principles.[1]

Background History Influencing the Study

This study cannot be separated from two important historical events that shaped future cultural interactions between the colonists and the colonized, (i.e., the dominant settler culture and the First Peoples' indigenous culture). The dual impact that Indian Residential Schools (IRS) and the Douglas Regime had on cultural trust cannot be overstated; it persists today in memories and experiences of many Aboriginal peoples.

---

[1] Terms used reflect the literature or the websites that post the term. Indigenous knowledge (IK) is always meant to include wisdom and may be stated as IK or IKW. TEKW is a referenced term used by the British Columbia Ministry of Education. LEK also has wisdom understood in its use. All terms are meant to include all people of Aboriginal ancestry.

Indian Residential Schools (1860–1996)

Discourses of the other have no deeper soul wound than the devastation of cultures wrought by the IRS system. Former Prime Minister of Canada Paul Martin (CBC News, 2013) stated:

> that what happened at the residential schools was the use of education for cultural genocide, and that the fact of the matter is — yes it was. Call a spade a spade … And what that really means is that we've got to offer aboriginal Canadians, without any shadow of a doubt, the best education system that is possible to have. (para. 2–3)

Throughout his business and political careers, The Right Honourable Paul Martin has been devoted to the cause of the First Nations, Métis, and the Inuit (FNMI). After he retired from political life in 2006, Mr. Martin founded the Martin Aboriginal Education Initiative (MAEI), a charitable organization. MAEI's activities provide educational opportunities for Aboriginal Peoples of Canada with a focus on elementary and secondary school outcomes on and off reserve (Martin, n.d.).

The Douglas Regime

The IRS system was formally instituted about a decade after Canadian Confederation in 1867. However, plans of assimilation and annihilation were in operation during the Douglas regime in British Columbia (1843–1864), where relations with First Nations went from trading partners to colonization in a relatively short period of time. Lutz (2008) provided an historical accounting of Aboriginal-White relations, beginning with Makúk's meaning, "let's trade" (p. ix). He pointed out that this was probably the first word exchanged between trading partners and which the Nuu-Chah-Nulth, on the west coast of Vancouver Island, would translate to exchange. This concept of exchange was seen to resonate throughout the interactions between Indigenous peoples and Europeans worldwide. Lutz suggested that these exchanges increased in complexity to include conversation, treaties, wages for labour, marriage, and biological impacts (including viral and genetic). The exchanges that focused on work for pay formed a key part to the greater puzzle of colonization. Appendix A provides a more comprehensive elaboration.

Organization of the Thesis

The purpose of the study is three-fold: first, an examination of the current state of Aboriginal students' performance and participation in science and mathematics in BC; second, to report on a model project that incorporates culturally responsive ways of knowing and WMS knowledge with Aboriginal students; and third, to suggest an approach to teaching and learning that could mutually benefit Aboriginal and non-Aboriginal students.

Chapter 2, Review of Literature, focuses on selected discourses, each representing a vast field of researchers and their writings as foundations for enacting the research questions, justifying procedure decisions, and supporting the argument and knowledge claims asserted. This four-part chapter provides an overview of relevant influential ideas that will guide an understanding of the existing achievement differences between Aboriginal and non-Aboriginal students graduating from Grade 12 science courses, pursuant of career options leading into adulthood and insights into culturally responsive education principles and exemplar international science education programs for Indigenous peoples.

Part I addresses science literacy and the nature of science (NOS) as they impact on the differing worldviews held by WMS and IKW and on other various forms of expression such as TEKW and LEK.

Part II will link these worldviews of knowledge to IKW as represented by Canadian provincial and territorial departments and ministries of education.

Part III will review the achievement in science and mathematics at the secondary level (achievement gap studies) and will include a brief background to the problem involving the inclusion of TEKW into curricular choices for students, especially relating to the BC MoE's recognition of the importance of TEKW and Aboriginal student achievement as reported in its Department of Aboriginal Education. The science curriculum from K–12 will be addressed regarding the culturally respectful choices that are outlined in the Aboriginal content in the science curriculum within the prescribed learning outcomes of the Integrated Resource Package (IRP) for each grade. IRPs state that Aboriginal science can be incorporated with western science to enhance learning for all students. However, difficulties in doing so are recognized and a model is suggested

that involves a parallel process, whereby Aboriginal and western understandings, or worldviews, exist separately, yet side-by-side, in partnership with each other. This partnership will be discussed as it relates to a culturally responsive curriculum.

Part IV provides an overview of culturally responsive educational principles and international examples of science education programs focused on Indigenous students while making a distinction between approaches to education that are culturally respectful, culturally appropriate, and culturally relevant and those that are culturally responsive to educating Indigenous students. The context of indigenizing the science and mathematics curriculum is discussed and problematized.

Chapter 3, the Study Design, is represented by two case studies; the first (quantitative) examines achievement, and the second (qualitative) examines the interaction between TEKW and WMS in the Supporting Emerging Aboriginal Stewards (SEAS) Community Initiative. The two case studies utilize archival records and documentation as sources of evidence. The data collected and analyzed employed an integrative paradigm described by Castro, Kellison, Boyd, and Kopak (2010).

In Chapter 4 (Case Study 1 — Archival), datasets obtained from the BC MoE Aboriginal Enhancements Branch and the Research and Data Unit provided information related to Biology 12, Chemistry 12, Physics 12, and Principles of Mathematics 12 final course marks for Aboriginal and non-Aboriginal populations in the province.

The first two research questions were addressed with respect to the current trends of Aboriginal science and mathematics education in BC. Performance trends for the three science courses and Principles of Mathematics 12 course were analyzed and discussed. Along with these province-wide results, a snapshot of selected school districts was considered and discussed using How are we doing? (HAWD) data (BC MoE, 2013a, 2013b).

In Chapter 5 (Case Study 2 — TEKW & WMS), a model program was documented and student voices were recorded as they related to a WMS science experience conducted on the Heiltsuk First Nation's unceded territory in the Great Bear Rainforest on the central coast of BC. The focus of this case study was on student reactions (in place) to WMS scientific methods as their experience co-mingled with LEK and TEKW. This case study was made possible by a special partnership between Qqs (pronounced "kucks")

Projects Society, the Heiltsuk First Nation, and two non-governmental organizations (NGO) working in the territory. The case study focused specifically on a two-month internship over three summers (July-August of 2010, 2011, and 2012) that Heiltsuk youth participated in as part of a five-year commitment that began in 2010.

Research question four was addressed by the Heiltsuk youth who participated in the SEAS Initiative summer internship, a model science project that was culturally responsive. The use of the SEAS student intern Blogs and several YouTube™ video recordings allowed for the intern voices to be heard, transcribed, recorded, and analyzed. The SEAS internship program was accessed through the Director of Traditional Ecological Knowledge at Qqs (Eyes) Projects Society, Ms Jessie Housty, and the two NGO partners to this project, Pacific Wild and The Nature Conservancy.

Chapter 6 begins with a discussion of Case Study 1 — Archival (Chapter 4) and its focus on Aboriginal students' performance and participation in Grade 12 science and mathematics, and the implications of the gaps in student achievement. The Heiltsuk SEAS Initiative (Case Study 2 — TEKW & WMS, Chapter 5) findings are discussed and related to the Māori successes of the Te Kotahitanga Project in Aotearoa/New Zealand with respect to culturally responsive curricula. This chapter then deals with the wisdom of TEKW, where spirituality and WMS become at odds with one another. Battiste's (2013) proposed Trans-Systemic practices that would link IKW with WMS are melded to create and unite the two worldviews in the spirit of the "Two-row Wampum belt" (Borrows & Rotman, 1997, p. 29; Muller, 2007).

Chapter 2
Review of Selected Literature

This study began by exploring the existing differences between Aboriginal and non-Aboriginal student scores on Grade 12 final science and mathematics examinations in BC and identifying a model project that might indicate productive approaches toward addressing any achievement and engagement differences. The literature consulted was drawn from the following areas of research: *nature* and *worldviews of science*, *science literacy*, *Canadian science curricula*, *Indigenous knowledge systems*, *place-based experiential learning*, *eco-justice philosophy*, and *complexity science*.

These literatures provide a broad basis for understanding the dynamic interactions that take place in the contexts of learning sciences. The purpose of this literature review is to establish the foundations for the research questions, procedural decisions, and interpretation of information collected to make assertions to inform the readers about the web of interactions that can and do take place when learning science, particularly from an Indigenous perspective.

This chapter is organized into four parts: Part I reviews the nature of science, science literacy and worldviews; Part II provides a brief overview of science curricula across Canada; Part III examines secondary school science and mathematics achievement; and Part IV discusses the question of indigenizing the science curriculum coupled with an overview of culturally responsive schooling.

Part I: Nature of Science, Worldviews, and Science Literacy

Nature and Worldviews of Science

The history of science has demonstrated that it is far from a unitary notion. Conceptions of science reveal differing and complex worldviews that are concerned with several core issues, such as the nature of evidence, the character of explanation, and the role of social factors. The nature of science will be addressed historically with respect to these core issues. Consideration of the worldviews presented by WMS and TEKW illustrates how the nature of science differs in the eye of the beholder.

Science is a process, a human endeavour that seeks to explain certain observable phenomena in nature and naturally occurring events. Scientists, as informed observers, must gather data, compare evidence, construct hypotheses, and test them. As part of this process, it is incumbent upon other scientists to challenge the hypotheses using their own experimental evidence and generate explanations for supported causal relationships. A body of knowledge develops that provides a measure of certainty to theories (umbrella ideas that have predictive and explanatory power) that are formed. All science claims and explanations are not end-points but remain tentative, open to being challenged in the future if contrary evidence surfaces. Science then is a body of empirical and theoretical knowledge about the natural world developed by a global community of researchers that makes use of scientific methods that incorporate observation, experimentation, and explanation of phenomena in the real world. Science has a dichotomous underpinning as a social construct and an objective body of knowledge. The history of science, therefore, includes a social history as well as an intellectual history; and it is from this history that the epistemology of science has evolved. Epistemology is concerned with the methods and procedures used to study a phenomenon and the types of evidence obtained that justify and explain the related knowledge claim. Metaphysical views of knowledge about nature and naturally occurring events

> vary along the philosophical continuum of specific ideas about reality, essential qualities, and relations amongst the properties, acceptable explanations, and methods of investigation called ontological assumptions and epistemological beliefs. … Furthermore, ontology and epistemology influence the traditions, conventions, and practices of knowledge communities: how knowledge is constructed, what data are evidence for a knowledge claim, and what mechanisms are acceptable explanations for an event. (Yore, 2008, p. 11)

Ontology deals with the reality of the relationship between the observer and the observed, and the claims and assumptions made, analytically, about that reality in order to substantiate and limit explanation about probable cause. These assumptions and beliefs can vary within the natural sciences (e.g., biology, chemistry, physics, and earth and oceans science) and between science topics with domains (e.g., classical physics and relativity, atomic models and quantum mechanics, wave-particle duality of light,

meteorology and climate modeling, etc.). WMS ontology limits explanations to physical causality, while TEKW explanations may include both physical and spiritual causalities.

A brief account of the history of western science includes Euro-centric contributions from the Ancient Greeks (e.g., Plato, Socrates, Aristotle, and Pythagoras); from the early modern period (i.e., the 12th to the 18th centuries), including the Age of Enlightenment (e.g., Andreas Vesalius, Nicholas Copernicus, Galileo Galilei, Robert Hooke, Johannes Kepler, Francis Bacon, Isaac Newton, and René Descartes); from the 19th century (e.g., Dmitri Mendeleev, Louis Agassiz, and Charles Darwin); and from the 20th century (e.g., Albert Einstein, Nils Bohr, and Max Planck, to name a few). This historical snapshot is indicative of the knowledge building and conceptual evolution that scientists have engaged, leading to the present WMS understandings of the world. This illustrates that scientific knowledge and understanding is not static; rather, it is dynamic and part of this dynamism is its interaction with the culture of the day.

Malegapuru William Makgoba, President of the Medical Research Council of South Africa, stated:

> The yearning need for science to be understood by the public; the need for scientists to communicate better; the need for the public to make choices about what science has to offer in their daily life; the need for the public to participate and shape the scientific process; the need for science to integrate the wealth of information that is already existent has never been greater than today. Perhaps no examples illustrate these better than the revolution in biology (the Human Genome Project and embryo stem cell research/therapy) and the human immunodeficiency virus (HIV)/AIDS epidemic that is sweeping Sub-Saharan Africa. (2002, p. 1899)

There is a close relationship between science and society that stresses the need for scientists to communicate better and for science to be better understood by the public.

Teaching the Nature of Science (NOS)

Teaching NOS has received varying degrees of emphasis in the past several decades (1960–2015). The US National Science Foundation (NSF) was mandated to create science curricula that emphasized NOS content, scientific method as inquiry, and

processes and practices (see Appendix L). The methodology of science had a profound impact on the teaching and learning of science in Canada and the USA, through such programs as PSSC Physics, Project Physics (Harvard), BSCS Biology (Green, Blue, & Yellow), and ChemStudy Chemistry. It was the expectation that students would learn something about how science works that would help them understand how it differs from nonscientific approaches to make sense of the world and its interactions with society and culture. These curricular goals moved science teaching from a traditional dissemination of established knowledge to a more liberal and humanistic approach.

In its Project 2061 publication, the American Association for the Advancement of Science (AAAS, 1989) expressed its commitment to cultural (humanistic) outcomes of science education — meaning education in science, mathematics, and technology —

> to develop the understandings and habits of mind they [students] need to become compassionate human beings able to think for themselves … to participate thoughtfully with fellow citizens in building and protecting a society that is … just. *Science for All Americans* (SFAA) consists of a set of recommendations on what understandings and ways of thinking are essential for all citizens in a world shaped by science and technology.
> (http://www.project2061.org/publications/sfaa/online/intro.htm)

The United States National Research Council (NRC, 1996) made policy recommendations that recognized the importance of philosophical and historical knowledge in the teaching of science. The NRC maintained that students should learn: science contributions to culture; the close relationship between science and technology; scientific literacy, NOS, and the role of science in society; understanding the history of science helps clarify its cultural roots; scientific innovators had to challenge ideas, current at the time; the progress of science and technology is affected by social issues and challenges (Matthews, 2009).

The National Science Teachers' Association (NSTA, 2000) endorsed the importance of NOS in its *Position Statement* (Declaration, para. 1, see Appendix L for complete statement). Matthews (2009) cautioned that the use of educators as the prime developers of NOS curricula without input from scientists, philosophers, and historians will likely

result in outcomes that are less informed and less sophisticated than would be possible with the inclusion of outside experts.

The Canadian Council of Ministers of Education (CMEC, 1997) adopted the *Pan-Canadian Protocol for Collaboration on School Curriculum*; its *Common Framework of Science Learning Outcomes K to 12* established a vision and foundation for science literacy in Canada, thereby embedding science within a societal framework and not separate from it. A search for NOS on the BC MoE website revealed that all K to 12 science courses refer to the goals of the Common Framework with respect to science literacy, a very different stance to that taken by the AAAS, NRC, NSTA, and SFAA in the United States. However, the BC MoE includes a unique cultural perspective by including *Aboriginal Content in the Science Curriculum* from K to 12 (see Appendix M). This cultural inclusion leads among Canadian provinces and territories and recognizes that there is another way of knowing and interacting with the natural world. The presence of worldviews is implied, without actually being used as a descriptor, when one considers the inclusion of NOS, or science as a way of knowing that is rooted in WMS, and IKW that are rooted in TEKW when they are written into science curricula. It is, therefore, only a small step forward, from learning about NOS to learning about science and worldviews. All of these nationally mandated goals for school science touch upon questions of science and worldviews, that is, the limits of science, the contribution of science to culture, the role of science in society, and the dynamic interaction of science with everyday religious, political, and cultural beliefs. Recognition of the connections between science and worldviews are "two-way certainly from science to worldview and metaphysics, but also from worldview and metaphysics to science" (Matthews, 2009, p. 654).

Worldviews and Science

Lacey (2009) described a worldview as "a comprehensive account of the nature of the various kinds of objects that make up the world, of how they are structured and related and interactive with one another, and of their origins, possibilities and (in some worldviews) destinies." (p. 841). Gauch (2009) identified seven important pillars of scientific thinking; realism, presuppositions, evidence, logic, limits, universality, and

worldview. He argues that the "presuppositions and reasoning of science can and should be worldview independent, but empirical and public evidence … can support conclusions that are worldview distinctive" (p. 667).

A worldview is "a set of beliefs, which provide, or purports to provide, a coherent and unified framework for answering worldview questions" (Irzik & Nola, 2009, p. 731). Therefore, worldviews in terms of culture give rise to a Euro-western worldview, an African worldview, a Chinese worldview, an Islamic worldview, a Māori worldview, and other Indigenous worldviews. Worldviews can be based on political, religious, or philosophical grounds. This is to emphasize that the most satisfactory answers to worldview questions are not necessarily scientific. "Science, even when it is characterized quite minimally, has substantial worldview content, … and a science education that did not acknowledge the worldview content of science and the interplay between science and worldviews would be an impoverished one" (Irzik & Nola, 2009, pp. 743–744).

Three contemporary scientists, Stephen W. Hawking, Stephen J. Gould, and Carl Sagan, have stated a commitment to the scientific worldview of scientism. "Scientism is a scientific worldview that encompasses natural explanations for all phenomena, eschews supernatural and paranormal speculations, and embraces empiricism and reason as the twin pillars of a philosophy of life appropriate for an Age of Science" (Shermer, 2002, p. 35). Scientism applies naturalistic answers to super-naturalistic questions. For example, Gould (1997) used his non-overlapping magisterial (NOMA) logic to separate science from religion — an argument that has raged for centuries, often with dire consequences (cf. Spanish Inquisition). In so doing, Gould is able to adopt the science of evolutionary reasoning, beginning with natural selection, as his guiding principle in proffering his position for NOMA.

Science-based Worldviews and Multiculturalism

There are a significant number of science educators and philosophers of education who argue that WMS is one of many sciences that exist and that many local cultures (FNMI of Canada, Alaskan Natives, and Indians of America) have their own sciences that contribute to the repository of human knowledge (cf. Aikenhead, 1996, 2001, 2002;

Kawagley & Barnhardt, 1998; Kawagley, D. Norris-Tull, & R. A. Norris-Tull, 1998; Ogawa, 1995; Snively & Corsiglia, 2000). Such belief systems are collectively referred to as IKW. There is no doubt that local cultures have contributed to understanding nature and naturally occurring events but they differ from WMS in their epistemological and ontological beliefs, resulting in worldviews that are opposed to one another. Other cultures are similarly challenged.

Taner Edis, a Turkish physicist, makes the point that Muslims "do not want their beliefs marginalized by such a well-respected institution as modern science" (2009, p. 901). Debates about religion, science, and science education are as familiar in the Islamic world as they are in the western world. The tensions that exist between science and religion have led to difficulties reconciling traditional versions of Islam with WMS, particularly theories such as evolution where "many conservative Muslim thinkers are drawn towards creationism, [in] hopes of Islamizing science, or other ways to retain the primacy of faith … [and] that some Muslims argue that science and Islam coexist in harmony, both intellectually and institutionally" (Edis, 2009, p. 885).

A parallel to spiritual worldviews is the worldviews of Indigenous peoples around the world, such as African Zulu tribes, Māoris in New Zealand, and Aborigines in Australia, and North American Indigenous peoples. If science has substantial worldview content, even when minimally characterized by common epistemic or ontological features (Irzik & Nola, 2009), then there are important implications for science education. The central implication rests on the inclusion of local belief systems, such as TEKW, into science education as with the BC MoE. Irzik and Nola (2009) take the position that there is a conflict between the two worldviews of WMS and IKW, and students should be taught the notion of criticizability to arrive at their own conclusions about these conflicting worldviews. This will support the core aim of science education "to turn students into critical inquirers, whether they inquire into science, scientific worldviews or non-scientific ones" (Irzik & Nola, 2009, p. 743).

A plausible consideration for the resolution of conflicting worldviews is that "science activity per se neither presupposes nor provides sound rational grounds to accept any worldview or value outlook" (Lacey, 2009, p. 839). The widely accepted view associated with WMS — materialism — constrains the scope of scientific inquiry. The core

activities in the classroom and laboratory deal with phenomena that are known and are being investigated; the understanding that is gained from this investigating has nothing to do with worldviews, including materialism. Lacey (2009) concludes that it is "consistent with maintaining that the first task of science education is to teach some scientific knowledge … and to cultivate a sense of how empirical inquiry and appraisal works" (p. 859), thus allowing for an enriched elementary and secondary science experience for all students by respecting a multicultural approach to science teaching. The broader purpose of science education — to examine the interrelationships between science and worldviews — could be introduced at senior secondary and postsecondary levels.

Scientific Literacy and Education

Scientific or science literacy has been mentioned as a goal of science education for over 65 years. However, the definition of this term has changed over time. Hurd (1958) was deeply skeptical about the ability of science education to meet the future needs of students: "The crisis in education has both an immediate and a future aspect. The immediate problem is one of closing the gap between the wealth of scientific achievement and the poverty of scientific literacy in America." (p. 14). Curriculum developers were alerted to the need for change to enable education to keep pace with advancements and demands in science and technology and a changing society. Thus, recognition of the need for science literacy among an educated public was born. Currently, it is an internationally recognized term as well as an internationally recognized and implemented educational goal for science curricula that is not without controversy regarding its precise meaning (cf. Laugksch, 2000). Historically, the initial focus of scientific literacy was directed toward the education of youth, and the interpretation of scientific literacy had "come to be an umbrella concept to signify the comprehensiveness of the purposes of science teaching in the schools" (Roberts, 1983, p. 29). Several factors influenced the diverse interpretations of scientific literacy, such as different interest groups, different conceptual definitions of the term, different purposes for advocating the term, and different ways of measuring it. "These different interpretations result in *scientific literacy* appearing to be an ill-defined and diffuse (and thus, controversial)

concept" (Laugksch, 2000, p. 74). The controversial nature of the concept is illustrated by examining the different interest groups. Four identifiable interest groups are:

> *first*, the science education community concerned with the nature of science and its teaching focus; *second*, the social scientists and public opinion researchers concerned with policies related to public support for science and technology; *third*, sociologists and science educators concerned with how people negotiate the various levels of 'science knowledge' and its mainstream acceptance; *fourth*, the informal and non-formal science education community concerned with developing an understanding of science geared to the general public. (Laugksch, 2000, p. 75)

Scientific literacy has had multiple and sometimes conflicting meanings but has served as a beacon for educational reform for the past 20 years or more (Pearson, Moje, & Greenleaf, 2010). A review of the literature indicates that there are two main interpretations of scientific literacy. One focuses on the natural world, in which the application of scientific concepts and principles leads to "ways of thinking about science [; the second deals with the] connections among the language of science, the representations of science concepts in textbooks, and resulting science knowledge" (Pearson et al., 2010, p. 459).

Scientific literacy in Canada is a primary focus in most provincial and territorial science curriculum documents. This is also the case, globally, and is reflected in statements by UNESCO and the Organization for Economic Cooperation and Development (OECD) where the aims of science education are articulated (OECD, 2003, p. 33).

In Australia, its Department of Education, Employment and Workplace Relations, Science Education Assessment Resources (SEAR) states that scientific literacy is the key component of school science courses; it builds upon the PISA definition to create three domains of scientific literacy: experimental design and data gathering; interpreting experimental data; applying conceptual understanding (SEAR, 2004).

Members of the Linné Scientific Literacy Society expressed their concerns about the current state of science education in many countries of the world. The report for the 2007 society meeting stated:

> Attitudinal data from many sources indicate that it is common for many school students to find little of interest in their studies of science and to quite often express an active dislike of it. In comparison with a number of other subjects, too many students experience science education as an experience dominated by the transmission of facts, as involving content of little relevance, and as more difficult than other school subjects. This experience leads to disinterest in science and technology as personal career possibilities, and only a mildly positive sense of their social importance. (Linder, Östman, & Wickman, 2007, p. 7)

The society's report emphasized a call for reform in science education and its goal of scientific literacy that stressed worldviews, values, and societal inequalities:

> Reforms of science education that continue to frame scientific literacy in terms of a narrow homogeneous body of knowledge, skills and dispositions, fail to acknowledge the different ethnic and cultural backgrounds of students. Such science education stands in strong contrast to the popular media. It omits discussion of the reciprocal interactions between science and worldviews and between values and science that the media regularly recognises as important to the public interest. Furthermore, it fails to contribute to a fundamental task of schooling, namely, *redressing societal inequalities that arise from differences* [emphasis added] such as race, sex and social status. Instead of equipping students to participate thoughtfully with fellow citizens building a democratic, open and just society, school science will be a key factor in the reproduction of an unequal and unjust society. (Linder et al. 2007, p. 8)

Roberts (2007) characterized scientific literacy, appropriate for school science, based on two visions: Vision I (inward looking to the products of science, laws, and theories and its processes: hypothesizing and experimenting) and Vision II (outward looking to situations in which science has a role, that is, the socioscientific issues of daily living). Vision I addressed goals for school science that are based on knowledge and skill sets, enabling students to approach and think about scientific situations as a professional scientist would. In Vision II thinking, goals for school science that are based on knowledge and skill sets enable students to approach and think about scientific situations as an informed citizen about science would. New methodologies that have arisen in the

past 20 years support either of Visions I or II, with an emphasis on one recurring theme: relevance for students. This has been possible with the

> expansion of acceptable theoretical perspectives such as those associated with gender studies, situated cognition, linguistics, non-Western/non-Eurocentric thought systems, moral and aesthetic philosophy, and the sociology of science. All of these allow us to explore the multiple qualities of students' and teachers' responses to aspects of Vision II scientific literacy. (Roberts, 2007, p. 16)

A great many scientists, science educators, and science teachers view the language used in Vision I as a reporting device for the particular science under study. However, the language to enable students to become informed and engaged citizens of science is the goal of Vision II; it assumes a rhetorical function to argue and persuade others. Furthermore, the language of doing science shapes students' understanding of science thus enabling a deeper understanding of the process of science. It is this use of language component that has been underestimated by scientists, science educators, and science teachers in scaffolding student science learning and engagement.

Yore (2008, 2012) argued for the epistemic importance of language, particularly written language, as a way of constructing meaning and understanding as cognitive and rhetorical functions with choices of language expression shaping scientific literacy. These communicative, epistemic, and rhetorical functions, for Yore and others, is the defining feature of *Vision III* of *Scientific Literacy for All:* fundamental, derived understanding and application. Yore (2012) pointed out that "many second-generation science inquiry programs have adopted a learning cycle or 5E approach to Engage, Explore, Explain, Extend, and Evaluate science learning." (p. 16). This results in a student focus on knowledge construction by science teachers whereby students develop discipline-specific language abilities. "Vision III integrates the cognitive, linguistic, pedagogical, and philosophical aspects of science and disciplinary literacy within a constructivist interpretation of learning and teaching in science." (Yore, 2012, p. 8).

> Science literacy requires in a fundamental sense that people be proficient in science language, thinking, ICT [Information and Communications Technology], and emotional dispositions, as well as in a derived sense that they understand the nature of science, the big ideas of science, and the relevance of the interactions

> among science, technology, society, and environment. (Yore & Treagust, 2006, p. 295)

The fundamental literacy component and derived understandings in Vision III are integrated into their applications to public debate and resolution of socioscientific issues. Most of the complex socioscientific issues involve tradeoffs amongst science, technology, and engineering and social, cultural, and economic factors.

The "three-language problem facing teachers in multi-cultural classrooms where the home language, instructional language, and science language require navigating and border crossings (in order to achieve reasonable comprehension)" was identified by Yore and Treagust (2006, p. 310). Learning the language of science is a necessary first step in attaining scientific literacy. The fundamental sense of literacy (i.e., fluency in the use of the language of science) would better serve scientific literacy in classrooms when teaching science; however, there is a far greater emphasis on the derived sense of scientific literacy, that is, knowledge and understandings of the big ideas of science (Norris & Phillips, 2003).

Erickson (2007) called for curricular changes and re-envisioned approaches to teaching science that consider the various functions of language by pointing out that

> as university level scientists begin to realize that the kind of science that we teach to students at all levels must be both engaging and relevant, then perhaps we will be in a better position to recruit them in our efforts to bring about significant curricular changes at the elementary and secondary school levels. (p. 36)

TEKW, WMS, and Science Curriculum

The TEKW and WMS worldviews of nature and naturally occurring events reflect common or distinctive epistemological, ontological, and cultural beliefs. Cajete (2005) stated:

> After 30 years of work in the field of culturally responsive science education for Native students, it was especially comforting to know that my work was not in vain … and that people in Canada were applying and innovating on the principles of Native science in new and exciting ways. (para. 15)

The recognition of the value of culturally responsive curricula has led to the inclusion of TEKW in the BC provincial curriculum documents and the inclusion of Aboriginal Perspectives in other Canadian provinces. Several provincial governments have special Aboriginal Branches as an adjunct to their ministries of education, notably in British Columbia, Saskatchewan, Ontario, and Nova Scotia.

Part II: Science Curricula across Canada

British Columbia

The BC MoE website (http://www.bced.gov.bc.ca/abed/) contains subject-specific IRPs in which the content standards for the provincial education system reside, called Prescribed Learning Outcomes (PLOs). Integrated Aboriginal perspectives that should be incorporated in science teaching from K–12 are outlined in subject PLOs along with a universal statement concerning Aboriginal Content in the Science Curriculum. This integration is most strongly represented in K–7 Science; it is carried forward in Science 8, 9, and 10 (BC MoE, 2005, 2006a, 2006b, 2006c, 2008b) but is less prescriptive. All senior science curricula contain sections in the introduction that deal with Aboriginal Content in the Science Curriculum and that includes definitions of TEKW. Meaningful dialogue among all participants and stakeholders in the educational forum is needed to ensure that the perpetuation of the silences and prejudices enclosing the environmental and cultural commons when a pressing problem confronts a community, a province, a country, and a world of cultural identities. A move toward a common approach to education that incorporates rich cultural values and a bridge between these cultures about how best to educate and engage succeeding generations of youth. In BC, those conversations have already begun by including TEKW in the K–12 science curriculum; however, this is not the case in all provinces of Canada.

Alberta

The Alberta education curriculum guides focus attention on science literacy and the nature of science. The introduction to these guides states:

> The senior high science programs will help all students attain the scientific awareness needed to function as effective members of society. Students will be

> able to pursue further studies and careers in science, and come to a better understanding of themselves and the world around them. The same framework was used for the development of all the senior high science programs, including Science 10, Biology 20-30, Chemistry 20-30, Physics 20-30, and Science 20-30. The expected student knowledge, skills and attitudes are approached from a common philosophical position in each science course. (Alberta Education, 2006, para. 1)

Alberta Education, however, does incorporate Aboriginal language and culture resources for a wide variety of First Nations languages, including Blackfoot and Cree. A template was created for the development of K–12 FNMI language and culture courses (Alberta Education, 2010); however, there are no cross-curricular science references in the document.

Saskatchewan

Saskatchewan Education notably began an examination of Aboriginal education when it struck a provincial advisory committee that produced Action Plan (2000–2005), which stated:

> Although much progress has been made in recent years, we know that Aboriginal students are not being served as they should by the education system and its programs. When students in Saskatchewan fail to thrive, we all fail to thrive. We hope everyone involved will examine this report and ask themselves, 'What is our role? What can we do? Are our efforts truly making a difference for Aboriginal students and their families? Are our efforts making a difference in our relationships as a provincial community?' (Saskatchewan Education, 2005a, p. 16)

Saskatchewan Education curricula include Common Essential Learnings (CEL) within the framework of the core curriculum. Among the CEL are the Indian and Métis Curriculum Perspectives that state:

> 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. (Saskatchewan Education, 2005b, p. 2)

It should be noted that Saskatchewan teachers are responsible for the integration of resources that will reflect both accurate and appropriate Indian and Métis perspectives and content.

Manitoba

Manitoba Education has taken steps to develop and implement a theme-based Aboriginal perspectives initiative into all curricula. Manitoba and the capital city, Winnipeg, are referred to as having the greatest concentration of Aboriginal people per capita in Canada. This initiative states:

> Aboriginal perspectives are being integrated into curricula to enable students to learn the history of Manitoba and Canada before European settlement and to give the perspective of Aboriginal people since that time. (Manitoba Education, 1994, n.p.)

There is a special government Aboriginal branch within Manitoba Education that addresses the stated Aboriginal perspectives and is very active in advancing educational concerns. The Aboriginal Education Directorate developed *Bridging Two Worlds: Aboriginal Education and Employment Action Plan 2008–2011* (Manitoba Education, 2008). One of its key initiatives is to promote the completion of high school graduation for Aboriginal students. Although initiatives are being implemented and disseminated to educators, there is no direct pedagogy linking TEKW with mathematics and science education.

Ontario

The Ontario MoE formed the Ministry of Aboriginal Affairs in 2007, with the hope of building stronger relationships among First Nation, Métis, and Inuit of the province. To facilitate this initiative, *Aboriginal Perspectives: A Guide to the Teacher's Toolkit* was published and contains strategies to aid teachers in the integration of resources with the encouraging cover page statement: "Aboriginal perspectives bring the curriculum to life!" (Ontario MoE, 2009).

Québec

The Strategic Plan (2000–2003) of the Québec Ministry of Education, Leisure, and Sport (MoELS) recognized an emerging knowledge society as driving socioeconomic change, with the result that "education is more than ever before an essential investment that is profitable in every respect for individuals, the State and businesses, as well as society as a whole" (Québec MoELS, 2000, p. 7). The website affirms that education in Québec is tied to the Charter of the French Language, which states that "instruction is to be given in French at the preschool, elementary and secondary levels [and that] most of the Aboriginal nations receive instruction in their own language" (Québec MoELS, 2008, p. 16). There is no special educational branch to deal with Aboriginal issues or to incorporate a TEKW perspective into the science curriculum or into the general curricula of the province.

Atlantic Provinces

The Departments of Education (DoE) for the Atlantic Provinces of New Brunswick, Newfoundland and Labrador, Nova Scotia, and Prince Edward Island all follow the Pan-Canadian *Common Framework of Science Learning Outcomes K to 12* (CMEC, 1997). The establishment of new science curricula for the Atlantic provinces has relied upon collaboration and development from the *Foundation for the Atlantic Canada Science Curriculum* (Newfoundland & Labrador DoE, 1998). Therefore, common educational goals are sought in all Atlantic Provinces, with the aim of assuring that science education stresses the development of scientific literacy. The Atlantic Provinces' vision for scientific literacy is:

> [A]ll students, regardless of gender or cultural background, will have an opportunity to develop scientific literacy. Scientific literacy is an evolving combination of the science-related attitudes, skills, and knowledge that students need to develop inquiry, problem-solving, and decision-making abilities, to become lifelong learners, and to maintain a sense of wonder about the world around them. (Newfoundland & Labrador DoE, 1998, p. v)

No provision has been made to acknowledge or incorporate TEKW into the science programs. However, Nova Scotia has made provisions for recognizing Aboriginal

peoples in their province by the formation of the Mi'kmaq Services Division within the DoE, established in 1997, following recommendations from the Task Force on Mi'kmaq Education, which became the Council on Mi'kmaq Education (CME). Following a review process, it was proposed that "the work of the entire division be relocated to Mi'kmaq Kina'matnewey (MK)," (Nova Scotia DoE, 2008, p. 1). The DoE provides services to all Aboriginal people in the province including non-MK bands, those who live off reserve and members of other First Nations. The Ministerial Education Act Regulations made under Section 145 of the *Education Act*, Clause 31(b) states: "the Council [CME] shall in respect of the Public School Program and Mi'kmaq students, advise the Minister on the development of appropriate curricula reflecting Mi'kmaq history, language, heritage, culture, traditions and contributions to society" (Nova Scotia DoE, 2015).

Yukon

The Yukon Territory is a full partner in the Western and Northern Canadian Protocol (WNCP; 2010) that supports the development of common curriculum frameworks. Within these frameworks, the BC Program of Studies forms the basis of the Yukon curriculum. The DoE (2009a) frequently adapts the curriculum to reflect local needs and conditions. In August 2006, the DoE created a new unit under the Public Schools Branch entitled the First Nations Programs and Partnerships Unit (FNPPU). In 2007–08, the DoE committed over $5.2 million to supporting the FNPPU and First Nations initiatives in education to:

- Build productive relationships with First Nations
- Improve the results of First Nation students in the K–12 system
- Work toward increased levels of cultural inclusion in Yukon schools
- Provide direct and indirect support to Yukon First Nations, schools and the Department of Education. (Yukon DoE, 2009b, p. 1)

Since the BC Program of Studies is followed for science, it is assumed that TEKW forms a significant part in the science programs of the Yukon.

Northwest Territories

The Northwest Territories (NWT) DoE follows the K–12 curriculum, diploma examinations, and achievement tests that are provided by Alberta Education. However, the recently adapted NWT K–6 Science and Technology Curriculum seeks to address some local initiatives for students to pursue. Apart from the Dene language and recognition that other First Nations languages should be respected, there is no application of TEKW to the science curricula (NWT DoE, 2004).

Nunavut

Nunavut (NT) became Canada's third territory in 1999, by dividing off the eastern part of NWT, which necessitated immediate formation of a government infrastructure with special attention to education. Therefore, the NWT curricula were downloaded, along with curricular files from Alberta Learning. These files recognize the importance of traditional and local knowledge in the science curriculum:

> Western science has the advantage of being able to examine living and non-living things at the microscopic level. Scientists can also compare data over greater distances and with scientists in other parts of the world. Traditional science has the advantage of being able to examine a particular area closely over a long period of time. People who have lived on the land for generations have an intimate knowledge of the habits of wildlife. They observe animals during all seasons over a period of many years. Many biologists who study animals often remain on the land for only a short period of time, often during summer only, so they do not have the benefit of long term observation. (NT DoE, 2004, pp. 7–10)

All Canadian provinces and territories follow the Pan-Canadian *Common Framework of Science Learning Outcomes K to 12* (CMEC, 1997) in the development of their curricula in science (Milford, Jagger, Yore, & Anderson, 2010). However, the departments and ministries of education follow different emphases and strategies for implementation of TEKW. Some choose to more closely adhere to the science literacy learning outcomes developed in the Pan-Canadian *Common Framework* at the expense of being able to enrich it with a collaborative TEKW perspective, while others have

incorporated the TEKW perspective and have engaged alternate ways of knowing and being that can only enrich the science students who are exposed to this pedagogy.

Part III: Secondary Science and Mathematics Achievement

Indigenous Students and Learning

Indigenous students represent a diverse and varied group of learners that cannot accurately be defined with any set of common characteristics. Kawagley and Barnhardt (1998) stated:

> For a Native student imbued with an indigenous, experientially grounded, holistic perspective, typical approaches to teaching can present an impediment to learning, to the extent that they focus on compartmentalized knowledge with little regard for how academic disciplines relate to one another or to the surrounding universe. (para. 6)

Many researchers support this assessment of Indigenous learners (cf. Aikenhead, 2001, 2002; Barnhardt, 2008; Battiste, 2013; Brayboy & Castagno, 2008; Demmert, 2011; Lickers, 2007; MacIvor, 1995; Snively & Corsiglia, 2000; Snively & Williams, 2008; Sutherland & Henning, 2009).

Aboriginal people share a common holistic vision of learning that requires key consideration when alternate ways of knowing and being are incorporated into curricula. Learning in this sense sustains relationships between the individual, family, community, and creator. It is the transmitter of values and identity. Some of the attributes of this vision of learning include that it is: holistic, connecting the individual with the wider community in a shared experience; lifelong, as a continuum, supported by previous generations; experiential, through observation, imitation, and storytelling; culturally rooted in language whereby worldviews and values are transmitted; and views learning as an integrated whole (see Appendix K: A First Nations Lifelong Learning Model).

Indigenous Challenges and Student Achievement — A Canadian Perspective

In Canada, various levels of government are ensuring that the Indigenous perspective is included and considered in elementary, secondary, and postsecondary scientific and technical programs as the nation moves forward in the 21st century. However, there are

difficulties to be overcome as a result of past colonial contacts as Indigenous/ Aboriginal peoples attempt to reshape their destinies and make contributions to national growth and identity. The FNMI each have its own worldview and "face persistent barriers that hinder their opportunities for learning, barriers that far exceed those facing non-Aboriginal Canadians" (Cappon, 2008, p. 60).

Access to instructional resources to facilitate FNMI engagement and learning in relevant science and technical learning are limited. To make such resources available, the Government of Canada, in partnership with the Inuit Tapiriit Kanatami and other National Aboriginal Organizations in 2001, developed the Aboriginal Canada Portal (ACP). The ACP was a single window for FNMI peoples to access online resources and government programs and services. The portal contained thousands of links for Aboriginal peoples and it was the only Government of Canada website to be translated into Inuktituk Syllabics. However, the ACP was rendered obsolete in February 2013 due to improvements in Aboriginal resources online and the rise of more effective search engines along with the impact of social media.

Postsecondary Challenges

Other countries and international groups have addressed the need for scientific and technical learning experiences and resources for Indigenous students. The Honourable Parekura Horomia, Minister of Māori Affairs for the Government of New Zealand, said: "Over the last ten years, there has been a growing number of Māori students engaged in doctoral degrees in Aotearoa, with the overall number of students enrolled nearly tripling from 77 in 1994 to 275 in 2005." (Horomia, 2007, para. 16).

The interconnected, global concern for the improvement of Indigenous peoples' educational life-chances has been growing since the latter part of the 20th century, gaining greatest momentum during the last decade. Universities across Canada have programs that are designed to assist capacity-building initiatives in various locales within the FNMI peoples, and many have stand-alone programs with a sole Aboriginal focus on learning that is congruent with the respective FNMI worldviews. Noteworthy among these are representatives from Eastern and Western Canada: Cape Breton University and the First Nations University of Canada (FNUC) at the University of Regina. FNUC offers

undergraduate and graduate degrees within an environment of Indigenous culture and history, combining First Nation-oriented and standard areas of study in all programs. Information on other university programs can be obtained from the website of the Federal Government's Department of Aboriginal Affairs and Northern Development Canada (AANDC; http://www.aadnc-aandc.gc.ca/eng/1100100010002/1100100010021).

Aboriginal programs and incentives at the tertiary level have been increasing globally for all Indigenous peoples. This has led to an increasing participation among the Aboriginal communities in Canada and globally, with an increasing number of graduates in all professional programs as well as those in the technology and trades branches. Despite this progress in accepting and incorporating Indigenous worldviews at tertiary institutions of education, there appears to be a lag in a corresponding program development in departments and ministries of education at the primary and secondary levels. However, "Aboriginal people in Canada are sharply under-represented in science and engineering occupations; more can be done to increase the relevance of learning and engagement of Aboriginal students in science and technology" (Canadian Council on Learning [CCL], 2007, p. 2).

Secondary School and Postsecondary Science Achievement

The FNMI underrepresentation in science and engineering at the tertiary levels (technical institutes, colleges, and universities) must be addressed by increasing the pool of qualified students completing secondary school programs with the prerequisite science and mathematics achievement to enter and successfully complete postsecondary programs. Fulfilling these needs at the secondary level will require ways that are "respectful and relevant to Indigenous worldviews, and offer reciprocity with respect to relationships with others, while engendering responsibility over their own lives" (Kirkness & Barnhardt, 1991, p. 1). Currently, postsecondary science and technology institutions compete furiously for the small number of qualified Indigenous students. Tertiary access, engagement, and success will continue to show marginal results without building a respectful, relevant, and responsible foundation based on reciprocity for Aboriginal students at the secondary level.

Snively and Williams (2006, 2008) studied BC MoE data for a five-year period from 1997 to 2002 and found that 36 to 42% of Aboriginal students graduated from Grade 12. However, amongst these high school graduates, only 8 to 14% took Biology 12, 5 to 8% took Chemistry 12, and 2% took Physics 12. The number of Indigenous students graduating has increased when six-year completion rate data are considered, but only marginally (~5%) to a 47% average, between 2003/04 and 2007/08 (BC MoE, 2009). Mathematics is often linked with science since numeracy skills translate well into science courses, with Biology perceived to have less reliance on a strong mathematical background.

Neel (2008) noted that performance and participation rates for Aboriginal students taking mathematics in British Columbia were significantly lower than the general student population — an observation that is mirrored for the sciences. He stated:

> [t]here is a tension between maintaining culture and evolving culture. There is also a tension about how school mathematics should connect with the daily numeracy practices. Many aboriginal communities feel the student performance is usually measured with a different cultural lens. These are artificial polarizations because in essence what the elders and role models are calling for is dual epistemologies: situate the learning in our culture to help them learn, also teach the students to know the Modern ways so that they measure up to the Western standards in order to succeed in the Western world. (Neel, 2008, p. iii)

Snively and Corsiglia (2000) suggested that WMS has been taught at the expense of Indigenous knowledge in most science classrooms around the world. TEKW is a rich, time-tested approach that fosters sustainability and environmental integrity and could inform WMS approaches that have resulted in poor ecosystem management, in turn resulting in many ecological disasters worldwide as well as burgeoning planetary pollution. Yellowhorn (2000) noted that by employing the scientific method, TEKW of the environment could be enhanced: “Native traditional knowledge was built around directed investigations into the nature of things, and … they arrived at conclusions that demonstrate an aptitude for inductive reasoning …. Native people were careful observers of nature and possessed a capacity for systemic analysis of natural phenomena” (p. 87). To create a truly green planet, a TEKW perspective is needed to provide connections

through long traditions and time-proven knowledge and wisdom. Clearly, cultural and scientific bridges must be crossed in order to make these connections.

It is incumbent upon science educators and teachers to engage in curricular dialogues that incorporate cultural and scientific worldviews embedded within Aboriginal and western cultures while there is still time to do so. Incorporating WMS-TEKW into a dynamic learning system will enhance students' understanding both culturally and scientifically; "Aboriginal science, as an intellectual partner to Western science offers a model for integration" (Snively & Williams, 2008, p. 123). The Aboriginal epistemology suggests that a thing is understood only when it is understood within the human experience of mind, body, emotion, and spirit (Cajete, 1994).

This raises the question about a cultural divide in science education for Aboriginal learners. F. Henry Lickers, biologist and member of the Turtle Clan of the Seneca Nation, described the difference: "The First Nations people view themselves not as custodians, stewards or having dominion over the Earth, but as an integrated part in the family of the Earth. The Earth is my mother and the animals, plants, and minerals are my brothers and sisters*"* (CCL, 2007, p. 2). This worldview sees the spiritual connectedness between the people, the land, and the living resources. WMS is in contrast to the Indigenous worldview and place-based knowledge claims, in that what is sought is an understanding derived from an analysis of the whole as represented by the sum of the parts that is generally applicable across places and times and physical cause-effect explanations. These ontological differences can create potential difficulties for Aboriginal students in science classrooms where the WMS perspective is dominant (Haggan, Brignall, Peacock, & Daniel, 2002).

Aikenhead (2001) described the majority of Aboriginal students' experience with science education "as an attempt at assimilation into a foreign culture [that will increase in] foreignness [for Aboriginal students] whose worldviews, identities and mother tongues create an even wider cultural gap between themselves and school science" (p. 338). Allen and Crawley (1998) explored the worldview differences within Kickapoo Indian children in off-reserve schools and found that several key differences accounted for their conflicting perspectives regarding their ability to learn in WMS classrooms:

> Kickapoo students prefer cooperative learning rather than the competitive learning espoused in Western classrooms; Kickapoo students think holistically about the natural world, compared to the 'reductionist' approach in Western classrooms in which complex systems are broken down to simpler parts; Kickapoo students view time and space as cyclical in nature, whereas, Western science students view them in a linear manner." (p. 121)

Among Kickapoo students, kinship, harmony, cooperation, and spiritualism with respect to the natural world are values that are held in high regard while western values tend to be more exploitative, competitive, decontextualized, rational, and materialistic (Allen & Crawley, 1998).

The resulting misalignment of values between IKW and WMS worldviews forces Indigenous students to adopt one of three problematic strategies for completing their science education: adopt a WMS worldview (abandoning or marginalizing IKW), acquire enough basic knowledge of science course concepts to pass (thereby not compromising IKW), or avoid participating in their WMS education (IKW not compromised, WMS rejected) and accept failing grades (Jegede, 1995; MacIvor, 1995; West & Pines, 1985).

The "cultural commons" must be used as never before in our lives (Bowers, 2008, p. 196). This means having a socially relevant educational system that recognizes cultural diversity so that the best of our cultures can pave the way forward for all citizens. The dialogue and conversations could begin here by a mutual sharing of the cultural commons. "The challenge is in knowing where to begin changing the ecological destructive course [environmentally and educationally] that our [western] culture is on" (Bowers, 2007, p. 15).

An examination of secondary science and mathematics in BC schools revealed a serious concern for the participation rates and achievement levels of Aboriginal students when compared to their non-Aboriginal counterparts (Snively & Williams, 2006, 2008). Aboriginal students were found to achieve approximately 10% lower than their non-Aboriginal counterparts. This participation and achievement variation has been referred to as a gap in achievement when data are compared in this manner (Mendelson, 2006; Yore et al., 2014). This has implications for scholarships and future career and education choices for Aboriginal students completing their secondary level requirements and leads

to the underrepresentation of Aboriginal students in tertiary level science and technical fields. Throughout their high school years, Aboriginal students are provided with a number of choices in mathematics and science that tends to lead them toward completion of their high school graduation requirements but away from the possibility of tertiary science and technology education and careers. Aboriginal participation in science and technology fields could provide a more holistic view of the natural world and new solutions for manmade problems.

The Achievement Gap (Brief Overview)

Ogbu (1987) studied the low school performance of minority black American children for over one-quarter of a century. He identified three sources that contribute to this result: society, school, and community. He stated:

> [w]hile cultural, language, and opportunity barriers are very important for all minorities, the main factor differentiating the more successful from the least successful minorities appears to be the nature of the history, subordination, and exploitation of the minorities, *and* the nature of the minorities own instrumental and expressive responses to their treatment, which enter into the process of their schooling. (Ogbu, 1987, p. 317)

Ogbu described "involuntary minorities" (e.g., American Indians, black Americans, and Native Hawai'ians) as people who were brought into American society through slavery, conquest, or colonization (p. 321). His work on deficit achievement studies within segments of the dominant white American population was concerned about the life lived by the subordinated other as they negotiated socialization to the standards of the hegemonic culture, not only in the United States but also worldwide.

The achievement gap — "the observed disparity in a number of educational measures in academic performance between different groups of students, especially groups defined by race/ethnicity, gender, and socioeconomic status" (Clark, 2014, p. 3) — is one of the most troubling international problems facing education today. The focus of attention here resides with the science, technology, engineering, and mathematics (STEM) literacies and achievement. A search of a number of STEM achievement gap studies has yielded

five research categories (or reasons for the gap), a challenge to the definition (of achievement gap), and some of the many contributing researchers:

- Access to skilled/subject qualified teachers: Bol and Berry (2005), Hirsh (2005), Morrison (2006)
- Access to high-quality schools: Beebe (2013), Dobbie and Fryer (2009), Richards, Hove, and Afolabi (2008)
- Government policies and reports for improving academic achievement: Braun, Wang, Jenkins, and Weinbaum (2006), Demmert, Grissmer, and Towner (2006), Demmert, McCardle, Mele-McCarthy, and Leos (2006), Giroux and Schmidt (2004), Mendelson (2008), Phillips (2010, 2011), Raham (2010), Richards et al. (2008)
- Literacy, racism, equity, and cultural differences: Chigeza (2011), Chinn (2006, 2007, 2010), Demmert (2011), Fryberg and Markus (2007), Fryberg, Markus, Oyserman, and Stone (2008), J. Lee (2002, 2004), Snow and Biancarosa (2003), Wagner (2010), Yore, Pimm, and Tuan (2007)
- Peer effects: Cooley (2006), Maltese and Tai (2011), Richards (2011)
- Challenge to the definition of achievement gap: Anderson, Medrich, and Fowler (2007), Carpenter, Ramirez, and Severn (2006)

J. Lee (2004) viewed the gap in minority students' achievement as a "serious breach of the principle of equity and justice [to the extent that the conditions of] equality [equal educational opportunity to learn], adequacy [able to achieve a minimally adequate level of competency, and] reciprocity [learn in a racially integrated school and benefit from the achievement of White students]" are not satisfactorily met (p. 57). In order to close the achievement gap, subordinated minorities need to embrace the standards, skills, and values of the dominant culture, often at the expense of their own hidden culture. For these inegalitarian conditions, a more comprehensive approach to education needs to be taken to include the conditions of life for the learners and their associated meanings to these conditions. "Education may have to begin with serious attention being given to the improvement of the quality of life for the learners." (Gordon, 2014, p. ix).

Mathematics as the Gatekeeper

Mathematics is often linked with science since numeracy skills can have a significant impact on success in science courses, particularly in the physical sciences. The WNCP mathematics research project reported that many aboriginal children struggle with mathematics (McAskill, Holmes, Francis Pelton, & Watt, 2004). Neel (2008) noted that both participation rates and performance for Aboriginal students taking Mathematics in BC were significantly lower than that of the general student population. He reported that by Grade 7 Aboriginal students lag behind non-Aboriginal students by about 20% in their performance on the Foundation Skills Assessment (FSA) of numeracy. By Grade 10, only 47% of Aboriginal students meet the expectations in numeracy, compared to 77% of non-Aboriginal students.

Presmeg (2007) suggested that, although mathematics was long considered to be value-free and culture-free, there is growing evidence that it is actually a cultural product. In fact, race has now been identified as one of the most salient characteristics underlying differential achievement in mathematics. Research in BC supports this claim (Epp, 2007). Using Grade 7 FSA scores, school size, gender, aboriginal status, and ESL status as predictor variables, Epp used regression analysis to develop equations to predict student performance on the BC Grade 10 Mathematics provincial examination. Aboriginal status was the only predictor variable that had a negative coefficient for all three Mathematics courses (i.e., Principles, Applications, and Essentials). This means that, if all the other factors were equal for two given students, the Aboriginal student would score lower on the provincial examination than the non-Aboriginal student.

Fisher (2010) interviewed Aboriginal students to hear their stories concerning Mathematics school experiences. The stories highlight the importance of relationships and connectedness to positive Mathematics experiences for Aboriginal students. Epp (2007) pointed out that how learners are treated with respect to race, culture, and language within a class and a curriculum affects their feelings and, subsequently, their performance.

Historical and systemic roadblocks or barriers to education that have confronted Aboriginal students need to be re-examined with a cultural lens that is inclusive and encouraging. Results reported in this study indicate that this cultural lens is urgently

needed because Aboriginal students have been lagging behind non-Aboriginal students for over a decade. This gap widens when high school and postsecondary education (PSE) graduation are compared. Mendelson (2006) found that 27% of the total population in Canada had attained university graduation compared to 11% of the Aboriginal population. This ratio was reversed when non-university PSE grads were compared: 49% non-Aboriginal to 64% Aboriginal. "Failure to complete high school explains 87.8% of the variation in PSE completion rates among provinces and territories. This is an extremely strong correlation and is further evidence that *the issue for PSE is K-12* [emphasis added]" (Mendelson, 2006, p. 31). Richards and Scott (2009) examined Aboriginal education in Canadian provinces and territories and noted that BC and Ontario "are achieving results much better than the national average" (p. iv); they also pointed out that "British Columbia is the only province to publish standardized test results by school and by student characteristics, including Aboriginal identity" (p. 22). They noted that the gap between Aboriginal and non-Aboriginal students was evident by Grade 4 in the reported BC FSA. This observation was also noted in Neel's (2008) doctoral dissertation; he suggested that the gap could begin prior to Grade 4.

Numerous factors cause the achievement gap globally, "but some of the strongest include poverty, early-childhood learning, teacher quality, and strength of the curriculum" (Clark, 2014, p. 3). Socioeconomic status in some high-poverty Canadian communities has been addressed by providing more resources in schools resulting in increased graduation rates (Clark, 2014, p. 5). Richards et al. (2008) identified parental education and family income as the two most important socioeconomic variables impacting children's educational prospects in Canada (p. 7). Mendelson (2006) showed that all Aboriginal groups (FNMI) have substantially lower incomes than the general population (at 58%, p. 5). Richards (2008) stated that "[a] marginalized community, such as Aboriginals, living in a modern economy can only escape poverty through an educational transformation" (p. 1). He also noted that "Aboriginal outcomes are better in schools where students come from families with better socioeconomic conditions, where non-Aboriginal students perform better, and where the share of Aboriginal students in a school is lower" (p. 8).

The Right Honourable Paul Martin (2013) has identified three needs for Aboriginal education: adequate funding, freedom from government paternalism (viz., Indian Act), and a partnership with Canadians to accelerate the process. It is to this final point that the researcher identifies and supports in the spirit of the Two-row Wampum belt. It is only through Aboriginal/non-Aboriginal partnerships that gaps in achievement can be overcome for the mutual benefit of all students as cultural biases are overcome.

Part IV: Indigenizing Science Education and Culturally Responsive Schooling

The literature abounds with recommendations for culturally responsive curricula for Aboriginal and non-Aboriginal students (Abrams et al., 2014; Aikenhead, 1996, 1997, 2001, 2002; Hammersmith, 2007; McGregor, 2004; McKinley & Gan, 2014; Nelson-Barber & Estrin, 1995; Sutherland, 2002; Sutherland & Henning, 2009). "[T]he future depends on the convergence of Indigenous worldviews, encapsulated through orality in their languages and knowledges, with imported Western worldviews and knowledges encapsulated through literality" (Hammersmith, 2007, p. iii). Tobin (2008) pointed out that "science education is positioned to thrive from the diversity that characterizes [it]" (p. 540). Effective practices for science education discussed by Brayboy and Castagno (2008) indicated that "scholars have recommended that science curricula be designed in culturally responsive ways and with practical, real-world application in mind" (p. 742). Tuhiwai Smith (1999) described indigenizing as "centring of landscapes, images, languages, themes, metaphors and stories in the indigenous world," (p. 146) and referenced the grounding in alternative worldviews and value systems. Findlay (2004) stated that "Indigenous studies can help transform the institutions that house them and the publics which fund them, but only if '*we'* work together to make that happen" (p. 367). "[T]he dialogue that will be most valuable in the development and implementation of local IK[W] … will be the dialogue that takes place at the level of the Indigenous community" (Aikenhead, 2008, p. 581).

Best practices for incorporating Indigenous knowledge in science and mathematics education identified four common components across all programs: Elders, language, culture, and experiential learning (Sutherland & Henning, 2009). These four components

were deemed "essential to instilling a sense of place" to indigenize the mathematics and science curricula (Sutherland & Henning, 2009, p. 173). Barnhardt (2008) described a "10-year educational restoration effort aimed at bringing the Indigenous knowledge systems and ways of knowing that have sustained the Native people of Alaska for millennia to the forefront in the educational systems serving all Alaska students and communities today" (p. 113).

Calls to indigenize the curriculum are implicitly asking for Indigenous content to be included, and preferably taught by Indigenous peoples, as a means of incorporating histories, traditions, and IKW that differ from the dominant WMS perspective. Darlaston-Jones et al. (2014) suggested that a false dichotomy is created when IKW and WMS are debated; they argued for a decolonizing discourse "based on conscientization (a critical pedagogical approach) rather than indigenizing the curriculum" (p. 86). They believe that the dominant culture (WMS) has no requirement to question its role relative to the Indigenous perspective (IKW), thus perpetuating hegemony. A critical approach to education requires "an awareness, acknowledgement, and shift on the part of the dominant group that a 'monocultural' approach to education … is harmful to both the Indigenous and non-Indigenous community" (p. 86). Thus, a third space is created whereby meaningful reconciliation and the advancement of social justice could occur "with the prospect of building new realities based on common understanding, mutual respect, and enacting substantive reconciliation" (p. 101). Bringing the two knowledge systems together requires consideration of the underlying assumptions, foundational to each, where points of inclusion can be identified and included. The need becomes one of "developing 'trans-systemic' analyses and methods — that is, reaching *beyond* the two distinct systems of knowledge to create fair and just educational systems and experiences so that all students can benefit from their education in multiple ways" (Battiste, 2013, p. 103).

The Te Kotahitanga Project, in place since 2001, "seeks to improve the educational achievement of Māori students in mainstream secondary schools" of Aotearoa/New Zealand (Bishop, Berryman, Cavanagh, & Teddy, 2009, p. 734). In this project, student voices were used for identification of a variety of discursive positions related to Māori student learning, formulation of teacher professional development activities to support

the learning, and the creation of an Effective Teaching Profile that would address educational disparities present prior to the inception of the project. An outcome from the project was that "operationalising a culturally responsive pedagogy of relations [involved the implementation of the effective teaching profile, thereby creating a] learning context that is responsive to the culture of the child [such that learners are safe to] bring who they are" to the classroom where their knowledge is legitimately acceptable (Bishop et al., 2009, p. 741).

Tuhiwai Smith (2005) stated:

> [q]uestions of Indigenous knowledge, language, and culture have usually been viewed as potential solutions to make classrooms, the curricula, and teachers more responsive and inclusive, with the students more engaged in schooling and therefore more likely to achieve … how to make it work better — how to fit students, parents, the curriculum, and teacher practices into a system that will work for all. (p. 94)

Horsthemke and Yore (2014) posited "IKW-WMS deliberations need to be placed within the context of worldwide sociopolitical, economic, and social justice influences and efforts" (p. 1761). Not only have rapid changes occurred in science and technology in recent and past decades but also they have been mirrored in educational change. They proposed *Transkulturalität*, or transculturality, as a philosophical perspective on the transmission of knowledge and related practices when referring to IKW-WMS educational approaches. It challenges the idea that monocultures traditionally exist with respect to IKW and WMS. "The concept of transculturality seeks to capture an understanding of a contemporary and future constitution of cultures that is no longer monocultural but transcultural" (Horsthemke & Yore, 2014, p. 1785). Transcultural pedagogy has been used successfully to teach Indigenous and non-Indigenous students about nature and naturally occurring events while addressing IKW and WMS issues. Yore and Guo (2008, n.p.) suggested that "transcultural science instruction in Taiwan might be less conflicting … if indigenous technologies (e.g., animal traps, food preservation, … household tools …) were used to engage students and build social capital and trust before considering WMS ideas." The principles and procedures for the development and delivery of a culturally responsive approach to IKW and WMS utilizing

transcultural science instruction was illustrated in a case study involving the Indigenous Taiwanese students — the Amis Peoples — at a community school in Southwestern Taiwan (H. Lee, Yen, & Aikenhead, 2012). They found that Indigenous and non-Indigenous students had a better appreciation of each other's cultures as a result.

Culturally Responsive Schooling

Culturally responsive schooling (CRS) has been a central focus for Indigenous cultures as a means of improving schooling experiences for community children and youth. The Assembly of Alaska Native Educators adopted CRS standards in five areas: students, educators, schools, curriculum, and communities. These cultural standards are

> predicated on the belief that a firm grounding in the heritage language and culture indigenous to a particular place is a fundamental prerequisite for the development of culturally-healthy students and communities associated with that place, and thus is an essential ingredient for identifying the appropriate qualities and practices associated with culturally-responsive educators, curriculum and schools. (Alaska Native Knowledge Network [ANKN], 1998, p. 2)

Alaska standards for a culturally responsive school include:

A. … fosters the on-going participation of Elders in all aspects of the schooling process.
B. … provides multiple avenues for students to access the learning that is offered, as well as multiple forms of assessment for students to demonstrate what they have learned.
C. … provides opportunities for students to learn in and/or about their heritage language.
D. … has a high level of involvement of professional staff who are of the same cultural background as the students with whom they are working.
E. … consists of facilities that are compatible with the community environment in which they are situated.
F. … fosters extensive on-going participation, communication and interaction between school and community personnel. (ANKN, 1998, pp. 17–20)

Abrams et al. (2014) noted that "efforts at CRS for Indigenous youth result in students who have enhanced esteem; develop a healthy identity; are more self-directed and politically active; give more respect to tribal elders; have a positive influence in their tribal community; exhibit more positive classroom behaviour and engagement; and achieve higher academic standings." (p. 681).

Barnhardt and Kawagley (2003) referred to managing the educational reform strategy of the Alaska Rural Systemic Initiative (AKRSI) as a complex adaptive system. The central focus of the AKRSI reform strategy "is the fostering of interconnectivity and complementarity between two functionally interdependent but largely disconnected complex systems … the indigenous knowledge systems rooted in Native cultures that inhabit rural Alaska, and the formal educational systems that have been imported to serve the needs of rural Native communities" (Barnhardt & Kawagley, 2003, p. 93). They indicated that these complex systems (i.e., IKW-WMS) can strengthen the quality of educational experiences throughout rural Alaska.

The six listed Alaska standards for CRS have their applicability within a complex adaptive system where the dynamics of WMS and IKW interact in the student learning environment. However, if learning is to be shared in the spirit of a Two-row Wampum belt, then professional staff need to culturally sensitive and supportive, and need to be vetted in the manner of the Te Kotahitanga Project, in order to provide the best educational experience for all students. In this case, teachers who share and understand the culture, but who are not necessarily of the same cultural background as Aboriginal learners, could effectively share the two worldviews represented by WMS and IKW.

The researcher's connection with Qqs Projects Society began with a fund-raising event for the Great Bear Rainforest. The information from this event led to an awareness of the SEAS Initiative that engaged youth in authentic science activities in their home territories. Following a meeting with the scientist-presenter at Pacific Wild, contacts were developed with the Heiltsuk First Nation and Qqs Projects Society. A significant limitation to researching this initiative manifested in generating contacts by telephone and email as an initial step in building trust. During these personal contacts, it was evident that IKW (TEKW) had a strong focus as the youth exercised the opportunity to

practice field-based science projects. The potential for studying the WMS/IKW dynamic was evident from website information and personal communication.

As a researcher, the integration of these two worldviews represented not only a challenge but also the possibility of gaining insight into ways that this would be manifested. The researcher has, from a very young age, always been aware of "the other" in a Canadian context as evidenced by the wonder presented by enduring pictographs painted on rocks, accessible only by canoe (now, other watercraft) viewed through the eyes of a camp counsellor. Storied histories were shared over campfires where Algonquin and Iroquois Peoples were said to have come into conflict. The researcher's belief that the true history of the Canadian nation should be told and that education should be equitable and accessible for all school age children in the spirit of sharing, described by the "Two-row Wampum belt" (Borrows & Rotman, 1997; Muller, 2007) analogy and additionally referred to as "transsystemic" by Battiste (2013), "transcultural" by Horsthemke & Yore (2012), and "co-equal" by Abrams et al. (2014), was a driving force behind this research.

Chapter 3
Research Methodologies and Design

This chapter discusses the methodology used in the two case studies and descriptions of each case study involved. Ethics approvals by the University of Victoria Human Research Ethics Board and the Heiltsuk Integrated Resource Management Department are outlined.

This study involved a pair of case studies to first establish a focus of concern and then to document a potential way to address this concern. Specifically, it surveyed achievement of Aboriginal and non-Aboriginal students in Grade 12 science and mathematics courses and then explored a program that might serve as a model of culturally responsive science education in BC. The exploration of Aboriginal and non-Aboriginal students from 2003–2011 considered: (a) participation in Grade 12 science and mathematics courses and (b) secondary school graduation average final marks. The archival data obtained from the BC MoE formed the basis for the first case study (Case Study 1 — Archival). This was followed by the second case study (Case Study 2 — TEKW & WMS) involving the identification and exploration of a model project, the SEAS summer internship program for students on the traditional territory of the Heiltsuk First Nation. The narratives from the SEAS interns and program coordinators were used to identify possible insights into the teaching and learning of knowledge about nature and naturally occurring events from an Indigenous and western perspective.

The focus of this study was to assess if there was an achievement and participation gap between Aboriginal and non-Aboriginal students and to assess the need for and potential of a CRS curriculum and pedagogy in a local community (place-based) in BC. Provincial examination results for 2003–2011 were obtained for four science (Biology 12, Chemistry 12, and Physics 12) and mathematics (Principles of Mathematics 12) courses that were examined for trends over the eight years. Characteristics of culturally responsive curriculum and instruction outlined in Chapter 2 were used to locate and examine an exemplary program that presented an interactive WMS and TEKW environment in the SEAS summer internships for 2010, 2011, and 2012.

The research questions that guided this study were:

1. What does an 8-year period of secondary science and mathematics achievement in BC schools indicate?
2. Are there a proportional number of Aboriginal students positioned to enrol in the sciences at the tertiary level when compared to their non-Aboriginal counterparts?
3. How do the BC results align with the gap studies that are widely reported in the literature?
4. Can an exemplary CRS project that addresses the importance of culture enhance Aboriginal students' science learning in BC?
5. Can the lessons learned from such a project be applied to a Canadian context to promote student success in the sciences?

Methodology

Research Design

This study evolved over a period of several years while staying focused on the central issue of Indigenous students, their culture and native knowledge systems, and learning and teaching about natural sciences and mathematics. Historically, science curriculum and instruction (teaching and assessment practices) have not served Indigenous students well. Putting aside the historic disasters of residential schools, current science instruction for many FNMI students does little to engage them and enhance their understanding of nature and naturally occurring events. Like other minorities in North America, FNMI students have not achieved similar levels of performance and participation in science, technology, engineering, and mathematics [STEM] studies and careers as majority students (Clark, 2014). The evolution of this research was necessary to accommodate the degree of trust and social capital as well as the waning opportunities and support of host agencies and nations to allow an outsider access to informants and data with which to address the research questions in an honest, rigorous, and respectful manner. After several years of exploration and negotiations, this research was developed around two case studies of Indigenous students' performance and participation in public secondary schools and their performance and participation in a model program.

This dual case study is best described as utilizing a *descriptive* (Yin, 2014) and *intrinsic* (Stake, 1995) methodology. Case Study 1 (Chapter 4) uses Grade 12 final

examination results in science and mathematics (quantitative data). Case Study 2 (Chapter 5) uses dialogue from posted weblogs (blogs) and video-weblogs (vlogs) to capture experiences recorded by the individual First Nations interns. Inductive content analysis (CA), as described by Elo and Kyngäs (2007), that utilized the summative CA approach of Hsieh and Shannon (2005) provided the analysis of the blogs and vlogs. A major limitation of a quantitative approach (Case Study 1) is becoming *decontextualized*, whereby measurement causes a detachment from its "original ecological 'real world' context; [the contrasting qualitative approach (Case Study 2) is *contextualized* and] examines the 'whole person' holistically within that person's natural environment" (Castro et al., 2010, p. 342). This study utilizes methods across the two case studies to conserve and strengthen the overall study of Indigenous students in the BC context and in a place-based environment within BC.

Case Study 1: Data Collection and Analysis

This quantitative case study accessed secondary school examination data from the BC MoE and calculated descriptive statistics to clearly report the academic achievement and participation of the province's Aboriginal and non-Aboriginal students in science and mathematics. This study builds upon participation analysis from 1997–2002 (Snively & Williams, 2008) and extends to include achievement and participation for 2003–2011. Datasets were obtained from BC MoE in 2008 and 2012. These datasets allowed the assessment of the current state of achievement and course participation for Grade 12 Biology, Chemistry, Physics, and Principles of Mathematics for Aboriginal and non-Aboriginal students from 2003–2011. In addition, data on Applications of Mathematics 10 and 12, Essentials of Mathematics 10, Principles of Mathematics 10, and Science 10 were obtained to widen the scope of analysis. These data were analyzed using Microsoft Excel 2010 for data trends and PASW Statistics 18.0 to obtain descriptive statistics (percentages, means, and standard deviations) for the entire datasets for Grades 10 and 12 mathematics and science courses.

The BC MoE website was examined and results were excerpted from the *Summary of Key Information* to supplement the results from the dataset analysis. These extended analyses included six-year completion rates and scholarships in selected school districts

(SDs) having an Aboriginal student population range of 1.2–99.2% to provide an initial overview and comparison of the two populations. The HAWD reports (BC MoE, 2013a, 2013b) provided additional data on graduation and scholarships for 2007–2012 to yield an additional perspective on achievement and participation among the two student populations. In addition, Science 10 and Mathematics 10 achievement for graduation data were synthesized to complete the analysis.

Case Study 2: Data Collection and Analysis

This qualitative case study had to identify a willing model CRS program based on the principles extracted from the literature and that ethics approval could be obtained from First Nation's authorities. CRS principles used to identify and assess the model program included the ongoing participation of Elders in key aspects of the process, multiple avenues for students to access the learning that is offered and multiple forms of assessment for students to demonstrate what they have learned, opportunities for students to learn in and about their heritage language, a high level of involvement of professional staff who are of the same cultural background as the students with whom they are working, facilities that are compatible with the community environment in which they are situated, extensive ongoing participation of the students, and communication and interaction between the project and community personnel; these principles were adapted from the Alaska Standards for CRS (ANKN, 1998).

The SEAS Initiative of the Qqs Projects Society of the Heiltsuk First Nation was selected since it was based on many of the CRS principles and offered potential informative insights into the dynamics of the interaction between TEKW and WMS. The Heiltsuk Integrated Resource Management Department (HIRMD) was contacted to obtain permission to interview the student interns about their experiences during their two-month (July–August) summer programs (2010, 2011, and 2012).

After over a year of communication with HIRMD via emails, phone conversations, and personal meetings at Bella Bella (Waglisla), permission was granted by Qqs (pronounced "kucks") Projects Society to use the interns' postings on YouTube™ as the basis for documenting and analyzing the interns' experiences. The interns' blogs and vlogs represented each student's personal accounting of their experience(s) at a particular

point in time and were posted throughout the project period (interns' entries are a matter of public record on the Qqs Projects website under the SEAS Initiative). Ethics approval from the First Nations authorities did not allow direct interview of the interns, but it did allow conversations with the SEAS program coordinators that could be used to triangulate the ideas included in the interns' blogs and vlogs. These data supported a descriptive single case study design "whose purpose is to describe a phenomenon in its real-world context" (Yin, 2014, p. 238). The research in the second case study was guided by *narrative inquiry* as the vehicle to capture the lived experiences (Barton, 2004, Clandinin, 2006, 2007; Clandinin & Rosiek, 2007) of the participants in the SEAS Initiative. The overall initiative involved a five-year period of summer internships from 2010–2014 during the months of July and August. This study covered a three-year period of the internship (2010–2012). Inductive CA was used to analyze the blogs and vlogs "where there are no previous studies dealing with the phenomenon" (Elo & Knygäs, 2007, p. 107) assisted by the summative CA approach described by Hsieh and Shannon (2005) whereby "keywords [were] identified before and during data analysis" (p. 1286) to establish themes.

Case Study 2 involved 12 participants; 10 SEAS interns and 2 program coordinators (Ms Jessie Housty, Heiltsuk First Nation, and Ms Diana Chan, Pacific Wild). The interns (all high school students) applied to be part of the summer program and were selected by the Qqs Projects Society (coordinated by Ms Housty). The project experienced a growth in student interest over time: 2010 (2 interns); 2011 (4 interns); and 2012 (6 interns), with 2 interns in 2011 repeating in 2012 due to their high interest in the project.

The SEAS eight-week, live-in, summer program interns contributed about eight hours a day to their field work centred at Koeye (the field base). A typical week began on Monday morning with field work such as surveys of Rock Cod, deer pellets, wolf tracks, whale and other marine mammal species, and organisms of the intertidal zones (cf. Chapter 5 for a more complete description of the field study curriculum) and concluded on Saturday morning. During their downtime, many interns chose the cultural programs offered (local and regional linguistics offered by community Elders, weaving, carving, singers, drummers, storytellers, local scientists, university and NGO scientists, etc.), or work in the garden, or assisting the field technicians with data processing. The SEAS

interns were exposed to a variety of influences to help them approach their learning from different perspectives. Qqs Society is focused on supporting cultural identity and encouraging the SEAS interns to spend a lot of time in the bighouse cultural learning space. They become grounded in science and stewardship along with a strong cultural understanding that enables resilience in their commitment to guard and manage their territories.

The program coordinators were responsible for designing WMS experiences within Heiltsuk territory that connected with place-based TEKW. The interns' vlogs and blogs were transcribed, coded, and analyzed to yield identifiable themes established using another information source. Preliminary themes evolved from a transcribed YouTube video (see Chapter 5, SEAS Data Overview, Theme Identification). This preliminary interpretation was followed by a theme analysis of the interns' transcribed vlog and blog content.

Ethics Approval

This research received a Certificate of Approval under Ethics Protocol Number 12-342 on November 8, 2012, with an extension to November 7, 2015, from the University of Victoria Human Research Ethics Board (HREB) under the submitted project title: Different 'Ways of Knowing' interact at the confluence of Indigenous Knowledge and Euro-Western Science Knowledge to influence outcomes in secondary science education (see Appendix B for completed forms and authorization).

Keeping with the University's Indigenous research protocol, approval from Heiltsuk First Nation was sought through the HIRMD following the initial approval by HREB. The proposed SEAS interns' interviews were not granted by HIRMD; however, permission was granted to contact the Qqs Projects Society who was directly responsible for the SEAS Community Initiative. Permission to use the vlogs and blogs was granted by Ms Housty, Tribal Counsellor, Director of Traditional Ecological Knowledge, and the Qqs Projects Society (April 2013). Permission was also granted by Ms Chan, Pacific Wild Coordinator of the SEAS summer internship responsible for WMS program delivery (March 2012). (see Appendices C, H, and I for approvals)

Chapter 4
Assessing Secondary Science and Mathematics Results in British Columbia, Canada

This chapter presents a complete accounting of this case study, designed to verify a concern, beginning with a background to Aboriginal education in British Columbia that focuses on science and mathematics achievement. The case study methodology is discussed along with the study strengths and weaknesses. Following a description of data collection, the results are presented and discussed, along with the three research questions related to the study and a concluding summary.

Case Study 1 — Archival

In BC, a First Nations Educational Authority was established following consultations between the federal and provincial governments and the First Nations Education Steering Committee (FNESC) resulting in the *First Nations Jurisdiction over Education in British Columbia Act* (Government of Canada, 2006) and provides for jurisdiction on First Nation lands in the province. The purpose and powers of the Authority section 18 states:

> The purpose of the Authority is to assist participating First Nations in developing the capacity to provide education on First Nation land and to provide for any other matters related to education that may be agreed to by the Authority and a participating First Nation in accordance with an individual agreement. (p. 5)

Education for First Nations, under Canada's Constitution, prior to The Act in 2006, was administered by the federal government's former Department of Indian Affairs (now Aboriginal Affairs and Northern Development Canada [AANDC]). In BC, concern for the educational achievement of all First Nations students was recognized by the MoE and the FNESC and culminated in the signing of a Memorandum of Understanding in 1999 to formally recognize and address this problem as stated:

> We the undersigned, acknowledge that Aboriginal learners are not experiencing school success in British Columbia. We state our intention to work together within the mandates of our respective organizations to improve school success for Aboriginal learners in British Columbia. (BC MoE, 2013 d)

Signatories to the *Memorandum of Understanding* included the Chiefs Actions Committee, the provincial Minister of Education, the federal Minister of Indian and Northern Affairs, and the President of the BC Teachers Federation. It is important to note that the FNESC, since its establishment in 1992, has articulated the educational priorities of BC First Nations to the federal and provincial governments in support of First Nations communities to advance educational issues. FNESC served to promote the signing of the *Memorandum of Understanding* through their ongoing communication, research, partnership-building, and advocacy with the various stakeholders.

Aboriginal Education in British Columbia

The MoE is responsible for Aboriginal Education in the BC public school system, kindergarten to grade 12. The Ministry is committed to working with educational partners, school districts, and Aboriginal communities to improve Aboriginal student success through the Learning Division, Aboriginal Education. To that end, a BC MoE First Nations Principles of Learning was formulated to promote deeper understandings of Aboriginal student background to learning that recognizes cultural differences when compared to the general non-Aboriginal student population.

> The First Peoples Principles of Learning are affirmed within First Peoples communities and are being reflected in the development of all K-12 curriculum and assessment. First identified in relation to English 12 First Peoples, the First Peoples Principles of Learning generally reflect First Peoples pedagogy. The term First Peoples includes First Nations, Métis, and Inuit peoples in Canada, as well as indigenous peoples around the world. (BC MoE, 2013c, para. 8)

Key examples of the Principles of Learning (BC MoE, n.d.) include:

> Learning ultimately supports the well-being of the self, the family, the community, the land, the spirits, and the ancestors.
>
> Learning is holistic, reflexive, reflective, experiential, and relational (focused on connectedness, on reciprocal relationships, and a sense of place).
>
> …
>
> Learning recognizes the role of indigenous knowledge.
>
> Learning is embedded in memory, history, and story. (p. 1)

The nine stated principles (see Appendix N for the complete list of principles) represent common points for all First Nations, but any individual First Nation may differ in its approach or have other stated and related principles of their own design.

It is noteworthy that the FNESC partnered with MoE to produce the English 12 First Peoples (EFP 12; BC MoE, 2008a) curriculum resource or IRP. This resource was developed with the assistance of the foundational work from the English Language Arts K to 7 IRP (BC MoE, 2006a) and the English Language Arts 8 to 12 IRP (BC MoE, 2007) working groups. Key features of the EFP 12 course include a focus on "texts that present authentic First Peoples voices (i.e., historical or contemporary texts created by or with First Peoples) [coupled with the] recurrence of central themes such as identity and the significance of colonization" (BC MoE, 2008a, p. 11). The attention to recurring themes in this document is characteristically part of the worldview of many First Peoples.

Aboriginal Education Enhancement Agreements (EAs)

The MoE, through Aboriginal Education Enhancements, has an established goal to improve school success for all Aboriginal students. The following objectives are central to meeting this stated goal through increased Aboriginal voice, increased knowledge of Aboriginal language, culture and history, and focused and informed leadership for increased Aboriginal student success. The responsibilities associated with these objectives include policies, procedures, and initiatives related to the education of Aboriginal students in BC. An important responsibility resides in work between SDs and Aboriginal communities to develop and implement Aboriginal Education Enhancement Agreements (EAs) that are designed to enhance the educational achievement of Aboriginal students. These agreements:

- are intended to continually improve the quality of education achieved by all Aboriginal students;
- support strong cooperative, collaborative relationships between Aboriginal communities and school districts;
- provide Aboriginal communities and districts greater autonomy to find solutions that work for Aboriginal students, the schools and the communities; and

- require a high level of respect and trust to function. (BC MoE, 2013d, para. 3)

EAs were conceived out of a need to increase the quality of education received by Aboriginal students. BC schools recognized that they had not been successful in ensuring that Aboriginal students received a quality education, one that allows successes in the provincial economy while maintaining important cultural ties. A framework was created that led to the creation of EAs within various provincial SDs. A complete accounting of the intent of EAs can be obtained from http://www.bced.gov.bc.ca/abed/agreements/ and the 54 SDs that have signed EAs as of November 2014 (see also Appendix O).

Aboriginal student achievement is central to these EAs with each report providing five years of data. In keeping with this intent, the MoE reports student achievement and demographics in the K–12 education system and makes historical data available on the DataBC website (http://catalogue.data.gov.bc.ca/dataset). BC is the only province to publish standardized test scores by schools with various student demographics that include Aboriginal identity. These datasets provide a longitudinal record of achievement and success among K–12 students and enable meaningful comparisons of overall student success. It was from these datasets that initial examination of Aboriginal and non-Aboriginal student achievement in science and mathematics was formulated. In 2002, Lorna Williams, in her role as Director of the MoE's Aboriginal Education Enhancements Branch, discovered that very few Indigenous students were enrolled in the secondary sciences. Science courses are essential for entry into postsecondary studies and science-related fields. Williams stated, "Aboriginal knowledge, until now, has been invisible and devalued … It was thought that in order to join the modern world we had to give up our traditional knowledge" (Gillies, 2005, p. 1). The MoE datasets could, therefore, serve to examine the current state of Aboriginal enrolment and achievement in secondary science and mathematics courses.

The British Columbia Science Curriculum

The MoE sets the education standards for students in Kindergarten to Grade 12 through the provincial curriculum with PLOs that outline the expectations for what students should know and be able to do at each grade and within each subject area. The

provincial curriculum for science outlines the educational standards in the following areas of study that are relevant to this study: Science K to 7, Science Grades 8 to 10, Biology 11 and 12, Chemistry 11 and 12, and Physics 11 and 12. All curriculum documents are accessible to the public via the MoE website (http://www.bced.gov.bc.ca/irp/irp.htm). The IRP for each grade provides the basic information for teachers to implement these science courses as well as other courses that form the curriculum documents. An introduction guides each science document and contains relevant information such as overviews of the course content, curriculum organizers, and suggested timeframes for program delivery. Within each introductory section of the curriculum overview are two sections: first, Aboriginal Content in the Science Curriculum (curriculum up to and including Science Grade 10), followed by Working with the Aboriginal Community (found in all science curriculum documents) under Considerations for Program Delivery. The integration of authentic Aboriginal content into the K to 7 science curriculum, and stated in the Grades 8 to 10 Science documents, with support from Aboriginal stakeholders "will help promote understanding of BC's Aboriginal peoples among all students" (BC MoE, 2005, p. 10). The integration of Aboriginal science within western science:

> can provide a meaningful context for Aboriginal students and enhance the learning experience for all students …. Traditional Ecological Knowledge and Wisdom (TEKW) is defined as the study of systems of knowledge developed by a given culture. TEKW tends to be holistic, viewing the world as an interconnected whole where humans are not regarded as more important than nature. It is a subset of traditional science, and is considered a branch of biological and ecological science. (BC MoE, 2008b, p. 14)

The introductory section is followed by the PLOs that represent the content standards that are the required curriculum, wherein the outcomes (i.e., attitudes, skills, and knowledge) are clearly stated and expressed in measurable terms. It is within the PLOs that content recommendations for integration with TEKW are stated.

The MoE recognizes that learning is a life-long endeavour and that education is necessary element for a healthy and successful life. K–12 programs help build a solid foundation for children's futures (BC MoE, 2013c). The integrated Aboriginal

perspectives that should be incorporated in science teaching from K–12 are outlined in subject-specific PLOs along with a universal statement concerning Aboriginal Content in the Science Curriculum (see Appendix M). This integration is most strongly represented in K to 7 Science and is carried forward in the Science 8, 9, and 10 introduction sections (BC MoE, 2005, 2006a, 2006b, 2008b) but with fewer suggested integrated connections. In senior science courses, Grades 11 and 12, integration is reduced in the introduction to the section that describes Working with the Aboriginal Community. Teachers are, therefore, left to plan and connect with the Aboriginal communities in their own SDs, where resources and implementation strategies with the individual communities can vary. All teachers from K to 12 are expected to incorporate integrated TEKW PLOs where appropriate but must individually plan to do so. In the K to 7 IRP, areas suggested for integration are present and represented within each appropriate PLO; however, it remains for the teacher to incorporate it with individual classroom contexts. Across the BC school districts, variations in presentation and approach to integration of TEKW can be expected primarily from the nature of a particular location or place-based perspective.

Methodology

Research Design

Yin (2014) and Stake (1995) have suggested that claims of truth are constructed and relative and that truth depends upon an individual's perspective. This perspective "recognizes the importance of the subjective human creation of meaning, but doesn't reject outright some notion of objectivity" (Crabtree & Miller, 1999, p. 10). Individuals, therefore, develop their own construction of social reality (Searle, 1995; Stake, 1995; Yin, 2014) and employ different terms to describe a variety of case studies. Yin (2014) defines case study research as an empirical inquiry that "investigates a contemporary phenomenon (the 'case') in depth and within the real-world context, especially when the boundaries between the phenomenon and context may not be clearly evident." (p. 16).

Context

Case Study 1 is designed to examine the current state of student performance and participation in science and mathematics in BC and answer research questions (RQ) 1, 2, and 3:

1. What does an 8-year period of secondary science and mathematics achievement in BC schools indicate?
2. Are there a proportional number of Aboriginal students positioned to enrol in the sciences at the tertiary level when compared to their non-Aboriginal counterparts?
3. How do the BC results align with the gap studies that are widely reported in the literature?

There are 60 SDs in BC whose function is to administer publicly funded education until the end of Grade 12 in local areas of the province, or province-wide in the case of francophone education. The MoE provides information about student performance and demographics for the K–12 education system in its provincial reports (http://www.bced.gov.bc.ca/reporting/province.php). The Aboriginal Report 2008/09 – 2012/13, (BC MoE, 2013b) provides a contextual background to the research questions. In the 2012/13 school year, there were 564,532 students attending public schools of which 62,161 students self-identified as *Aboriginal* (11%). Over the past decade, this reported percentage has shown very little variation, remaining in the 11% range. Other selected data illustrate the current performance levels reported for 2012/13 as *meet (M) – exceed (E)* ratios (MERs) as follows:

- FSA results: Numeracy, Grade 4 … *Aboriginal* MER, M = 45% & E = 3% (82% FSA participation; 4,236 tested) … *Non-Aboriginal* MER, M = 59% & E = 9% (85% participation; 33,200 tested (BC MoE, 2013b, p. 12)
- FSA results: Numeracy, Grade 7 … *Aboriginal* MER, M = 38% & E = 2% (79% FSA participation; 4,575 tested) … *Non-Aboriginal* MER, M = 55% & E = 9% (85% participation; 34,595 tested) (BC MoE, 2013b, p. 15)
- Course options leading to graduation: Foundations of Mathematics 10 … *Aboriginal* C+ (Good) or Better = 44% (967/2218 assigned final mark) … *Non-Aboriginal* C+ (Good) or Better = 64% (21,840/33,996 assigned final mark) (BC MoE, 2013b, p. 16)

- Course options leading to graduation: Science 10 … *Aboriginal* C+ (Good) or Better = 42% (1,764/4,230 assigned final mark) … *Non-Aboriginal* C+ (Good) or Better = 68% (27,141/40,048 assigned final mark) (BC MoE, 2013b, p. 16)

These elementary-junior secondary school results represent a background to the data analysis that will examine senior secondary science and mathematics courses (Grades 11 and 12) with a focus on Grade 12 results. The results for Science 10 and Foundations of Mathematics 10 illustrate that Aboriginal students are coming to senior courses in mathematics and science already at a deficit when compared to their non-Aboriginal counterparts. The HAWD Report (BC MoE, 2013b) data use a blended final mark that are derived from a course mark (classroom work) that is teacher assigned and an examination mark. The student marks recorded, therefore, represent the best mark obtained in the year indicated. Marks were available for C- (pass) or better but these were not reported here based on the assumption that students who continue with optional senior science and mathematics courses are likely to be represented more widely from the C+ or better group. However, there was little change in the already noted deficit between Aboriginal and non-Aboriginal secondary student populations when the pass or better group was considered.

Background to the Data Analysis

The MoE datasets for Grade 12 Biology, Chemistry, Physics, and Principles of Mathematics, Applications of Mathematics 10 and 12, Essentials of Mathematics 10, Principles of Mathematics 10, and Science 10 for both Aboriginal and non-Aboriginal students from 2003–2011 were obtained. These data were analyzed using Microsoft Excel and PASW Statistics 18.0 to obtain descriptive statistics (percentages, means, and standard deviations). Analyses were performed directly on the data to obtain examination participation rates as well as measures of final outcomes for the courses taken. The final outcomes over the entire dataset included average final marks per course, percent of the total student population (Aboriginal and non-Aboriginal) taking a particular course, average number of students per year taking a particular course, and total numbers of

students taking a particular course. A final analysis, using PASW Statistics 18.0, included all available data for all Grades 10 and 12 mathematics and science courses.

The MoE website was examined and data were excerpted from the *Summary of Key Information* (2008/2009) to supplement the results of data set analyses. These quantitative data were analyzed and examined for possible trends and exceptions.

Study Strengths and Limitations

The strengths of this archival case study resides with the stability of the data (unchanging once recorded) and that these data are accessible over time on the government website. These data are specific, containing records for all student results in BC as well as data from individual SDs. However, the data used covers two Graduation Programs (i.e., 1996 and 2004) reflected graphically as separated trend lines for the study period (2003–2011). During the transition period, students could choose either the 1996 or 2004 Graduation Program option for writing final examinations. Furthermore, the procedures and analyses of these data are clearly described to allow replication by other researchers to verify the results of the case study.

The limitations may include predetermined parameters for data specification and collection outside the control of the author and reporting bias of the documents' authors and data specialists employed by the MoE. In the case of the Physics 12 (2006/07) results, details of Aboriginal students that achieved higher than their non-Aboriginal counterparts were not available, suffice for a verbal confirmation that the seven students involved were from different SDs and did not have the same teacher. Perhaps the main limitation of the data resides with assessments themselves. The resulting analyses of these test data may reflect the inequalities of standardized testing across divergent student populations, such as the lack of authentic measures, inappropriate language demands, limited response modalities, and the lack of culturally sensitive testing administration for Indigenous students (Atkinson, 2010).

Data Analysis

Data on Grade 12 science and mathematics final student scores were obtained from the Aboriginal Enhancements Branch in 2008 and from the Open Government and Community Partnerships Division: Business Intelligence Unit in 2012 (see Appendix G).

Analysis of these data has resulted in the generation of two tables of descriptive statistics and five figures based on these statistics.

Results

Table 1 shows the enrolment and achievement of Aboriginal and non-Aboriginal students in Grade 12 science and mathematics courses for the 2003–2011 school years. All students taking the diploma examination were tabulated for both student populations. Subject choices within these populations show that, among Aboriginal students, Biology 12 was the most popular choice with 63% preference, followed by Chemistry 12 (24%) and Physics 12 (13%). Likewise Chemistry 12 and Physics 12 were the two least popular science courses selected among the non-Aboriginal student population. Among these four option courses, both student populations followed the same order for science preferences; biology, chemistry, and physics, respectively, and showing an equal preference for mathematics. However, the preference for Biology 12 was almost 20% greater for the Aboriginal population compared with the non-Aboriginal one, whereas chemistry and physics were preferred at a population difference of less than 10%. Since Principles of Mathematics 12 represents a single course selection, as opposed to a selection of three subjects in Grade 12 science courses, the enrolment average number per year was used to calculate the percent of the individual population choosing to take Principles of Mathematics 12, which resulted in a population equivalent of 12.5% for both Aboriginal and non-Aboriginal students' selecting this course. Non-Aboriginal students scored higher when Aboriginal and non-Aboriginal average final marks were compared for all four mathematics and science courses. The approximate differences were 8% for Principles of Mathematics 12, 9% for Biology 12, 7% for Chemistry 12, and 6% Physics 12.

Table 1

Student Enrolment and Achievement in British Columbia Grade 12 Science and Mathematics Courses 2003–2011

Course	Student population	Total number of students	Annual average number of students	Student course choices (%)	Average final mark
Biology 12	Aboriginal	5,729	716	63	64.4
	Non-Aboriginal	158,662	19,832	46	73.0
Chemistry 12	Aboriginal	2,183	273	24	68.8
	Non-Aboriginal	113,480	14,185	33	75.7
Physics 12	Aboriginal	1,175	147	13	70.6
	Non-Aboriginal	70,543	8,818	21	76.8
Principles of Mathematics 12	Aboriginal	3,765	471	12.5[a]	66.7
	Non-Aboriginal	186,802	23,350	12.5 [a]	74.6

[a] Derived from use of average enrolment numbers for mathematics.

Although some of these courses may be required as prerequisites to a particular postsecondary program, none of these four courses are required for general admission into postsecondary institutions. Generally, these courses are taken by students with an interest in further studies in mathematics and science and technology-related fields. Postsecondary institutional requirements vary in both intraprovincial and interprovincial institutions as well as international institutions.

Sample Calculations for Table 1:

Aboriginal students taking biology, chemistry, and physics were added over the reporting period = 9,087 total (column 3, total number). Each course preference was calculated and recorded in Student Course Choices, for example, Biology 12 = 5729 / 9087 x 100% = 63%.

Assessment of Grade 12 Science Course Results

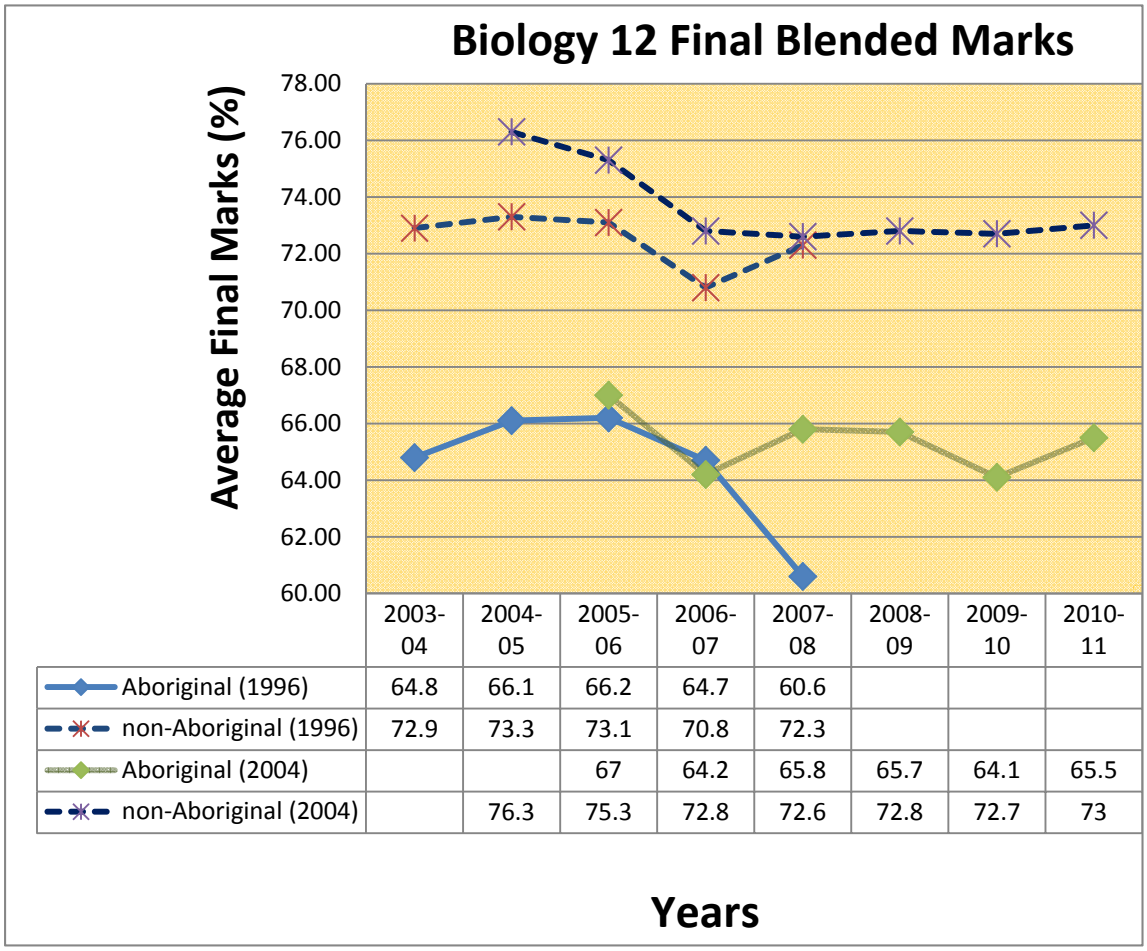
The course results for Biology 12, Chemistry 12, and Physics 12 are illustrated in Figures 1, 2, and 3; each figure includes the two graduation programs with different requirements. Under the 2004 Graduation Program guidelines, students may choose to write the final diploma examination or not. Prior to 2007–2008, very few students chose

not to write the final diploma examination in all courses. However, an increasing number of students chose not to write final diploma examinations after 2007–2008, relying on their course grades, exclusive of provincial examination results. For example, in the school year 2010–2011, 100 out of 1,102 Aboriginal students (9%) and 3,090 out of 22,212 non-Aboriginal students (14%) chose to write the Biology 12 examination. This suggests an increased degree of self-confidence toward traditional assessments among non-Aboriginal than Aboriginal students. Results for Chemistry 12 and Physics 12 showed a similar downward trend toward final examination writing.

The graphed results for Biology 12, Chemistry 12, Physics 12, and Principles of Mathematics 12 are for the student average final marks and illustrate trend lines for the Aboriginal and non-Aboriginal student populations from 2003 to 2011. The numerical data for each year is shown at the bottom of the figure and the identified trend lines graphically displayed. Blended final marks were used exclusively to reflect the best mark attained by the student data in keeping with the reporting in the HAWD reports. It is important to note that in all cases of Biology 12, Chemistry 12, and Physics 12 examination scores students on average scored lower on examinations compared to course marks. When considering examination scores alone, it can be seen that there is a greater gap between Aboriginal and non-Aboriginal student results than if blended marks (course mark plus examination mark) are used. For example, the greatest difference between an examination mark and a course mark (13.7%) was recorded for Biology 12 (2006–2007) for Aboriginal students, with a difference of 11.1% for non-Aboriginal students under the 1996 Graduation Program. These low examination scores were likely the result of a difficult Biology 12 final examination that affected both student populations more or less equally. The least difference between examination and course marks was 1.6% (Aboriginal) and 3.0% (non-Aboriginal) for Physics 12 in the same examination year under the revised 2004 Graduation Program. The final blended marks or best marks attainable by the students offers a fair comparison of Aboriginal and non-Aboriginal student populations.

Interpreting Figures 1, 2, 3, and 4

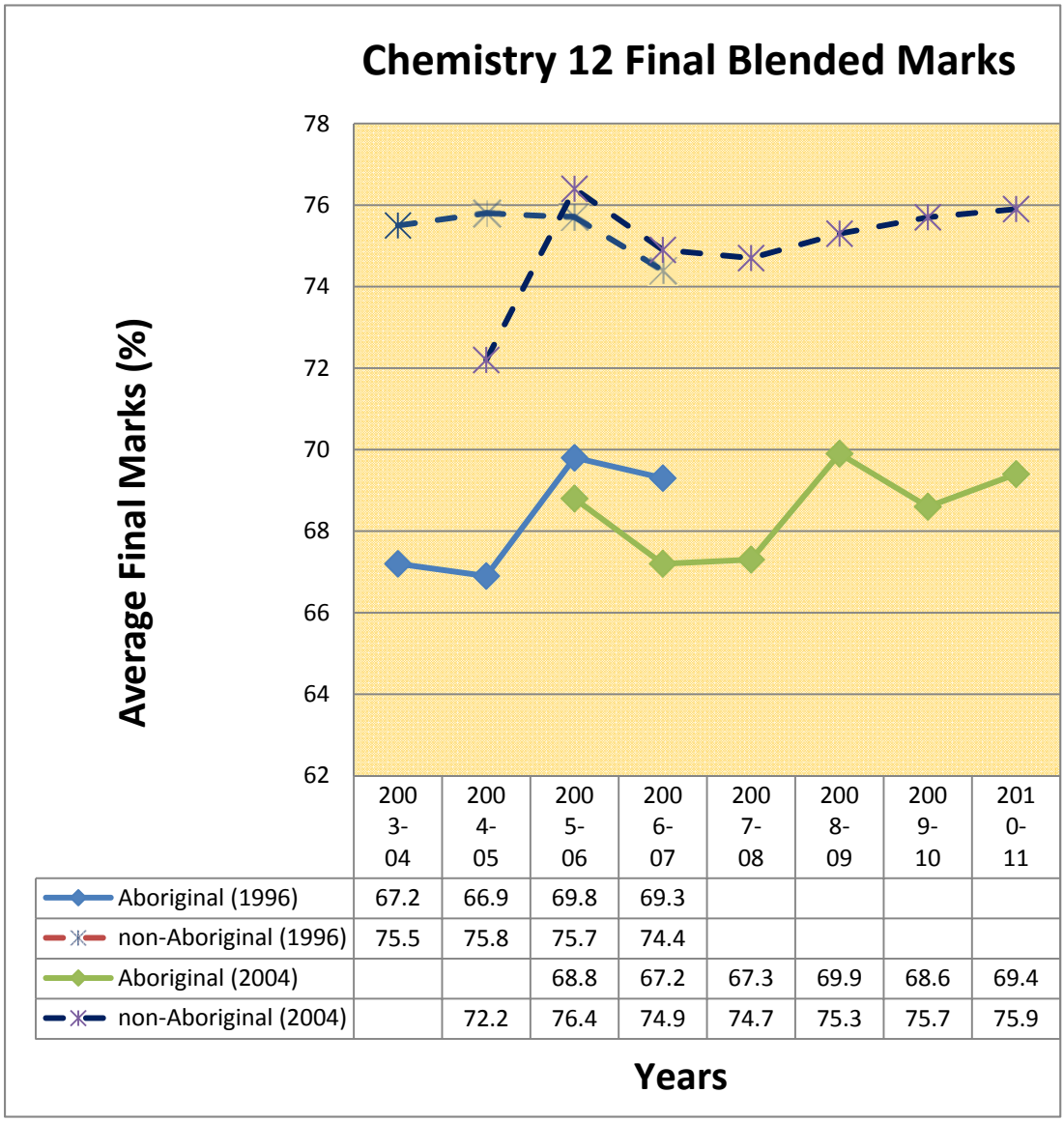
Each figure shows final blended marks in Biology 12, Chemistry 12, Physics 12, and Principles of Mathematics 12 for Aboriginal and non-Aboriginal students in BC from 2003 to 2011. The data span two graduation programs, 1996 and 2004, with different examination requirements. Trend-line comparisons should be made between Aboriginal and non-Aboriginal populations for the requisite graduation program, which are colour coded and keyed with each line having a distinctive plot marking. For best comparisons, match the correct Aboriginal (solid line) and non-Aboriginal (dotted line) trend lines for each graduation program in turn.



	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
Aboriginal (1996)	64.8	66.1	66.2	64.7	60.6			
non-Aboriginal (1996)	72.9	73.3	73.1	70.8	72.3			
Aboriginal (2004)			67	64.2	65.8	65.7	64.1	65.5
non-Aboriginal (2004)		76.3	75.3	72.8	72.6	72.8	72.7	73

Figure 1. Achievement trend lines for Biology 12 (1996, 2004)

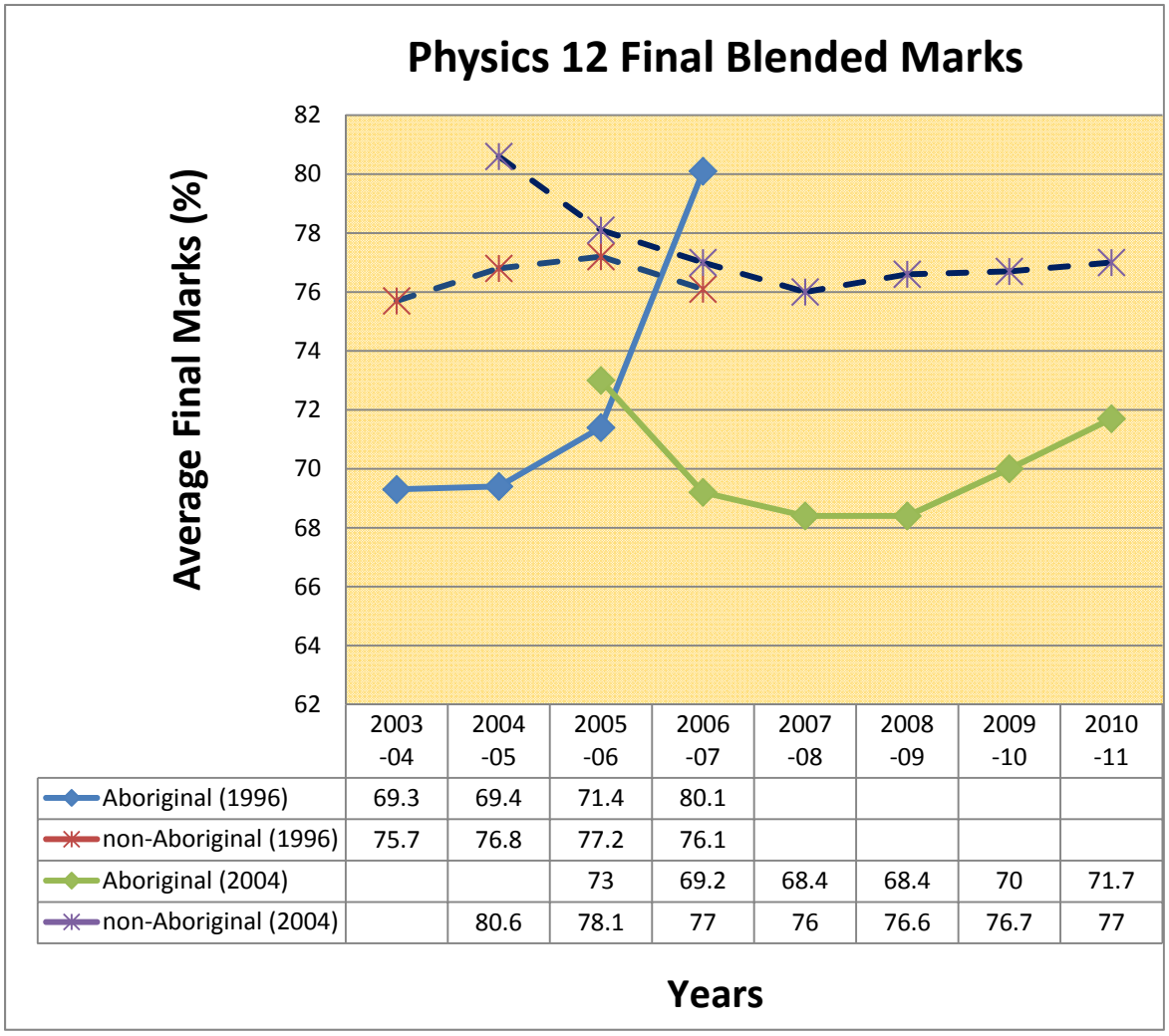
The resultant trend lines illustrated in Figure 1 indicate that the achievement of Aboriginal students lags behind their non-Aboriginal counterparts for Biology 12. Table 1 indicates that the average difference between the final marks, the first choice among Aboriginal students, is approximately 9%. The general trend lines shown in Figure 1 for Aboriginal students (in both graduation programs) is in the 64–66% range, compared with a 72–74% range for non-Aboriginal students.



	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
Aboriginal (1996)	67.2	66.9	69.8	69.3				
non-Aboriginal (1996)	75.5	75.8	75.7	74.4				
Aboriginal (2004)			68.8	67.2	67.3	69.9	68.6	69.4
non-Aboriginal (2004)		72.2	76.4	74.9	74.7	75.3	75.7	75.9

Figure 2. Achievement trend lines for Chemistry 12 (1996, 2004)

Chemistry 12 was the second most popular choice for both Aboriginal and non-Aboriginal student populations (24% and 33%, respectively). Chemistry 12 results show a similar lag in final performance of Aboriginal students when compared to the non-Aboriginal student population. Both graduation programs show this marked separation of blended final marks. Figure 2 illustrates these differences on a year-to-year basis where the gap in scores is approximately 7%. The Aboriginal students' scores that are consistently lower than their non-Aboriginal counterparts are the real concern.



	2003 -04	2004 -05	2005 -06	2006 -07	2007 -08	2008 -09	2009 -10	2010 -11
Aboriginal (1996)	69.3	69.4	71.4	80.1				
non-Aboriginal (1996)	75.7	76.8	77.2	76.1				
Aboriginal (2004)			73	69.2	68.4	68.4	70	71.7
non-Aboriginal (2004)		80.6	78.1	77	76	76.6	76.7	77

Figure 3. Achievement trend lines for Physics 12 (1996, 2004)

Of the four courses examined, Physics 12 has the lowest number of Aboriginal students enrolled. Physics 12 was a third most popular choice for optional programs in

science among both student groups but also carries the highest average final blended mark for both Aboriginal and non-Aboriginal students. This senior physics course illustrates an overall difference in average final marks between Aboriginal and non-Aboriginal students of approximately 6% for the years of study (Table 1). Figure 3 shows Aboriginal students' final blended marks for 2006–07 (1996 Graduation Program) at a higher value (80.1%) than the non-Aboriginal students (compare with 76.1%). This 80.1% score was based on a population of seven Aboriginal students compared to 847 non-Aboriginal students. This result created a great deal of interest since it represented an encouraging note among all the 2003–2011 data. Results such as this cause much speculation about its nature and cause: one class with an exceptional teacher; motivated students in a school district that collaborate with one another; or perhaps seven unrelated, motivated students who scored well as a group (unknown to each other). Figure 3 also shows the first year for the 2004 Graduation Program and a score of 80.6% for non-Aboriginal students; no Aboriginal students wrote the corresponding Physics 12 examination in this school year. Another noteworthy statistic occurs in the 2008–09 school year for the new graduation program: Aboriginal students' examination marks were higher than their course mark; their final blended mark was 68.4%. This is an important result for the 174 Aboriginal students since, traditionally, final examination marks are lower than course marks for both Aboriginal and non-Aboriginal students.

Assessment of Principles of Mathematics 12

The results for the Principles of Mathematics 12 course for Aboriginal and non-Aboriginal students are illustrated in Figure 4. The trend lines illustrate a performance lag between Aboriginal and non-Aboriginal students of approximately 8%. This course was the highest preference among the group of four courses examined for non-Aboriginal students. The high participation among non-Aboriginal students is probably due to student postsecondary goals and preparations for future courses, not only in mathematics and science, but also other areas of study. Principles of Mathematics 11 is a basic requirement for university admission; therefore, Principles of Mathematics 12 is likely chosen to deepen understandings for future learning. It should be noted that Applications of Mathematics 10, Essentials of Mathematics 10, and Applications of Mathematics 12

are associated with provincial examinations, but these choices do not lead to acceptance at all tertiary institutions.

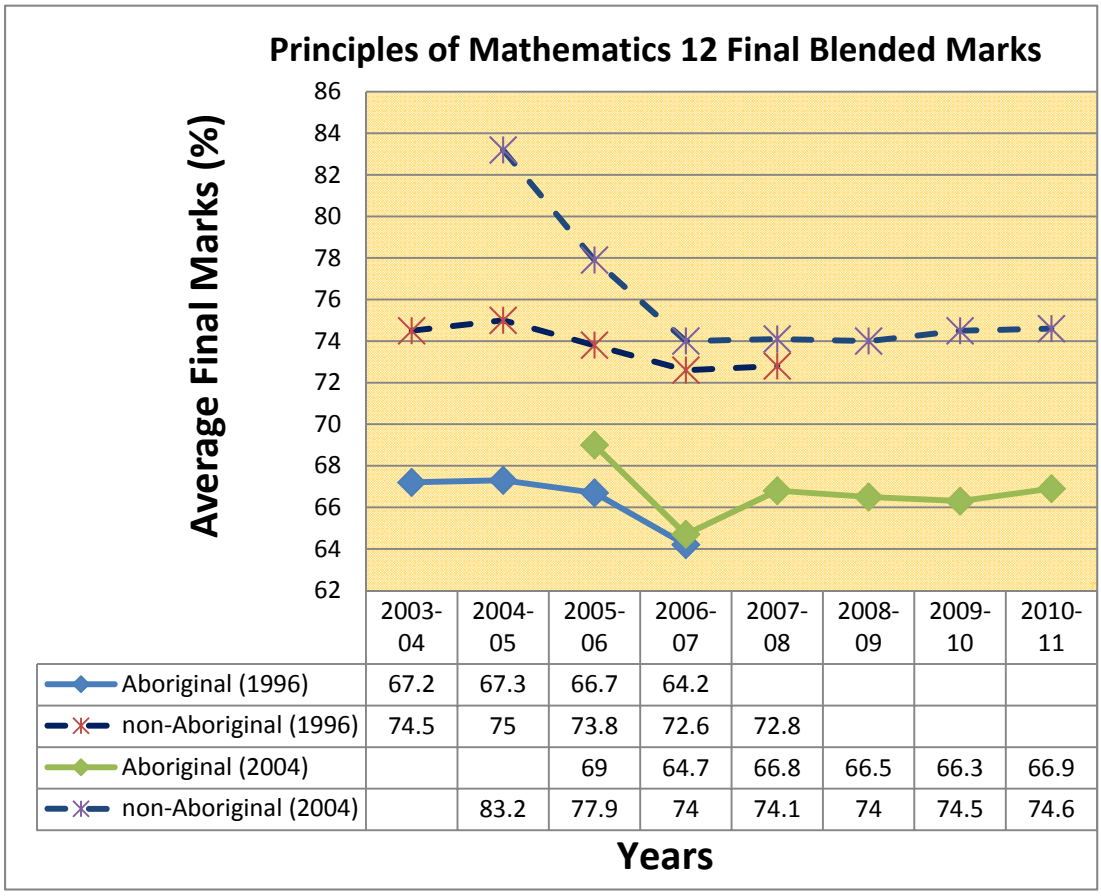


Figure 4. Achievement trend lines for Principles of Mathematics 12 (1996, 2004)

Overall Assessment of Grades 10 and 12 Mathematics and Science

A final assessment of the data resulted in boxplots data generation for Aboriginal and non-Aboriginal student populations. The average blended final marks for the following mathematics and science courses, 2004–2009 (2004 Graduation Program); Application of Mathematics 10 and 12, Essentials of Mathematics 10, Principles of Mathematics 10 and 12, Science 10, Biology 12, Chemistry 12, and Physics 12 formed the basis of analysis. The boxplot data generated showed that when Aboriginal and non-Aboriginal student populations were compared, with respect to their collective average blended final marks for Grades 10 and 12 mathematics and science courses, Aboriginal students lagged behind their non-Aboriginal counterparts. The boxplot data illustrated in Figure 5 shows that the Aboriginal student population final marks in mathematics and science, as the

previous Figures 1-4 show, lag behind their non-Aboriginal counterparts by about 10 percentage points, with median marks of about 62% and 72%, respectively. The Aboriginal median mark of 62% barely aligns with the lower quartile whisker (a line from the top and bottom of the box defining the farthest data point) of the non-Aboriginal box plot. However, the non-Aboriginal median of 72% surpasses the upper whisker of the Aboriginal box plot data. Clearly, Aboriginal student data, as represented by the average blended final course marks for Grades 10 and 12 mathematics and science courses, lags behind the non-Aboriginal student data.

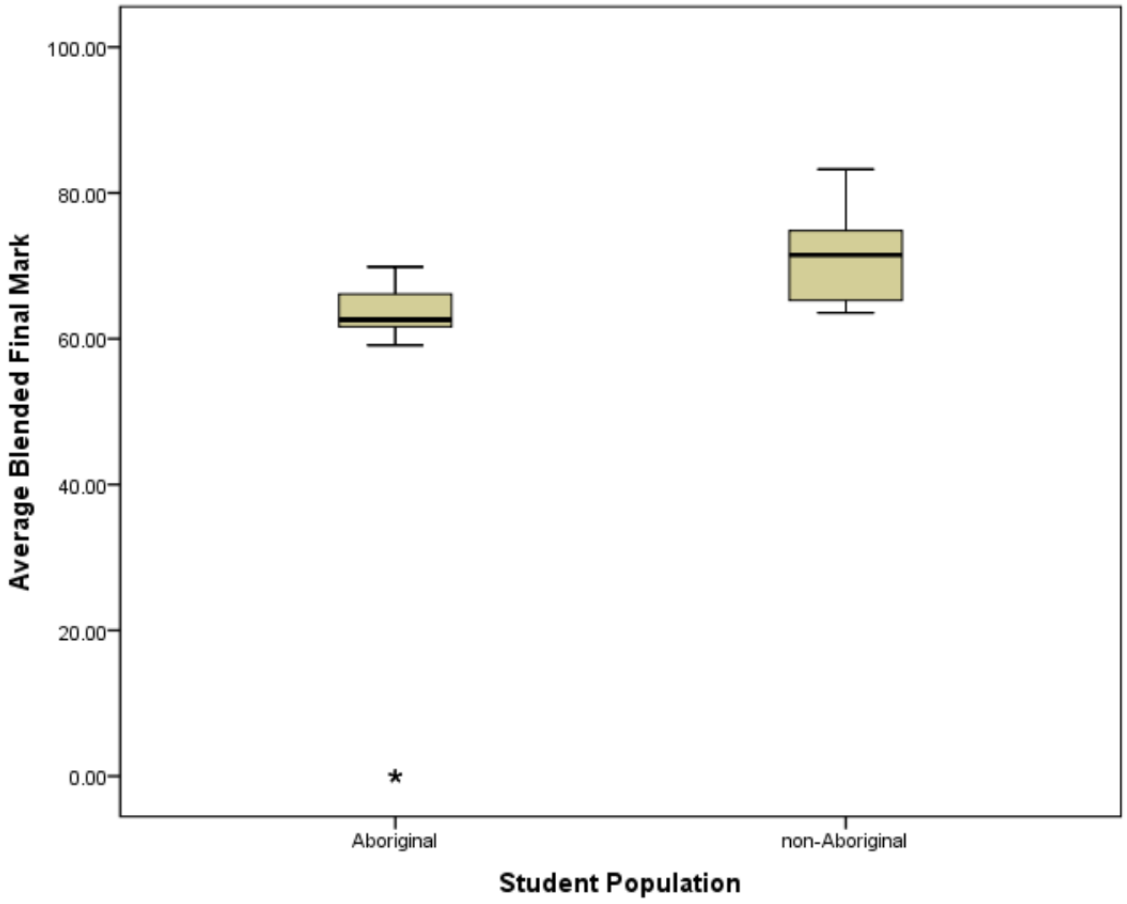


Figure 5. Boxplots for Nine Science and Mathematics Courses

* represents outlier data in 2004-2005, where Aboriginal data was entered at '0' for MA 12, BI12, and PH 12 and 2005-06 for PH 12

In all cases of this study, Aboriginal students' final blended course marks lag behind those of non-Aboriginal students. In most cases, the difference between non-Aboriginal and Aboriginal students' average final mark is 8.9% or less in science courses and 9.3%

or less in mathematics. However, the lower range of the Aboriginal student scores are still passing marks for these courses. Overall, the data input to create Figure 5 boxplots shows a median difference of about 10% when Grades 10 and 12 science and mathematics courses were analysed collectively. One notable exception to this profile is the comparison for Physics 12 in 2006–2007, where Aboriginal students' average score was four percentage points higher than that of their non-Aboriginal counterparts. However, in this case the actual number of Aboriginal students (7) enrolled in Physics 12 compared to non-Aboriginal students (847) means that the score represented an outlier due to a small, high-performing, non-representative sample. After consulting with the MoE, it was discovered that these results came from seven separate schools in six school districts. However, this does not diminish the accomplishments of these seven students in any way and illustrates the potential performance for Aboriginal students in a highly demanding discipline.

Scholarships and Achievement

Relevant data from the *Summary of Key Information 2008/09* (BC MoE, 2009) from selected high-proportionate Aboriginal population and high-performing SDs that might provide insights into their achievement and performance has been excerpted and presented in Table 2. Seven SDs were selected from the 60 SDs based on an Aboriginal student population of over 50%, accompanied by two other districts (Richmond 38 and West Vancouver 45) that exhibited high levels of student achievement but lower enrolment of Aboriginal students. Six-year completion rates were compared between 'all students' and 'Aboriginal students' as well as provincial scholarships of $1,000 or $2,500 awarded to all students for Grade 12 examination results over 86% and a minimum B in English course choices. (For further information on these scholarships, refer to http://www.bced.gov.bc.ca/awards/)

Table 2

Aboriginal Student Data for Selected School Districts in British Columbia 2007–08

School district	Aboriginal students (%)	Six-year completion all students (%)	Six-year completion Aboriginal students (%)	Scholarships number of students	Scholarships Grade 12 students (%)
38 Richmond	1.2	91	65	213	8
45 West Vancouver	0.6	93	60	44	6
49 Central Coast	66.7	70	40	1	6
50 Haida Gwaii	67.1	50	44	1	2
52 Prince Rupert	60.2	63	39	4	1
74 Gold Trail	57.1	63	46	1	0
84 Vancouver Island West	51.0	62	49	0	0
87 Stikine	79.0	36	26	0	0
92 Nisga'a	99.2	41	41	0	0

Note. Table data excerpted from BC Ministry of Education: *Summary of Key Information* for 2008/2009

The percentage of Aboriginal students in the selected SDs ranged from 99.2% for Nisga'a (92) to 0.6% for West Vancouver (45). Six-year completion rates for all students (the proportion of students who graduate with a BC Certificate of Graduation within six years from enrolment in Grade 8) vary from a high of 93% (West Vancouver 45) to a low of 36% (Stikine 87). When comparing six-year completion rates for Aboriginal students in these same SDs, the range is from 60% to 26%, respectively. Of the 264 scholarships awarded in these nine SDs, 257 were received in the two districts having a combined Aboriginal population less than 2%, accounting for 97% of the scholarships awarded to these SDs.

A comparison of the scholarships awarded to all students reveals that the number awarded did not exceed four (Prince Rupert 52); and in three districts, there were SDs that awarded no scholarships to Aboriginal students. These results, when compared with 213 (Richmond 38) and 44 (West Vancouver 45) scholarships awarded, further indicate the higher successes of SDs having lower Aboriginal student populations. However, data for six-year completion rates for Aboriginal students is highest (65%) in SD 38

(Richmond) where the number of awarded scholarships is also the highest. SD 45 (West Vancouver) showed a similar trend. More information would be needed to derive any meaningful conclusions from these data, other than the indications that it presents in this instance.

British Columbia Ministry of Education "How Are We Doing?" (HAWD) Report

Aboriginal performance data were examined for the 2011-2012 school year. The HAWD report (BC MoE, 2013a) includes demographic, assessment, and scholarship data at the district and school levels for all public schools in the province; it provides a mechanism for dialogue and a vehicle for improvements to Aboriginal achievement through recommendations that it generates. Achievement data were excerpted to create the following tables for comparative purposes to further examine achievement amongst Aboriginal and non-Aboriginal student populations.

Scholarship data were examined further to illustrate the continuation of the observed differences in achievement and scholarship awards amongst Aboriginal and non-Aboriginal students recorded in Table 2. Table 3 summarizes the Grade 12 Graduation Program Examination Scholarships and shows that no scholarships were awarded in the $2,500 category (the top 20 among these scholarships) to Aboriginal students, compared with 99 non-Aboriginal recipients (1.2% of recipients). Several Aboriginal and non-Aboriginal students met the basic eligibility qualified to graduate and achieved the required Grade 12 provincial examination achievement scholarship ($1,000). However, proportional to the relative student populations, the percentage difference in these awards ranges from 1–14%, again in favour of the non-Aboriginal student population. It is noteworthy that for the 2011/12 school year both groups showed a marked increase in the number of recipients for this scholarship. Highlighted entries in Table 3 indicate that Aboriginal students garnered 231 (4%) and non-Aboriginal students 8,057 (14%) of the $1,000 scholarships.

Table 3

Grade 12 Graduation Program Examination Scholarships for Aboriginal and Non-Aboriginal Students 2007–2012

School year	Sep/Feb students (*n*)	$1,000 scholarship (*n*)	Recipient (%)	$2,500 scholarship (*n*)	Recipient (%)
Aboriginal students					
2007/08	5,353	33	1	0	0
2008/09	5,577	24	0	0	0
2009/10	6,001	20	0	0	0
2010/11	6,533	18	0	0	0
2011/12	6,379	**231**	**4**	0	0
Non-Aboriginal students					
2007/08	55,019	3,090	6	21	0
2008/09	54,928	2,078	4	20	0
2009/10	57,070	2,057	4	20	0
2010/11	59,274	2,093	4	22	0
2011/12	58,239	**8,057**	**14**	16	0

Note. Data excerpted from HAWD (BC MoE, April 2013a, p. 32), Scholarships and Awards, 2011/12.

Table 4 reports the Dogwood District/Authority Award (graduate diploma) as a proportional number for both groups attaining the award criteria. Of particular interest is the consistent 2% of Aboriginal students who received this award, compared with the 5% of non-Aboriginal students. Using the 2011/12 data (highlighted), there would need to be an additional 180 Dogwood Awards earned by Aboriginal students to bring them to parity (5% of the appropriate population) with their non-Aboriginal counterparts. This raises the question about the 3% discrepancy between the awards granted to the respective populations. The participation, achievement, scholarship, and graduation data suggest there is a problem that needs careful attention and correction, in spite of the current and ongoing government initiatives with Aboriginal K–12 education programming. Attention needs to be directed to the required examinations for graduation in mathematics and science.

Table 4

Dogwood District/Authority Award for Aboriginal and Non-Aboriginal Students 2007–2012

	Aboriginal students		Non-Aboriginal students	
School Year	Total	Awarded *n* (%)	Total	Awarded *n* (%)
2007/08	5,353	107 (2)	55,019	2,671 (5)
2008/09	5,577	121 (2)	54,928	2,673 (5)
2009/10	6,001	149 (2)	57,070	2,658 (5)
2010/11	6,533	126 (2)	59,274	2,682 (5)
2011/12	**6,379**	**139 (2)**	58,239	2,666 (5)

Note. Data excerpted from HAWD (BC MoE, April 2013a, p. 32), Scholarships and Awards, 2011/12.

Mathematics (i.e., Foundations of Mathematics 10, and Apprenticeship and Workplace Mathematics 10) and Science 10 course results for required examinations leading to graduation are highlighted in Table 5. Each student's final mark is the result of blending a course mark (of 80%) with a final examination mark (of 20%). The marks in Table 5 represent these blended final marks or best marks obtained (i.e., final examination score and a teacher assigned course mark). In 2010/11, two new mathematics 10 courses were added to replace the previous three mathematics 10 courses, where the Foundations of Mathematics 10 leads to entry into postsecondary programs and the Apprenticeship and Workplace Mathematics 10 leads to entry into the majority of trades and the workforce. Table 5 compares marks using two criteria: C- represents pass marks or better, and C+ represents marks designated as good or better. Results from the second criteria tend to represent those students who will be taking more advanced courses in the subject. For example, students interested in taking further courses in science-related fields tend to be represented in this grouping, particularly where success in future science studies depends upon foundational knowledge in the chosen science subject area.

Table 5

Science 10 and Mathematics 10 Achievement for Graduation

		Aboriginal students					Non-Aboriginal students			
	No. final marks	C-		C+		No. final marks	C-		C+	
Course		*n*	%	*n*	%		*n*	%	*n*	%
Math (Found.)	2,268	1,899	84	884	39	35,086	30,284	93	20,279	62
Math (Appren.)	2,133	1,844	86	732	34	8,212	6,927	91	2,937	39
Science	4,155	3,655	88	1,652	40	41,468	40,545	96	27,054	64

Note. Data excerpted from HAWD (BC MoE, April 2013a, p. 16), Scholarships and Awards, 2011/12. C- = pass or better; C+ = good or better.

Results from Table 5 indicate a 5% gap between Aboriginal and non-Aboriginal marks at both the C- and C+ categories for the Apprenticeship and Workplace Mathematics 10 course. However, the results are quite different for Foundations of Mathematics 10 with a gap of 9% at the C- level and 23% at the C+ level. Similar results are also reflected for Science 10, with gaps of 8% and 24%, respectively.

Addressing Case Study 1 Research Questions

RQ 1: What does an 8-year span of secondary science and mathematics results in BC indicate?

RQ 2: Are there a proportional number of Aboriginal students positioned to enrol in the sciences at the tertiary level when compared to their non-Aboriginal counterparts?

Reported underrepresentation of Aboriginal students in tertiary level sciences can be seen to begin with the culmination of science requirements (i.e., Science 10) for graduation. Many students tend to move away from the sciences at this point; however, those choosing to take science subjects beyond Grade 10 do so because of a personal interest in science. Yet, the science achievement gap for Aboriginal students remains at about 10%. It should be noted that many students (both Aboriginal and non-Aboriginal) achieve success in STEM careers, but more are needed to meet national and global demands in this field. However, reasons and explanations for the achievement gap in

science have been sought by a great many researchers who direct attention to science literacy and science literacy for all, WMS and TEKW, and CRS.

The meaning these results have for education in BC resides with MoE initiatives that are already in place and require time to develop trust and understanding within the individual SDs of the province. Clearly, the EAs that have been established with 53 SDs is a step in the direction toward narrowing this achievement gap. Concomitant with the EAs is the "Accountability Framework" that through school planning councils and achievement contracts engages individual SDs in planning for student success. An exemplar of success can be seen in SD 67 (Okanagan Skaha) where Richards et al. (2008) concluded that "collaboration between school-district personnel and local Aboriginal communities is a prerequisite to improved academic outcomes." (p. 16).

The observations from 1997–2002 (Snively & Williams, 2006, 2008) were consistent with the current study of 2003–2011, where the preferred selections for three Grade 12 science courses remained unchanged for Aboriginal students. Average final course marks (Table 1) were Biology 12 (64.4%), Chemistry 12 (68.8%), and Physics 12 (70.6%). Aboriginal students who chose Physics 12 experienced the greatest success among the three courses; however, there was a 6% gap in achievement when compared to non-Aboriginal Physics 12 students. It should be noted that the earlier study (Snively & Williams, 2006, 2008) examined Aboriginal student participation rates, which was somewhat different than in this study. Table 1 reflects the percent of total individual population, which enabled the comparison between Aboriginal and non-Aboriginal students. It is noteworthy that, although Biology 12 is a preferred choice, its final scores were the lowest on average and that Physics 12 final scores with lower student participation were the highest. There were no comparative data available for the 1997–2002 study.

An examination of Table 1 and the range of marks provided above indicated a mark range comparable to the current study data. It is likely that the approximate gap of 10% or higher has existed for the past 15 years; all data illustrated marked underachievement of Aboriginal students compared with their non-Aboriginal counterparts. These data are confirmed by Yore et al. (2014), where Biology 12 (17.1%), Chemistry 12 (15%), Physics 12 (10.2%), and Principles of Mathematics 12 (17.1%) were reported for students

achieving good ratings (C+ or better) in their Grade 12 elective science course examinations (2010–2011). These data are potential indicators of the performance gaps between Aboriginal and non-Aboriginal students and, therefore, serve as predictors of acceptance into postsecondary studies and future success in the STEM disciplines. MoE data for 5-year completion requirements (Grades 9–12) for the school years of 1995–2002 and 2006–2011 reported graduation rates for Aboriginal students at about 36–42% (Snively & Williams 2006, 2008). An examination of 6-year completion rate data for the years 2006–2011 showed a continuing increase in graduation rates for Aboriginal students from 48% (2006/2007) to 54% (2010/2011), while participation rates in all of the subjects remained relatively stable. Although this is a positive trend, it is still a concern that this completion rate significantly lags behind the 83% rate for non-Aboriginal students, which is a graduation rate gap of approximately 29%.

Indigenous students are greatly underrepresented in enrolment in most postsecondary programs and institutions and, in particular, Aboriginal people are highly underrepresented in science (Mendelson, 2006). Although this could indicate a lack of interest in these careers, enrolment and performance in the necessary prerequisites at the secondary school level may be a significant barrier to pursuing postsecondary mathematics- or science-related programs and STEM careers. However, the completion rates were reversed for community colleges and technical institutions where graduation rates are 49% for non-Aboriginal and 64% for Aboriginal students. Collectively, these participation and success rates for Indigenous students appear to support the need to build STEM programs in relevant, authentic, supportive, and culturally responsive environments.

Evidence that progress in addressing these concerns is occurring in BC schools can be found in Aboriginal Education EA reports. For example, Sooke SD 62 (King-Hunt, 2013) reported that Aboriginal students with C+ or better showed a yearly increase of 22% (from 25% to 47%) for Science 10 over the previous year and a six-year completion rate of 62%. SD 62 also reported an increase in the number of students taking Foundations and Pre-Calculus 10 mathematics (BC MoE, 2013a). In addition, EA Report Four showed how an increase in Aboriginal content impacted the classroom with reference to the T'Sou-ke Solar Tours curriculum that was developed by T'Sou-ke Smart Energy Group.

Fifteen school classrooms participated in the tours that began in February 2013. Students were welcomed to the territory by an Elder and learned about the extensive solar projects and energy conservation within the T'Sou-ke Nation. The conservation workshops are inclusive learning about complex energy ideas through storytelling, games, quizzes, and hands-on activities. Students learned how First Nations follow traditions and values in respecting Mother Earth. A student commented following a tour:

> Thank-you T'Sou-ke Nation for the tour of your beautiful home. I love the way you guys use the solar power in a different way. You use solar energy instead of BC Hydro. I enjoyed the tour and meeting the staff. Andrew, thanks a lot for showing how you use your solar panels. I know two kinds of panels: one is solar voltaic panel which makes energy/electricity. Then there are solar hot water panels that heat water. Melanie and Angie, thank-you for the story and Jeopardy. (King-Hunt, 2013, p. 12)

Okanagan-Skaha SD 67 in their Aboriginal Education Mid-Year Summary highlighted many achievements and initiatives engaging district students and staff alike. One example is this excerpt from Cultural Awareness Professional Development for SD 67 Staff:

> A Land-Based Learning Project: the LBLP is a multi-year project that aims to have regular K-12 lessons taught at the ECOmmunity Place as a means of meeting Prescribed Learning Outcomes in the context of the local environment and Syilx culture. Lesson plans are being co-created by SD67 teachers/staff and En'owkin Centre staff. (Tenning, 2013, n.p.)

Cultural awareness programs for students highlight many activities, including classwide presentations. A stated new goal in the Aboriginal Education program is to offer classwide cultural awareness presentations, replacing the pull-out presentations solely for Aboriginal students. These presentations are to be all-inclusive and to raise the understanding of Aboriginal people and culture for all students.

This archival case study has revealed areas that require attention and improvement if STEM literacies are to be addressed satisfactorily. This process does not occur overnight due to the complexity of the issues surrounding student achievement and participation in pipeline science courses leading to postsecondary programs and careers in STEM.

However, from the examples cited, SDs are addressing this short-fall and are beginning to achieve the cultural responsiveness necessary to engage students in science learning that respects and includes worldviews of IKW and WMS and, as a result, is more inclusive for all students.

RQ 3: How do the BC results align with the gap studies that are widely reported in the literature?

Measuring Achievement Nationally and Internationally

In BC, achievement analyses focus on Grades 10 and 12 provincial examinations and the FSA in Grades 4 and 7. The published student achievement data for all school districts by the MoE is among the most comprehensive in Canada. These data were explored by many researchers: notably, Mendelson (2006), Richards (2008, 2011), Richards et al. (2008), Richards and Scott (2009), and Richards, Vining, and Weimer (2010). A concern of public education in Canada resides with achievement differences in national and provincial or territorial jurisdictions with the specific achievement domains of science, mathematics, and reading. Achievement differences, or gaps, can become serious education and social justice issues when they are large and associated with group membership over which the student has no control or influence; for example, recent immigrants, Indigenous people, urban or rural dweller, or a person of a certain socioeconomic status (Ogbu, 1987).

The PISA measures Canadian achievement differences in three literacy areas (i.e., reading, mathematics, and science) with respect to other OECD countries. The Pan-Canadian Assessment Program (PCAP) is administered by the CMEC and examines achievement across provinces and territories. PISA has a mandate to measure how well prepared 15-year-olds are to meet an idealized interpretation of adult literacies for an information-rich society and knowledge economy. An understanding of this Canadian context is essential to relating to the data presented in any international, national, or provincial and territorial comparisons and their associated claims. Yore et al. (2014) noted that, when nations are compared in PISA 2003 (mathematics) and 2006 (science) using student-level variables such as self-concept, self-efficacy, SES, and positive academic achievement, “students with higher levels of motivation and self-concept

tended to achieve higher scores than students with lower levels of these attributes, from all nations sampled" (p. 79).

Nationally CMEC administers PCAP to 13-year-old students for the same three literacy measures as PISA; it is complementary in defining achievement domains, age of students, and year of administration. The relative performance among provinces showed Québec with the "highest mean performance on reading (0.26 standard deviations above the Pan-Canadian mean) and mathematics (0.17) and Alberta having the highest relative performance in science (0.24). BC, however, performed consistently below the Pan-Canadian average in all three disciplines [-0.12 to -0.16]" (Yore et al., 2014, pp. 82–83). The PCAP results also indicated a consistent gap in achievement between Indigenous and non-Indigenous students "by approximately a quarter standard deviation on reading and science and almost a half standard deviation on mathematics" (Yore et al., 2014, p. 83).

Richards and Scott (2009) examined Aboriginal education in Canada with the belief that improving educational outcomes will provide a means to alleviate poverty and marginalization of Aboriginal peoples in Canadian society. Their focus is on strengthening the K–12 foundations to address the distressing Aboriginal school dropout rates and stress the importance of completing high school certification. They stated that "no community can prosper unless the overwhelming majority achieves reasonable rungs on the education ladder, starting with high school certification." (Richards & Scott, 2009, p 4). The Aboriginal/non-Aboriginal achievement gaps in education that have widened over the last generation also illustrate that some provinces (i.e., BC and Ontario) are achieving results much better than the national average. Richards and Scott (2009) identified a number of initiatives that will potentially enhance Aboriginal outcomes and serve to close the achievement gap:

- Early childhood education programs … to offset disadvantages faced by Aboriginal children entering primary school.
- Validation of the Aboriginal community within the school system … in curricular design that reflects Aboriginal culture, in teacher hiring, and in the engagement of local Aboriginal parents and community leaders
- Addressing peer effects … these can be positive or negative, but the racial composition of the school catchment area should be considered in order to

avoid potential negative peer effects by concentrating Aboriginal students in one or a few schools in a provincial school district

- Adaptation of district level school administration to the needs of the local Aboriginal community … noting that, educational needs vary, depending on attendance at rural, inner city, suburban schools, or on-reserve schools. (pp. iv-v)

They make the case that "many of the Aboriginal/non-Aboriginal gaps have complex origins and that improving education outcomes is probably the most important dimension of social policy to tackle" (p. 6).

Addressing the Principle of Equity and Justice

J. Lee (2004) drew attention to achievement gaps as a serious breach of the principle of equity and justice when he examined equality, adequacy, and reciprocity as conditions to close the achievement gap. Many researchers have joined in various analytic measures in order to interpret the gap in achievement among involuntary minorities both nationally and internationally. In their examination of Aboriginal education in Canada's provinces and territories, Richards and Scott (2009) pointed out that BC is the only province to publish standardized test results by school and by student characteristics, including Aboriginal identity. They noted that the gap between Aboriginal and non-Aboriginal students was evident by Grade 4 in the FSA; Neel (2008) also noted the gap and suggested that it could begin earlier.

Many studies have examined the factors that determine educational performance between Aboriginal and non-Aboriginal students in BC schools, notably, Mendelson (2006, 2008), Richards (2008, 2011, 2013a, 2013b), Richards et al. (2008), Richards and Scott (2009), and Richards et al. (2009). The Right Honourable Paul Martin, along with provincial premiers and leaders of major Aboriginal organizations formulated the Kelowna Accord in 2005. Among the goals undertaken was the initiative to close the gap in high school completion rates between Aboriginal and non-Aboriginal students within a decade (i.e., by 2015). Unfortunately, with changes in federal governments, this goal will not be realized from a federal perspective. However, efforts continue to identify factors or influences that contribute to achievement in education; among these are family

characteristics, student peer effects, and the relative importance of formal education from a cultural perspective. To this end, after he retired from political life in 2006, Mr. Martin founded the MAEI whose mission is "to improve elementary and secondary school education outcomes for Aboriginal Canadians through the implementation of specific programs and appropriate research" (Martin, n.d., p. 3).

Richards et al. (2008), in their detailed study of Aboriginal student performance in BC schools based on meet-exceed ratios for FSA results across the 60 SDs (involving 366 designated schools), identified school quality, including curricula, teacher proficiency and qualifications, engagement strategies for students and parents that reflect evaluation options for students, and in-school facilities and teaching support materials as major influences. Their study identified several school boards with superior performance, notably, SD 67 Okanagan Skaha, where if the "negative peer effect could be eliminated, it would reduce the gap by nearly half (47.5%), [and] without any other changes in the forecast impact of socioeconomic conditions and in-school dynamics … two-thirds (66.6%) of the gap would be eliminated" (Richards et al., 2008, p. 12). Peer effects also suggested that a greater number of Aboriginal students in a school yielded lower MERs than those schools with fewer Aboriginal students. Successful SDs were those that demonstrated the most consistency and history across district leadership and coordination measures.

Summary

Indigenous students in BC — and indeed nationally and internationally — must bridge between different culturally based languages and the language of science upon which standardized science assessments are based. Atkinson (2010) argued that "current assessment measures only continue to reveal the embedded deficit ideology within the standards." (p. 445). The use of standardized science tests needs to be reassessed and replaced with authentic assessments of student knowledge, accomplished by adaptation of the classroom experience to become more community-based. Science education needs to connect with the communities of Indigenous students that it serves. Students' everyday lives are the entry point for a humanistic, constructivist approach to learning, as illustrated by the initiatives that are ongoing in SDs 62 and 67 in BC, communities are

now investing in the education of K–12 students as evidenced by the ongoing EAs being developed within all SDs that are signatories to these agreements. A commitment to the First Peoples Principles of Learning (see Appendix N) is a grounding, first step toward reforming curricular practices for the benefit of all students. BC school districts are becoming more focused on inclusivity and its benefit for the learning of all students and the potential benefit of society at large.

Chapter 5
The SEAS Community Initiative Project

This chapter provides a complete accounting of the second case study that addressed the concern identified in the first case study. The research design and context is discussed as contributors to the methodology of the SEAS community initiative, along with the study's strengths and weaknesses. The SEAS participants' transcribed data were analyzed to develop themes for a greater understanding of the dynamics of WMS and IKW (TEKW) that were taking place within Heiltsuk territories.

Case Study 2 — TEKW & WMS

Case Study 1 validated a persistent problem, where differences of 24% and 23% in Science 10 and Foundations of Mathematics 10 were shown between Aboriginal and non-Aboriginal students. Science 10 will be the final compulsory science course for many students, which will impact future enrolments in biology, chemistry, and physics. Aboriginal students who enrol in postsecondary education often choose non-science-related disciplines (Hogue, 2012), usually after completing their secondary education with only the single required science course (i.e., Science 10).

The BC MoE has identified the need to address Aboriginal achievement in science by including a means of integrating Aboriginal Knowledge into the K–7 and the 8–10 science curricula. Within each curriculum overview, there are two sections, first, Aboriginal Content in the Science Curriculum, followed by Working with the Aboriginal Community found under the heading of Considerations for Program Delivery. The integration of authentic Aboriginal content illustrates the ongoing efforts to address achievement and success among Aboriginal students. Examples from the K–7 science curriculum include the activities of Aboriginal peoples in BC in each seasonal cycle, how animals are important in the lives of Aboriginal peoples, the special significance of celestial objects for Aboriginal peoples, and how Aboriginal worldviews of the interconnectedness of the environment are reflected in resource stewardship (Gillies, 2005). However, there are no fully developed topic-specific activities to be used by teachers as they plan for science instruction, which makes the development and

implementation much more difficult for teachers of science, especially those with a generalist teaching background. In order to understand to what extent the integration of science concepts was being incorporated into Aboriginal communities, a special project or initiative was sought that would address the two worlds of WMS and IKW or TEKW as recommended in the science curriculum. This search identified several potential projects; after a significant investment of time, one project stood out.

Search for a Model Project

The search for a model project required a connectedness to land-based stewardship that would serve as an example that integrated WMS and technologies while responding to TEKW and other ways of knowing local natural phenomena. The model project selected involved a special partnership between the Qqs (Heiltsuk meaning *eyes*) Projects Society of the Heiltsuk First Nation at Waglisla/Bella Bella, BC and two NGOs (i.e., The Nature Conservancy and Pacific Wild). This partnership was manifested in the SEAS Community Initiative and took place on the traditional territory of the Heiltsuk First Nation. This part of the central BC coast has come to be known as The Great Bear Rainforest. The SEAS Initiative summer program was a five-year internship project that took place during the months of July and August beginning in 2010. Interns were drawn from the Heiltsuk First Nation to take part in field studies that incorporate WMS technologies and TEKW with participation from Heiltsuk First Nation Elders.

Methodology

Research Design

Case Study 2 is a descriptive case study that mixes quantitative and qualitative methods and allows the "boundaries between the phenomenon and context [that] may not be clearly evident" (Yin, 2014, p. 16) to be explored from multiple perspectives: a First Nation and two NGOs. The Qqs Projects Society (an independent group within the Heiltsuk First Nation), The Nature Conservancy, and Pacific Wild coordinated the project.

The case is the SEAS summer internship program where TEKW and WMS dynamically interact in place on traditional territory of the Heiltsuk First Nation. The

boundaries between TEKW and WMS are not clearly evident, therefore, the need to study and record the findings. Thus, the contextual boundaries amongst the players or agents (i.e., First Nation and NGOs) and the content domains (i.e., TEKW and WMS) needed clarification.

Intrinsic case study calls for the researcher's intent to focus on developing a better understanding of the case (Stake, 1995). The purpose is not to come to understand some abstract construct or generic phenomenon, nor to build theory; but it should reflect interest in a unique situation. The SEAS internship program is unique with its emphasis on the "interpretive and subjective dimensions … [and] it provides a unique example of real people in real situations, enabling readers to understand ideas more clearly than simply by presenting them with abstract theories or principles" (Cohen, Manion, & Morrison, 2000, p. 181). The real people are the SEAS interns as they engaged in the real situations of a closer examination of their territory that utilizes the field study technologies of WMS and the interaction of place-based TEKW within their territory of the Great Bear Rainforest. A case study is an empirical inquiry that naturally engages the boundaries between the phenomenon and the contexts that are not clearly evident (Yin, 2014).

The SEAS initiative presents a complex phenomenon. Human systems have an integrity to them that is indicative of the whole being greater than the sum of the parts. Over the three year (2010–2012) period of this study, complex interactions took place as the interns moved from a superficial understanding of their territory and culture to a more in-depth awareness and appreciation of them. The three-year study delved into the complexities of interactions within people, tradition, and events that are unique to this case study.

Context

Case Study 2 examines the complex interactions that take place at the confluence of WMS and TEKW within the territory of the Heiltsuk First Nation. This second part of a two-part doctoral study was designed to examine the remaining two research questions:
RQ 4. Can an exemplary culturally responsive science project that addresses the importance of culture enhance Aboriginal students' science learning in BC?

RQ 5. Can the lessons learned from the SEAS project be applied to a broader Canadian context that could promote student success in the sciences?

SEAS Partners

The following excerpts from The Nature Conservancy, Qqs Projects Society, and Pacific Wild websites serve to frame the SEAS initiative and how this partnership evolved to meet the stewardship needs of the Great Bear Rainforest and the youth who live there.

The Nature Conservancy (TNC)

The Nature Conservancy (TNC) is a global NGO institution that pursues "non-confrontational, pragmatic, market-based solutions to conservation challenges" (Nature Conservancy, 2015, About us/Our partners). (N.B. All quotations in this section are taken from various pages on the TNC's website: http://www.nature.org/index.htm.) This approach necessitates working collaboratively with other nonprofit organizations. TNC collaborates with Indigenous peoples, approximately 370 million worldwide, as a global priority to foster a shared commitment to environmental stewardship, recognizing that Indigenous peoples hold nearly 25% of lands and waters, globally representing 80% of the Earth's biodiversity. TNC, founded in 1951, is the world's leading conservation agency, dedicated to "protecting nature, for people today and future generations. The mission of TNC is to conserve the lands and waters upon which all life depends." (TNC, 2015, Vision-Mission). This mission is achieved through the dedicated efforts of a diverse staff that includes over 600 scientists, located in over 35 countries (Africa, Asia and the Pacific, Australia, Caribbean, Central America, Europe, North and South America) and the 50 states of the United States of America. Partnerships assisting in this effort include governments and local NGOs that utilize a nonconfrontational, collaborative approach that aligns with TNC's five core values: ethical and professional integrity beyond reproach; respect for people, communities, and cultures; commitment to diversity; one Conservancy, working together in local places and across borders; tangible and lasting results, using the best available science for solutions to complex conservation problems that will endure (TNC, 2015, Vision-Mission). An important initiative is the empowerment of Indigenous peoples throughout the world through recognition of their

human rights and their economic, spiritual, physical, and cultural well-being. TNC's Emerald Edge Program partners with Indigenous peoples, coastal communities, and local NGOs to facilitate transboundary conservation efforts in Alaska, BC, and Washington state. An important component of this work is increasing local leadership and authority over resource management and stewardship. In Canada's Great Bear Rainforest, for example, four First Nations communities are participating in the SEAS Community Initiative, a program that empowers young leaders to be stewards of their land.

Qqs Projects Society (Qqs)

Qqs Projects Society (Qqs) is an Heiltsuk First Nation NGO that supports youth, culture, and environment in their territory of the Great Bear Rainforest. The Heiltsuk cultural viewpoint is that "[I]n Heiltsuk culture it is essential that important business be conducted in public view, as at a potlatch or feast. … We accomplish our goals by working together with a broad range of like-minded people and organizations." (Qqs, 2014, para. 1 & 4). (N.B. All quotations in this section are taken from various pages on the Qqs website: http://www.qqsprojects.org/.)

The history of First Nations in the Great Bear Rainforest extends beyond human memory, with recent archeological evidence for present-day Heiltsuk settlements dating back to at least 12,000 years ago (Haggan, Turner, Carpenter, Jones, Mackie, & Menzies, 2004). Today, the Great Bear Rainforest region remains home to First Nations peoples whose histories, identities, and spirituality are one with the unceded lands and waters of the rainforest. The future of this ecologically unique region depends upon its future stewards, the youth of First Nations communities. It is from this perspective that the SEAS Community Initiative was conceptualized as a partnership between First Nations communities, TNC, and local nonprofit environmental organizations, such as Pacific Wild. The purpose of the initiative is to empower First Nation youth to become stewards of their land and natural resources by building educational capacity through hands-on field experiences that have the potential of leading to individual career goals in science. The programs within the five-year SEAS Initiative are developed by Aboriginal communities, for Aboriginal communities, that use local environmental knowledge, led by Elders to blend TEKW with WMS technological approaches.

The Qqs recognizes “a gap exists in the social framework of our community [that stems from] the challenges faced by First Nations schools in providing comprehensive math and science programs.” (Qqs, 2014, Projects). Their stated objective targets a need “to interest First Nations youth in science and health careers at an early enough age that they can take the necessary pre-requisite classes in high school.” In order to facilitate these objectives, Qqs’ role was to implement the SEAS summer internship program, whereby Heiltsuk youth can experience a place-based field study using science technologies within their home territory.

Permission to use the blogs written on the Qqs website was granted by J. Housty (personal communication, April 19, 2013). Ms Housty was the contact and informant check for feedback regarding the analysis of the SEAS blogs and vlogs. She has been involved in the SEAS summer educational camps and field operations in the Koeye River Watershed and in the establishment of a scientific field station, ecotourism operations, and youth camps. She has worked with the Raincoast Conservation Society as a field assistant in its first study of Sandhill cranes on the central BC coast and is also involved in ongoing research into the Great Bear Rainforest’s wolf population. Her strong interest in Heiltsuk culture and language has engaged youth and community in the practice and preservation and restoration of Heiltsuk language and ceremony. She is involved in learning and perpetuating the traditional practice of oral history and of preserving the bighouse protocol and Heiltsuk traditional laws (gvi’ilas).

Pacific Wild

Pacific Wild is an NGO that is focused on being a “conservation voice dedicated to ensuring that the Great Bear Rainforest remains one of the planet’s greatest cradles of biodiversity” (Pacific Wild, 2008, Great Bear LIVE). (N.B. All quotations in this section are taken from various pages on the Pacific Wild’s website: http://pacificwild.org/.) Pacific Wild’s founders, Karen McAllister and Ian McAllister, have been involved in wilderness and wildlife protection in the heart of the Great Bear Rainforest for over 20 years. The “Great Bear Live” button on their website cites their involvement with the SEAS Community Initiative as “an educational program focused on utilizing new technology, experiential learning, and locally-relevant resources to connect youth with

the lands and waters of their traditional territories" (Pacific Wild, 2008, SEAS community initiative), where ecology and conservation are brought to life to empower a new generation of stewards to engage, understand, and protect their home territories.

Pacific Wild, as a Qqs partner, publishes the summer internship blogs that are duplicates of the postings on the Qqs website. The Pacific Wild contact for the SEAS initiative was Diana Chan, SEAS Internship Coordinator (a second informant check for this case study). She helps bring wildlife cameras and hydrophones into the classrooms during the school year and coordinates the Bella Bella internship program during the summer. Diana, originally from Milwaukee, WI, first came to the central coast in 2007 for a conservation field school. She returned every summer but did not move to the West Coast of Canada until she completed undergraduate studies in biology and environmental studies at Carleton College and earned a certificate in GIS at the University of Wisconsin-Milwaukee (D. Chan, permission granted by personal communication, June 3, 2013).

SEAS Vision

For the purposes of this study, only these three partners were considered, with the realization that the SEAS Initiative is operative in other communities. Other SEAS partnerships include the Bella Bella Community School, Hartley Bay School, Gitga'at Land and Resources Stewardship Society, Cetacea Lab, and the American Museum of Natural History. However, the place-based summer program provided a greater opportunity to be out on the land and allowed for the interns to potentially gain from the experiences in their territory, the study areas of the BC outer central coast (Figure 6).

Figure 6. Outer central coast of British Columbia showing the study areas

Data Collection and Interpretation

Student experiences during their summer internships with the SEAS Community Initiative were accessed from their recorded entries into blogs and vlogs from July–August, 2010 to 2012. These blogs and vlogs were made available on the Qqs (2008)

website under *Projects* and *SEAS Internship*. The web and video logs were the starting point for the data collection and interpretation.

The vlogs and blogs were first transcribed in text files and then analyzed for their content. During 2010, the inception year, when this initiative was called The Virtual Rainforest Initiative, student experiences were recorded as interviews and video-weblogged on YouTube. The SEAS internships of 2011 and 2012 were recorded as blogs and augmented with the vlogs of the student experiences. Analysis of the web and video logs yielded identified themes that were then coded and analyzed. Themes that evolved from a YouTube video called Inspiring Citizen Scientists (5:20 minutes), where the SEAS program was first articulated by Ms Jessie Housty, served as the framework for theme identification. Figure 6 shows the study areas mentioned in the blog and vlog transcripts. These preliminary results denote the individual identities of the interns where letter designations were used along with the year of participation; for example, SI = SEAS Intern, M/F = male/female, and # = intern number from blog entry under to following years 2010, 2011, or 2012.

In order to situate the analysis of the SEAS Community Initiative data, consideration has been given for the following features (Herring, 2010, pp. 239, 243): discipline (sociology, communication, and linguistics); methodology (social network analysis, content analysis, and discourse analysis); and application to the Web (link analysis, theme/feature analysis, computer-mediated discourse analysis [CMDA]). Content analysis of these communications to reveal themes/features formed the basis of the data interpretation. However, in the wider view of Web computer analysis (WebCA), the faceted classification has been adapted to elucidate the faceted characteristics of medium and situation (Herring, 2007) to provide the reader with a clearer description of the SEAS blogs. This preliminary interpretation was followed by a theme analysis of the transcribed vlog and blog content. Content analysis (CA) provided the interpretive framework that sought “to analyze [the] data within a specific context in view of the meanings someone – a group or a culture – attributes to them” (Krippendorff, 1989, p. 403).

Study Strengths and Limitations

The strengths of this descriptive case study, which took place as a field study within Heiltsuk traditional territory, resides with the voices of the SEAS student interns as expressed in their blogs and vlogs. These recordings represent authentic first-hand accounts of the interns' experiences almost at the time that they took place. The results generated were shared with the two principle contacts (informant checks) responsible for developing and delivering the SEAS Internship Program. The informant checks asked for their feedback on the reporting and content of the results; sharing and feedback of the results was conducted by email between the author and Jessie Housty and Diana Chan of the two NGOs. This sharing-feedback cycle helped identify additions and corrections to the interpretation of the vlogs and blogs and contributed to the validity of the data and interpretations.

The limitations of this study resided primarily in the lack of face-to-face access to the SEAS interns for interviews and first-person informant checks. This limitation resulted from the research ethics application being negatively reviewed by the HIRMD. Such a reaction is not uncommon when an outsider is the primary researcher of a First Nations research project. This limitation could be ascribed to the lack of a culture broker who would have facilitated the negotiations between the researcher and the First Nations authorities. Furthermore, access to the SEAS co-ordinator at Bella Bella Community School, who is responsible for the classroom program initiatives throughout the school year, was not possible following HIRMD review. However, these limitations were partially addressed by being granted the use of the blogs on the Qqs website. Further limitations of CA used in the theme analysis are attributed to a commitment to scientific decision making (qualitative data to quantitative interpretations); a replicability requirement (ambiguity … analyst vs. material analyzed); and generalizability (not possible beyond the given data; Krippendorff, 1989, p. 404).

Validity and Reliability Concerns

Psychometrics, like validity and reliability, have historically been a quantitative research consideration; and they have received a mixed response from qualitative researchers, ranging from being incompatible, both epistemologically and ontologically,

to being worthy of consideration. These researchers hold that the consideration of qualitative data is better based on their plausibility, credibility, and trustworthiness (Johnson, 1997). The following strategies (in italics, Johnson, 1997, p. 283) were applied to this study, to promote qualitative validity and reliability:

- *"Low inference descriptors"* … SEAS intern blogs and related transcriptions pertaining to their experiences were the source of analysis, with limited revoicing and interpretations imposed by the researcher, of participants' voices.
- *"Investigator triangulation"* … Qqs and Pacific Wild leaders were asked for their collaboration with the analysis and reporting of the data and results; their feedback and suggestions served as informant checks since the interns were not available. Furthermore, their suggestions were acted upon to effect change in the results reporting where indicated.
- *"Participant feedback"* … Although the interns were not accessible for direct feedback, their project leaders were consulted as indicated above; and Eduardo Sousa, Greenpeace Canada, provided an outside participant validation on a site visit.
- *"Reflexivity"* … This involved personal critical self-reflection in order to avoid researcher bias and predisposition that would potentially affect the conclusions of this phase of the research. Eduardo Sousa also served as trusted other in the interpretation of the data.

These four strategies were enacted to address concern and the overarching focus on qualitative validity.

SEAS Data Overview

The SEAS Initiative data (blog and transcription entries) were analyzed based on content analysis and application to the Web CMDA, which can be quantitative (i.e., involving counting and coding) or qualitative, as it is used in this study (Herring, 2010). The faceted classification of Herring (2007) provides the reader with an overview of the SEAS blogs by utilizing the faceted characteristics of medium and situation. This was followed by a theme analysis of the transcribed vlog content and blogs.

Table 6 provides a description of the SEAS blog characteristics that enabled a quick snapshot of the three years of the internship from 2010 to 2012 with respect to the

medium and situation of CMDA and WebCA. There were 12 active participants of which 10 were 14 to 17-years-old. The interns' highest level of school science was unknown, but it was assumed to be Science 10 (minimum). Also, their level of IK was unknown. The key feature, participation, was the experiential learning taking place as the interns turned their attention to this field work, with a view of discovering the extent to which IK is involved in place as WMS technologies are used to document, explain, and understand natural phenomena. The medium categories refer to the asynchronous, one-way transmission of the blogs and vlogs posted by the interns.

Table 6

SEAS Blog Descriptions for Medium (M) and Situation (S); adapted from Herring (2007)

M1	Synchronicity = Asynchronous	S1	Participation structure	-One-to-many -Public -Open (no anonymity) -Group size = 12 active participants -Participation = individually determined
M2	Message transmission = One-way	S2	Participant characteristics	-Demographics = 5 female; 5 male students 14-17 years old -Preexisting knowledge = minimum Science 10; IK, unknown
M3	Persistence of transcript = at least 5 years	S3	Purpose	-To engage in Euro-western science techniques in traditional unceded territories
M4	Size of message buffer = limitless	S4	Topic	SEAS internship experiences
M5	Channels of communication = text and video	S5	Tone	Serious, informal, friendly, cooperative
M6	Anonymous messaging = none	S6	Activity	Information exchange, problem-solving, experiential learning
M7	Private messaging = none	S7	Norms	Fieldwork and experiential learning on the land
M8	Filtering = none	S8	Code	English and Heiltsuk
M9	Quoting = none			
M10	Message format = newest message on top			

Theme Identification

Ms Housty, Tribal Counsellor, Director of Traditional Ecological Knowledge at Qqs, in a video-recorded interview for www.smallchangefund.org called "Inspiring Citizen Scientists" (http://www.youtube.com/watch?v=NCpqw-mAfdY&feature=youtu.be) uploaded on June 13, 2011, spoke about the evolving SEAS Initiative Internship Program at Bella Bella. The following is an edited transcription of this vlog (critical ideas are in italics):

> What we want to do with the Internship Program is *inspire* young people, to *empower them* to give the sense that there are incredible tools at their disposal, to be *protecting the places they love*, to give them a greater sense of *connection to their territory*, to help them build a *stronger cultural identity* by reconnecting them to our land base and, to *encourage them to pursue careers in the sciences* that will enable them to come back to our community someday and take on *roles in our stewardship offices and resource management* and to really step up as leaders. … We don't want to be pandering to these young people, we want them to feel they are making legitimate contributions to the work we are doing, so we have a really *strong focus on training them to the same level as our field technicians* are working at, so they can really get a genuine experience of what it's like to be out in the field. … I think it's incredibly important when you live in a place like the Great Bear Rainforest, to have a *really strong traditional perspective* and a *really strong western scientific perspective* in your work. The two are really intertwined here, just given the incredible ecological richness of the coast and given how strong our way of life still is … to incorporate both into your work is really to take a *holistic perspective* on how it is to live here and how it is to exist with our environment and to *protect it and, to protect who we are as a people*. … There are places of unparalleled *ecological integrity*, the richness of the ecosystems here is absolutely incredible, but there is this really *strong, deep, cultural history here* as well, with all of the village sites up the river [Koeye, see Figure 6] and the artifacts that wash out of the banks and the canoe blanks the kids can find, and the stories that are located here; both here and on Goose Island [Figure 6]. It's just an *incredible meeting of two different worlds* that the kids are

> able to experience … you can really see in action, all the *ties between the ecology and the culture*, coming together into something really beautiful, it's a *really cool synergy*. … There is a really *strong sense of family* with the people who participate in our programs and the people who run them and I think it's really contributed to the success that we've seen with a lot of our participants, is that we're really invested in each other. … I think we'd love to see this grow; we'd love to see this *happening in other communities*. I think all the communities on the coast are doing really important work, in terms of *land management and stewardship*, and *protecting their cultural and natural resources* and finding a way to *share this model of engaging youth more broadly*, is going to be a really strong goal for us. We want to see everybody able to *engage youth in culture and nature* in really important ways.

The italicized phrases in the foregoing transcription have informed the identification of the 18 initial themes listed in Table 7.

Table 7

Inspiring Citizen Scientists — Theme Phrases

1.	Inspire
2.	Empower
3.	Protect place they love
4.	Connection to their territory (land base)
5.	Strengthen cultural Identity
6.	Encourage careers in science
7.	Future community roles/stewardship
8.	Science training to a high level/to the level of a field technician
9.	Holistic perspective
10.	Ecology of Great Bear Rainforest
11.	Ecological integrity / Rich ecosystem
12.	Strong, deep, cultural history … village sites (Koeye river) … artifacts, canoe blanks, stories located here and Goose Island
13.	Incredible meeting of two different worlds … ties between ecology and culture (a synergy)
14.	Strong sense of family among participants
15.	Land management and stewardship
16.	Protecting cultural and natural resources
17.	Finding ways to share this model of engaging youth (project goal)
18.	Engage youth in culture and nature

Theme Selection

In order to select appropriate themes for coding the blogs and vlogs, key words and phrases that were identified from the Inspiring Citizen Scientists video as 18 initial themes were then matched and consolidated to arrive at the main themes for identification and analysis of the interns' blogs and vlogs. This theme identification yielded six main themes (Table 8): Culture, a holistic perspective with a sense of place and the support of family; Protection of Culture (place); Engaging in Science (technologies); Recognition of Ecological Richness (place); Careers in Science; and Two Worlds Meeting (WMS and TEKW). The six identified main themes contain several of the initial theme phrases. For example, Culture is strongly represented by strengthen cultural identity (#5) and by strong deep cultural history (#12) but can be seen to contain elements of themes 9, 16, and 18 (Table 7). For each of the six main themes, corresponding initial theme phrases will have applicability, thereby rendering the examination of the interns' blogs and vlogs for the identification of themes more

quantifiable. Five theme phrases provide a more universal categorization into the main themes (i.e., themes 1 and 2 relate to the SEAS overall initiative and are coupled with themes 17 and 18, the project goals). Theme 14, strong sense of family among the participants (Table 7), could be interpreted as the strong cultural ties that each participant shares with the group as a whole.

Table 8

SEAS 18 Theme Phrases within 6 Main Themes

Main themes	Corresponding initial theme phrases
1. Culture	5 and 12; 9 and 16
2. Protection of culture	3 and 12; 5 and 16
3. Engaging in science	8; 7, 10, 11,15, and 16
4. Recognition of ecological richness	10 and 11; 3, 10, 11, and 15
5. Careers in science	6; 7, 8, and 15
6. Two worlds meeting	13 (synergy); 4, 5, 7, 8, 9, 10, 11, 12, 15, and 16
No theme identified	1, 2, 14, 17, and 18. Themes that have general applicability or are SEAS project, goal oriented.

These six themes were used to code the SEAS blogs to develop the SEAS Theme Perspectives (2010–2012). Blogs were also coded by gender, followed by a summary from the Greenpeace blog of Eduardo Sousa as a means of establishing outsider observer corroboration of the SEAS program for validity. It is recognized that interpretations may vary when placing theme phrases within each main theme. Twenty-two blog entries were coded for the identified themes from the 12 participants; results of the coding were repeated on three occasions as a numerical check and are summarized in Table 9. The highlighted sections of the blogs and vlogs are representative samples; not every entry used in Table 9 has been highlighted.

Table 9

SEAS Gender Frequency Theme Coding (2010–2012)

Gender	Culture	Protection of culture	Engaging in science	Recognition of ecological richness	Careers in science	Two worlds meeting
Male	1	0	20	2	1	2
Female	10	5	19	5	2	3
Total	11	5	39	7	3	5
%	15.7	7.1	55.8	10	4.3	7.1

2010 SEAS Data (initially known as Virtual Rainforest Initiative)

During the 2010 inaugural year, student voices were only recorded as vlogs because there were no blogs for that program year. Themes were identified (italics) from the interns' vlogs. There is an obvious sense of the interns being engaged in science and, additionally, the emergence — without obvious prompting — of cultural appreciation, whereby two worlds meet in a dynamic synergy.

Examples from YouTube video (vlogs) transcriptions

- SI#1F (SEAS Intern#1 Female): I applied for the "Virtual Rainforest Initiative" and it's [the Project] right up my alley, because *I'm going into Biology and Environmental Studies*. … We did rock cod surveys, deer pellet, and crab surveys. … I did a little booklet, like *a field guide for about 20 to 30 plants* on Koeye and Goose Islands. I took pictures of various plants that I studied and learned their *botanical names, their English names, and their Heiltsuk names* [and recorded] where you can find them, what plant properties they have [such as] leaves and berries, and their *cultural uses*. [Transcribed from http://www.youtube.com/watch?v=NCpqw-mAfdY&feature=youtu.be]
- SI#2M (SEAS Intern#2 Male): [My summer involved] working on whales and [I] learned different calls … different feeding calls, humpback whale calls and [I] actually heard them singing … [also] got to hear a few orcas. [I heard them] from the hydrophones set up around our territory … you have to dive to [position and] tie down the hydrophones. [I also] got some photo IDs of humpback whales and transient killer whales [and] identified them. [I was

surprised to see] a fin whale for the first time, [and to see] how big they are … [I] never knew we had them around here. *I could see myself doing this* [scientific survey work] *in the future*. [Transcribed from http://www.youtube.com/watch?v=G0tg5vCHRlo&feature=endscreen&NR=1]

- SI#1F: This summer we did so much … we got to see the sea lions on Goose Island, and we did a lot of fishing and hunting, set minnow traps and did studies of little fry fish … [we] got to do veg[etation] plots to see what kinds of plants were out there … [there was a medicinal] part to [the study, that involved] *devil's club and* [other] *medicinal plants*. I also got to learn how to clean devil's club and go *cedar bark picking*, which I've never done before. [I was surprised by] *how much we can utilize the land* … you can come out here and live, without going back to town. I've always been interested in this kind of work and *it's something* [that] *I want to do as a career* and now I have a sense of direction of where I want to go. [My advice to next year's interns is to] *be really appreciative of the opportunities* [that] being out here [provides]. [Transcribed from http://www.youtube.com/watch?v=Qq8F2jQDGXk]

2010 Intern Theme Coding

The interns' vlogs illustrated all six themes identified in Table 9 with a special emphasis on Careers in Science; however, the synergy of Two Worlds Meeting as cultural appreciation was clearly evident, particularly with SI#1F. Her creation of a field guide for local plants exhibited both a cultural and scientific perspective as she named the plants with botanical, common, and Heiltsuk names. Examples of the two main themes follow:

Examples of Careers in Science

- SI#1F: it's something [that] I want to do as a career and now I have a sense of direction.
- SI#2M: [I was surprised to see] a fin whale for the first time, [and to see] how big they are … [I] never knew we had them around here. I could see myself doing this [scientific survey work] in the future.

Example of Culture

- SI#1F: [there was a medicinal] part to [the study, that involved] devil's club and [other] medicinal plants. I also got to learn how to clean devil's club and go cedar bark picking, which I've never done before. [I was surprised by] how much we can utilize the land.

The interns' comments were cross-referenced with the SEAS Coordinator's vlog that articulated a very strong focus on the science-technology aspect of the summer experience for them. There was no cultural reference by the SEAS Coordinator, which suggests that the interns were already culturally attuned with their environment and its sense of place.

> SEAS Coordinator: I coordinated the Virtual Rainforest Initiative Internship from Bella Bella. I like being able to work with youth and get them interested in *natural resources and ecology*. When we were out at Koeye, we did *various science activities* and we'd go fishing and learn about salmon and their life history. We had some research people from Raincoast, who came and taught about *wolves and island-bound geography*. We went snorkeling and set minnow traps to study juvenile salmon fry. We went to the estuary [of Koeye River] and learned about plants and their traditional uses. At *Goose Island*, the 10 day camp, we did *all field work*; deer pellet surveys, rock cod surveys, forest cover ground-truthing, and shoreline ground-truthing. [Leadership skills were exhibited by several of the interns, but one in particular stood out]. [Transcribed from http://www.youtube.com/watch?v=XlbboluBGbI]

The vlog phrases highlighted represent a strong focus on science-related technologies. To summarize, in Year 1 all six main themes were represented, identified, and tabulated (Table 9) to capture the perceptions of the SEAS interns in Heiltsuk territory.

2011 SEAS Data

The coding of Year 2 data sources revealed a similar pattern to the one established in 2010. All six main themes were articulated by the interns and identified; although the stronger references to careers in science expressed in Year 1 were not as evident, they

were present nonetheless. The overriding theme for this group of interns was their engagement in science and related technologies.

Examples from vlogs

- SI#3F: This job has pretty much made a 360 of what I see on a daily basis in Bella Bella, and it *made me respect the animals and the nature* around us … because, *if we lose this* then there is really nothing that we have left.
- SI#4M: Before I even came out here, *I didn't even understand this territory* and all the animals in it and just how beautiful it really is. I just love this place; *it's changed everything*.
- SI#5F: *I've seen* killer whales, sea lions, deer, and I've seen one wolf.
- SI#6M: [We've done] deer pellet *surveys*, cod surveys, bug snares …
- SI#4M: It's amazing, you're surrounded by the forest, mountains, *you get to see and do stuff that you didn't even think you'd be able to do* … this is amazing!
- In one of the last remaining coastal temperate rainforests left on Earth, the SEAS Community Initiative is empowering First Nations youth with nature-based classroom plans and activities, field research initiatives and mentorship with community elders. [Transcribed from http://www.youtube.com/watch?v=TMNPEq3wsH4]

Examples from blogs

- Qqs Coordinator: We are wrapping up our second camp of the 2011 season: Biodiversity Camp! We were joined by Katrina and Abe from Hakai Beach Institute who have been working with our staff and campers [interns] throughout the week to learn about and *celebrate the incredible biodiversity of the Koeye River Watershed* (posted July 15, 2011).
- SI#6M: I really enjoyed getting back out there this week and settling back in. We spent a lot of time *setting and collecting insect traps*. Aside from the bug traps being smelly, *I enjoyed getting them*. It was fun picking out the live insects one by one.

- SI#4M: I was *super stoked to get back to Goose* this week. I have no complaints. Everything we're doin' is hella fun. Well sure the bug traps baited with rotten meat were a little smelly and the sea lions didn't exactly smell like roses – I didn't care.
- SI#3F: We just got back from our third week out at Goose Island, and *so far I think it can't get any better*. There are many parts that I enjoy, but the best part is either hiking through the forest looking for deer pellets or going fishing and taking mussel samples.
- SI#4M: Just about to start week 6 in the *Goose Island internship and it only feels like it's been 2 weeks* since we've started. *It's been one heck of an experience*. We've been doing lots of work all over Goose Island finding out a lot about the plants and …

The 2011 interns were engaging in science to the point of being immersed in their tasks and losing track of time, an important recognition of this engagement. Other themes identified were protection of Culture and Recognition of Ecological Richness. Examples of these three themes are described by each respective intern.

Example of Protection of Culture (place)

> SI#3F: This job has pretty much made a 360 of what I see on a daily basis in Bella Bella, and it made me respect the animals and the nature around us … because, if we lose this then there is really nothing that we have left.

Example of Engaging in Science

> SI#6M: [We've done] deer pellet surveys, cod surveys, bug snares …

Example of Recognition of Ecological Richness

> SI#4M: Before I even came out here, I didn't even understand this territory and all the animals in it and just how beautiful it really is. I just love this place, it's changed everything.

2012 SEAS Data

Year 3 of the SEAS Community Initiative witnessed engagement in science but on a different level, where grizzly bear sightings and close proximity to the group heightened their overall experience. As with the previous two years, it was evident that the 2012 interns were surprised by how much they enjoyed the science-technology interaction as they sampled the environment. The following highlighted blogs capture their reactions.

Examples from blogs

- SI#7M: We *caught ten fish* that day and eight of them had *stomach samples to collect*. After that we went up river to see if there was a stream to survey in the future. We were checking it out to see if it was survey-able. On the way back to the lodge we were going down the river and we saw a *grizzly bear just past the grass flats*. We were roughly *25 feet away from it*.
- SI#8F: Wednesday was the day *we went to Namu*. We left early in the morning at about 9:00am. *I thought it wouldn't be much fun to catch and tag fish, but I thought wrong*. On the first set we caught two fish, which was exciting at the time. As soon as they were tagged, we let them go. It was also a *fun experience trying to catch fish in a seine net*. Everybody would be in hip waders or shorts in the water pulling in the net. Some things were challenging, but after one or two sets I got the hang of things. *I liked that we went to Namu* to do the tagging because it was fascinating but *also eerie to see all the old buildings there*; some collapsed in, some half intact. Overall, it was hard work but enjoyable. *I am looking forward to the coming weeks* of working at Koeye and surrounding areas.
- SI#9F: Well my week went something like this: *it was busy, fun and awesome*. Day 2 was busy. We went to set *some g-traps up river* two times in two places. We actually caught a lot of fish this time: Chinook and coho fry. Then as we were coming back to camp we saw a bear. That day *was pretty awesome*. And the last day of the week is always fun watching the kids from camp dance in the big house.

- SI#s 7, 8, 9, 10, 11, 12 (group blog): During this week *we went to Namu* twice to do seining. *We caught 82 fish* in total during the two days. We caught fish in every set this week*, something that has never happened before*. SI#8F12 tagged her first fish and so did SI#7M. This week the water was the coldest it has ever been since it was raining the first day. The tide came up much higher than usual and everyone got soaked that first day, even the people in waders. While we were waiting for the fish to jump so we could close the net, SI#8F *found an old spear head below the old restaurant*. It's hard to believe she could find something like that on the beach.
- SI#8F: This was the last week of Kvai (Koeye) camp for the kids this summer. It was a busy week, I'm sad that the kids won't be around for another two weeks. *Friday was feast day; 82 people came out here from the village. It was amazing*. The kids were practicing all week to show the community members what they learn while they're out here and the kids have learned a lot. After the first part of the ceremonies was performed, *some people stood up and made speeches*; one of the elders from Bella Bella got up and spoke in Heiltsuk to William Housty. *Her whole speech was in Heiltsuk. It was pretty amazing to hear because I haven't heard anyone speak of lot of Heiltsuk like that in a long time*. Hearing her talk *inspired me to learn my Heiltsuk language. I want to be able to fluently speak it*. In the next couple years I want to take the time to learn.
- SI#9F: We tagged 15 fish in Namu this week. The water was both cold and warm depending on where we were. We went up to the river and I fell in when I was trying to get in slowly. It was very, very cold at the bottom. I snorkeled for a couple minutes before we left, but I didn't see any fish though, just rocks. It was my *first time snorkeling this summer. I liked it*. It reminded me of when I was a kid. I'm excited to go back to Namu next week. Hopefully we'll get more fish so we can get to our goal of tagging 200 sockeye.
- SI#10M: One day we were supposed to go up river and talk about bear snares but the tide was too low and we couldn't make it up river so we ended up just *spotting a grizzly and just bear watching for about 20 minutes* or so. Then all

of the sudden this helicopter came out of nowhere and scared the bear, it ran into the woods. About five minutes later it came back out to the same spot and it slowly walked the beach going up river. That was pretty sweet. *Closest I've been to a bear in a long time*.

Another day we went to Namu to do some seining. Only had to do one set and we had the *biggest set we ever got*! We tagged sixty-three sockeye and coho. And we must have caught about 75 or 80 easy. One point I was in the water watching the net and I saw a lot of fish getting out because the lead line was being dragged over rocks and they'd slip under. After that we kind of just had a fun afternoon. We went swimming around and snorkeling, we were jumping off the floats at Namu and we have a couple funny videos of the crew jumping in.

- SI#12M: What can I say about the last week out at Kvai? Well first of all, we were *supposed to go up the river to check out the bear snares*… but the river was too shallow and we couldn't make it, *which was heartbreaking kinda*. We did see a juvenile bear not too long after though, so it was all good. We watched it for 15 to 20 minutes walking on the beach … eating grass, doing bear stuff. *Was pretty awesome*!

  Tuesday, we went to Namu which was okay. We only tagged 22, but the second day out there was pretty crazy, 63 FISH!!! … In one set, not even joking! It was pretty epic, it took us all morning to finish, another crazy-awesome summer with SEAS.

The interns all reflected on the importance of going to Namu, perhaps knowing that Heiltsuk people have inhabited the central coast for thousands of years, and the awe at finding an old spear head by an intern. This same intern described the experience as "eerie" but also "fascinating" with the old buildings in a state of disrepair; she was inspired by hearing her Heiltsuk language spoken at great length, to the point that it inspired her to say "I want to be able to fluently speak it." Her reaction is at the root of cultural transmission of knowledge, which is undoubtedly a motivation for her to do so. This Year 3 group of SEAS interns captured the synergy of the scientific-technical challenges (WMS) that aligned with TEKW within their territory in a Two Worlds

Meeting framework. There is a sense of this energy communicated in their blogs. This final main theme example captures synergy when considered with the entire blog commentaries. These citizen scientists have been inspired, reflecting the words of the Director of Ecological Knowledge: "it's just an incredible meeting of two different worlds that the kids are able to experience … you can really see in action, all the ties between the ecology [WMS] and the culture [TEKW], coming together into something really beautiful, it's a really cool synergy."

Example of Two Worlds Meeting

> SI#s 7, 8, 9, 10, 11, 12 (group blog): During this week we went to Namu twice to do seining. We caught 82 fish in total during the two days. While we were waiting for the fish to jump so we could close the net, SI#8F found an old spear head below the old restaurant. It's hard to believe she could find something like that on the beach.

Addressing Qualitative Validity

The SEAS interns were not accessible for direct contact by the researcher; however, Eduardo Sousa of Greenpeace Canada provided outside observer–participant validation resulting from his onsite visit. His observer blog is highlighted (using underlining) in the same manner as the SEAS intern blogs to identify with the main themes developed and identified for Table 9.

> Qqs Coordinator: Our sixth camp, Baxvala Camp, was run with support from our friends and colleagues at Greenpeace Canada. We were fortunate to have Greenpeace's Eduardo Sousa join us in Koeye for Baxvala Camp; and below, he shares his reflections on his time with us in Koeye. We raise our hands in gratitude to Eduardo and to Greenpeace Canada for their ongoing support of our programs! [August 22, 2011]
>
> *BLOG FOR QQS: Baxvala and Biodiversity*, Eduardo Sousa
>
> I recently had the privilege of spending a week in the Koeye River Watershed in Heiltsuk traditional territory. More specifically, I spent a week witnessing the last of six youth camps for 2011 organized by Qqs Projects Society.

Over the past few years, Greenpeace Canada has had the pleasure of supporting individual Qqs youth camps, which intertwine cultural and environmental stewardship themes. This year, Greenpeace provided support to the last camp of the season, Baxvala Camp, which explored what a sustainable relationship with Heiltsuk traditional territory and its resources looks like. Baxvala means to harvest food in a traditional (sustainable) way.

Since beginning my work at Greenpeace Canada as a senior forest campaigner on the Great Bear Rainforest, I have often heard through different circles of the innovative work Qqs has been doing on the ground in instilling a sense of stewardship over the lands and waters amongst the youth – but in a way that reinforces their sense of what it means to be Heiltsuk.

Over the course of the week, children ranging in age from 9 to 15 worked with elders and camp staff (themselves a great group of young Heiltsuk leaders) to harvest traditional foods and medicines, all the while learning about western science-based approaches to understanding ecosystems, biodiversity and stewardship. An important component to this work was deepening an understanding of environmental ethics from a Heiltsuk perspective.

Being in the natural setting of the Koeye, with its deep cultural history and rich variety of flora and fauna, reinforces the meaning of stewardship and what it is to value the forces that give life to the land and people.

One of the more memorable experiences for me came as I walked through old growth forest teeming with life, where the Koeye River enters the ocean. In the midst of moss and lichen hanging from old cedar trees, nestled in the dense forest was a small group of the campers playing a game: with ribbons tied between trees in a web-like pattern, one child stood in the middle, touching the various strands. They were learning about the web of life and how we are all connected, both to one another and to life-sustaining forces. More importantly, they were doing so in a place that exudes that sense of life force.

At times the youth camps coincide with family camps that take place at the nearby Koeye Lodge, and this particular week was such a coincidence. Taking advantage

of the overlap, over the course of a few mornings, elders from the family camp also taught the Koeye campers about their language. I quite enjoyed listening to the lessons, while Heiltsuk traditional songs played in the background. And in fact this is a key component of the camps – the kids have to leave their iPods, MP3 players, etc. behind – the only songs and music played are those that are traditionally Heiltsuk.

I was also able to learn much myself as I was taken up Koeye River to learn about medicinal plants – in fact I was very fortunate in learning hands-on about traditional plant medicines found in older, mature forests by assisting in harvesting and preparing devil's club and false hellebore. I was also taught what signs to look for to get a sense of if and when bears have passed through an area, and indeed we spotted a large grizzly bear not too far from our canoe.

The week was also memorable for me for two other significant reasons. First, it was the very same week that a ground-breaking article appeared on the website of Scientific American marking the important grizzly bear DNA-based research that Coastwatch, Qqs' research and monitoring arm, has been doing alongside Raincoast Conservation Foundation – a collaboration that brings together Heiltsuk and western science. There was quite a buzz around the lodge with the release of the article and its findings; you can read it (along with a series of interesting blogs delving deeper into the research) here.

But perhaps most memorable for me was the final day of the Baxvala Camp. The last day of these week-long camps always culminates in a Feast Day in which youth, who have been also learning (or refreshing their knowledge of) their traditional dances and songs, come together in the Bighouse to celebrate and reinforce their culture and identity. The Feast is open to the Heiltsuk community, so members from Bella Bella come in by boat and spend the day witnessing and participating in the dances and songs that are central to their cultural identity. It is deeply symbolic and moving to me to watch cultural values and traditions carry through the youth, but in a way that is very rooted in the present.

> Over the past couple of years, as I have continued my own work with Greenpeace, with First Nations on the coast, and with the land and water, I have become aware of the importance of being grateful for the opportunities I have been given. I am grateful to Qqs and the Heiltsuk for welcoming me and allowing me to walk among them to witness powerful cultural and ecological forces at work.
>
> Along with gratitude, I have also come to fully value the profound interrelationship between cultural diversity and biodiversity – both are interconnected, mutually supportive, and in witnessing what is taking place through Qqs initiatives like the youth camps, that bond becomes ever so apparent. [Permission granted by Eduardo Sousa, November 21, 2013, see Appendix J)

Eduardo Sousa's blog provides validation to the SEAS vlogs and blogs and to the interpretations that have been developed from them in the form of the six main themes. The connections between Two Worlds Meeting is exemplified with commentary concerning Baxvala (harvest[ing] traditional foods and medicines), "while learning about western science-based approaches to understanding ecosystems, biodiversity and stewardship." There is strong evidence throughout his blog, the SEAS interns' vlogs and blogs, and the Director's vision for the SEAS Internship that WMS and TEKW are working together in a dynamic synergy that is engaging and beneficial to the interns and to engendering a strong statement of stewardship within their home territory. The one theme that was not addressed directly but could be implied from Sousa's blog is Careers in Science; all remaining five main themes can be identified in the highlighted phrases of Baxvala and Biodiversity.

SEAS Theme Analysis

Due to the nature of the SEAS Initiative and the themes identified, it is not surprising to find that 56% of the coded responses identified Engaging in Science since the internship was science-based and field-oriented activities. However, Culture and Protection of Culture garnered 23% of the responses. This is a strong indicator of the importance of cultural recognition in the learning experiences of Heiltsuk youth and most likely all FNMI youth. The indicator of cultural recognition reaches 30% when Two

Worlds Meeting is included with Culture and Protection of Culture. These three themes have been identified in the words of Heiltsuk Elders Angela Mason and Frank Brown and verified by outside observations of Eduardo Sousa. Their contributions strongly align with the importance that culture represents in the SEAS initiative.

A number of students were inspired by their science work in the field as represented by tallies for the Recognition of Ecological Richness theme (10%). When this result is coupled with Engaging in Science, over 65% of the codes were accounted for. However, only 4% of the coded evidence was associated with Careers in Science. This result does not appear significant; however, to have an interest in a science career is a great leap for any student, particularly at the age group represented here (15–17 years old). The SEAS experience was transformational for many interns, which can be observed in their blog commentaries. At the very least, the SEAS internship was an extremely positive experience as the students learned new science technologies in their home territory.

SEAS Engaging in Science

An examination of Table 9 reveals that 60% of the blog theme entries by the SEAS interns involved science either directly or as a career in science. During their blogs, the SEAS interns made the following science and technology references.

- Surveys for Rock cod, deer pellets, crabs, plants, intertidal zone organisms, and marine mammal surveys of sea lions, seals, sea otters, and whales (e.g., humpback, orca, and fin)
- Local whale population data recording for whale calls related to feeding; whale calls for communication among species; whale call identification for humpback, orca, and fin whales; photo identification of whales; underwater sound recordings using hydrophone technologies
- Sea lion colony for numbers and location, particularly on Goose Island
- Plant identification for cataloguing local plants and notations on medicinal plants for traditional uses
- Insect identification using insect traps of various kinds (unknown to the author)
- Salmon life histories, involving stream studies of minnows using minnow traps (g-trap), seine netting for fish habitat identification, and snorkeling to observe the natural

habitats and stream locations of various fish species in conjunction with stream morphology measurements; tagging coho and sockeye salmon that were counted by researchers later in the fall but very dependent upon the efforts of the summer interns

- Wolf population studies using the benefits of field camera locations coupled with field observations
- Ground-truthing for establishing the extent of forest ground cover and shoreline extent. Marine mammal and rock fish data were recorded using geographic information system technology

Ground-truthing involves the performance of surface observations, measurements, and identification of features, on site, with ground resolution digital imagery using global positioning system technology and comparing both of these in order to extrapolate the features over a wider range of observations. In that way, observations over a range, say 1 m^2, can be applied to a larger area, say 100 m^2, to gain an overall idea of the number of plant species or shoreline attributes occupying a given area of study. The g-traps, mentioned by the interns, are known as Gees G-40 minnow traps; they effectively allow the minnows to enter one end of the trap but prevent them from exiting. The rigor of the science approaches engaged during the SEAS initiative field experiences, and observed here from 2010–2012 in the interns' blogs, is a real testimony to the point made about training the interns to the level of a field technician. This rigor, in the home territory of the interns, was met with great enthusiasm and engagement.

The SEAS initiative taken by the Heiltsuk First Nation whereby WMS is introduced in place at Waglisla with Indigenous youth on an internship program suggests that a culturally responsive approach can create new educational journeys for First Nations' youth. Thus, a future of environmental involvement among the youth of Waglisla may serve as a model for future generations of Indigenous youth in BC that will spread and impact other Indigenous communities.

The SEAS Initiative represents an effective project that could be incorporated by other Aboriginal communities with each community identifying what will work best for them. As a guideline, the Te Kotahitanga Project (described in Chapter 2) has been successfully applied in Aotearoa such that their procedural approach could inform development of innovative, culturally responsive educational programs in Canada.

Case Study 2 Summary

This case study has shown the connection with culture that exists among the Heiltsuk First Nation SEAS interns as they were immersed in relevant place-based science technologies in their home territory. Even with the daily presence of a new technique, whether they were engaged in shoreline ground-truthing or listening to orcas communicating on hydrophones, there was still the impact of the study in place that holds meaning — whether or not the interns themselves were aware of this as implicit border crossing. The dynamic interactions between WMS and TEKW that have evolved with the SEAS initiative have a level of complexity that is not immediately evident, due in large part to the relative ease that the interns negotiated "a dialogic space … that engages students in co-constructing an understanding of science that incorporates their cultural knowledge and the way of living within their community" (McKinley & Gan, 2014, p. 288). This dialogic, or third, space is described by some researchers as a means to bring together school science (first space) with home and culture (second space) to create a "form of hybrid knowledge" (McKinley & Gan, 2014, p. 288). The second space of home and culture (family) can be viewed as an organic system with boundaries and patterns that change in complicated ways. Much the same as the first space, in this case, the SEAS internship incorporating school science has a set of boundaries and patterns that also changes in complex ways. The experiences of the SEAS interns over the course of three summers can be viewed as a complex adaptive system that is best described with the lens of complexity theory. This complex adaptive system involves the following; the TEKW and WMS dichotomy, science literacy, STEM careers, and culturally responsive schooling. The first of these, IKW-WMS, pertains to the two worlds meeting and movement between these two worlds.

TEKW and WMS Knowledge Systems

Border crossing, or bridge building, between the TEKW and WMS knowledge systems has received a great deal of attention in the literature (Abrams et al., 2014; Aikenhead, 2006; McKinley, 2007; McKinley & Gan, 2014; McKinley & Stewart, 2012; Snively & Williams, 2008; Yore et al., 2014). An example of this was apparent in Year 1: SI#1F shared her creation of a field guide for 20 to 30 plants where she had recorded

their botanical names, English names, and their Heiltsuk names along with plant properties that included their cultural uses. She was engaged in authentic IKW, allowing her to seamlessly cross between TEKW and WMS where, on her initiation, she was referencing IKW and WMS knowledge systems in her field guide. This was due, in part, to her place-based engagement as she observed and recorded her findings. She offered some cultural connectivity in her description of a medicinal plant (i.e., the devil's club), how to clean it, and her recognition of the importance of cedar bark picking and the meaning it holds for First Nations on the BC coast. In Year 2, SI#3F reflected on her experience that has "pretty much made a 360 of what I see on a daily basis in Bella Bella, and it made me respect the animals and the nature around us." Another intern (SI#4M) commented that "before I even came out here, I didn't even understand this territory and all the animals in it and just how beautiful it really is … I just love this place, it's changed everything." These two students had a sense of awakening to the ecological and cultural richness that is present in their home territory. The way they view their world has been changed, probably because they have become engaged with it as TEKW and WMS interest to provide a very different perspective for them. The combined codes (Table 9) of ecology and culture, ecological richness, and two worlds meeting indicate the strong potential prior knowledge and ways of knowing that these students would bring to formal classroom science instruction.

The SEAS Theme Coding (Table 9) illustrates that approximately 60% can be identified as having an association with WMS and technology and that the remaining themes can be identified with culture and ecology, aligned with TEKW, and would include the interaction of WMS and TEKW in two worlds meeting. The result is a close balance between the two worldviews of WMS and TEKW. When one considers the teaching and learning of Indigenous students in science classrooms, there is a need to recognize the differing epistemological and ontological tenets of TEKW and WMS (Snively & Williams, 2008; Yore, 2008), coupled with a need to recognize the nature of Indigenous learners and the possible colonizing influence of schooling (Battiste, 2013). In this case study, the structure of the science classroom was replaced by the openness of fieldwork that apparently has been met with favour and enthusiasm by all the SEAS

interns for the three years of this study. Jessie Housty clearly linked both TEKW and WMS knowledge systems when she stated:

> I think it's incredibly important when you live in a place like the Great Bear Rainforest, to have a really strong traditional perspective and a really strong western scientific perspective in your work. The two are really intertwined here, just given the incredible ecological richness of the coast and given how strong our way of life is … to incorporate both into your work is really to take a holistic perspective on how it is to live here and how it is to exist with our environment and to protect it and, to protect who we are as a people. [Transcribed from "Inspiring Citizen Scientists"]

The results from the SEAS Community Initiative support her vision for the student interns of this project, enabling them to continually cross borders between the two knowledge systems. The observation that TEKW and WMS operated in a co-equal manner was validated by outside observer Eduardo Sousa:

> Over the course of the week, children ranging in age from 9 to 15 worked with elders and camp staff to harvest traditional foods and medicines, all the while learning about western science-based approaches to understanding ecosystems, biodiversity and stewardship. An important component to this work was deepening an understanding of environmental ethics from a Heiltsuk perspective.

The uniqueness of this field study result begs the question concerning the decades-old TEKW-WMS debate and the suggestions of integrating TEKW into the WMS school curriculum. Developing a co-equal, parallel curriculum is indeed achievable and should be pursued in BC schools. That is not to say that some school districts are not already doing this with the various EAs in place. But, here, without an EA, Aboriginal interest and success was evident, with one student (SI#1F) proceeding to tertiary studies in science. Abrams et al. (2014) recognized that "the recruitment of indigenous researchers also makes possible the development of place-based indigenous research methodologies and practices that fully reflect the sociopolitical and sociocultural perspectives" (p. 690). Before this can be fully appreciated, it is necessary to examine the fit of TEKW and WMS with a brief comparison.

IKW and WMS Comparisons

Dichotomous comparisons should be approached with a measure of caution; hidden Euro-centric assumptions about Indigenous knowledge systems can often undermine what can be gained by making comparisons in order to come to a greater understanding of the dynamic and changing relationships that exist when these two worldviews are considered. Aikenhead (2006) stated:

> Indigenous sciences (IKW) are guided by the fact that the physical universe is *mysterious* but can be survived if one uses *rational empirical means*. Western science (WMS) is guided by the fact that the physical universe is *knowable* through *rational empirical means*. [emphasis added] (p. 113)

Both IKW and WMS are guided by ontological features, and both knowledge systems rely on empirical evidence from field studies and experimentation. IKW can take place over many generations, relying on natural changes to occur and be observed. These place-based IKW claims are dynamic since they are verified over time by revisiting the place and are revised by the designated knowledge keepers (Snively & Williams, 2008). The epistemic quality of these observations and interpretations are not much different from those of western scientists but with less reliance on modern technologies. Rational ways of knowing are employed by both IKW and WMS, but the ontological nature of their explanations are seen to be different. Aikenhead (2006) proposed a number of dichotomous comparisons and their respective cultural underpinnings; for example, social goals, in which IKW knowledge is applied for survival and harmony with nature versus WMS knowledge for economic gain and power over nature; intellectual goals, where IKW embodies the mystery and celebration of nature versus eschewing mystery by western scientists, in favour of explaining nature; and with IKW perspectives that are holistic, accommodating, intuitive, and imbued with spiritual wisdom versus WMS that is reductionist and mechanistic in explanations of natural phenomena. Science is viewed as inquiry by WMS and technology, as design, to modify the environment to meet peoples' needs or alleviate problems. There is no differentiation between science and technology for IKW that holds a technoscience view as an integrated whole and not serving the needs of humans (Abrams et al., 2014). Battiste (2013) reminds us that "while Indigenous knowledge (IKW) is as encompassing as Eurocentric knowledge (WMS), the science of

the Indigenous worldview is founded upon an understanding of how humanity fits with nature." (p. 121). IKW is a dynamic, living process that embodies a holistic view of the world, a view in which all human, animal, and plant life are connected and interdependent, not a collection of observations, facts, and measurements. When comparing IKW to WMS, theoretical physicist David Peat (2005) noted:

> Indigenous science does not seek to found its knowledge, as we do, at the level of some most ultimate elementary particle or theory, rather it is a science of harmony and compassion, of dream and vision, of earth and cosmos, of hunting and growing, of technology and spirit, of song and dance, of color and number, of cycle and balance, of death and renewal. (p. 8)

Science educators in Alaska shared their experience with the Yupiaq peoples of southwestern Alaska who practice IKW in ways that are similar to, as well as different from, WMS; the worldview that underpins their vision of science has valuable implications for science instruction (Kawagley et al., 1998). Furthermore, IKW hold valuable implications for the development of western science itself (Cajete, 2000).

Abrams et al. (2014) discussed a number of solutions for incorporating IKW and WMS into science classrooms, from not including it altogether (assimilationist view) to "develop [ing] co-equal interpretations of IKW and WMS as multiple views of sciences and knowledge about nature and naturally occurring events." (p. 672). Perhaps this case study has shown that this latter course of co-equal interpretations has practical applications that are naturally present in this research. However, as Abrams et al. (2014) have cautioned, resolution of the issues of Indigenous engagement and achievement will likely be "context specific [with consideration of its] sociopolitical and sociocultural dimensions that would include cultural preservation, linguistic restoration, equity, social justice, economic prosperity, and identity as well as the content, pedagogical, and assessment dimensions normally considered in educational reforms." (p. 672).

Looking forward, there is good reason for optimism for a co-equal application of TEKW and WMS, as illustrated in this study that could have application in science classrooms. Recognition that this project operated at a technology-as-design level and served as an effective bridge between TEKW and WMS and trust was inherent as a result of being place-based within the Heiltsuk traditional territory. WMS approaches should be

avoided in favour of a technological-humanistic approach espoused by constructivist methodologies in order to facilitate two-way border crossings that are culturally responsive (Abrams et al., 2014; Aikenhead, 2006; Battiste, 2013; Chinn, Hand, & Yore, 2008).

Chapter 6
Discussion of Results, Summary, and Conclusions

The results generated from these case studies will be discussed as follows: First, quantitative results from Chapter 4, Case Study 1 — Archival; second, qualitative results from Chapter 5, Case Study 2 — TEKW & WMS; the final part attempts to integrate these case study results by examining the overall outcome and the importance of cultural responsiveness. Third, a consideration of the Te Kotahitanga Māori model for teaching and learning that offers a possible strategy for connecting culture with culturally responsive schooling.

Case Study 1 — Archival (Quantitative Results)

There are patterns that present from this case study and reside with the successes that are emerging from the Aboriginal Education Enhancement Agreement Reports. It is encouraging to see the achievement profiles among school districts that are developing strong EAs; for example, Sooke (SD 62), with a yearly increase of 22% (C+ or better) in Science 10. Okanagan-Skaha (SD 67) has developed their Cultural Awareness Programs from pull-out presentations for Aboriginal students exclusively to an all-inclusive program, whose aim is to raise cultural understandings for all students. These examples point to the strengths of the EA program within each community and how it impacts student achievement when the community is partnered and included in the planning of these educational initiatives.

The BC MoE's mandate to publish annual reports that chart the achievement of all students and all school districts is unique in Canada; it is an example for other provinces and territories to aspire toward. It is through consistent reporting of student achievement that improvements can be discussed and acted upon. The concern for educational achievement is evident from the BC Government website and is strengthened by historical documents such as the signing of the *Memorandum of Understanding* in 1999, to address the need to improve school success for Aboriginal learners, which will need to be a long-term effort. There can be impatience with the outcomes from such a move forward; however, it is beginning to have a measureable effect as EA reports across the

province are being developed and acted upon, thereby strengthening the communities involved. Clearly, border crossings are taking place and the students are benefiting. Finally, after more than a decade of reporting achievement and highlighting deficits of Aboriginal students, there appears to be a change in favour of reducing or moving toward the elimination of the achievement gap, resulting in a more equitable education for all students.

Case Study 2 — TEKW & WMS (Qualitative Results)

The overall pattern that emerged from this case study resides in the interactions that occurred for the SEAS interns when WMS and TEKW were embedded in authentic place-based experiences. The interns were engaged with field-based scientific research that had a technological basis and became excited by the possibilities that they encountered when viewing their home territory through the technoscientific lens of WMS. It is not surprising that their engagement with the technological aspect of science led to an overarching perspective that supported this theme. However, Culture, although not stressed by the program coordinators, was seen to weave its way through the experience — as evidenced by the intern who was very excited at finding a spear point at Namu and the group sharing this excitement. The Recognition of Ecological Richness theme identified a cultural basis for the SEAS interns; if it is included with the other cultural marker themes, then approximately 40% of the themes reflected a cultural basis or TEKW. An approximate balance was achieved probably as a result of this initiative occurring in place on Heiltsuk territorial lands. Overall, the SEAS intern voices reflected a dynamic interplay between TEKW and WMS that witnessed several students desiring to continue the scientific stewardship within their territorial lands.

Outcomes from Case Studies 1 and 2

The overall outcome, or big idea, emanating from and unifying Case Studies 1 and 2 is the importance of culture. Culture is central to education of First Nation youth especially when coupled with the transmission of knowledge to future generations. A great many studies have focused attention on this important issue for creating curricula that are culturally responsive to Aboriginal students. In Canada, Aikenhead (1996, 1997, 2001, 2002) drew attention to border crossing into the subculture of science and a First

Nations cross-cultural science and technology curriculum and teaching. Nnaemeka (2003) sounded a cautionary note:

> Border crossing has its dangers, its seduction, its unpredictability, its humbling moments, but it also has its enriching rewards. Border crossing entails learning *about* the 'other,' but more importantly, it should also entail learning *from* the other. Learning *about* is a gesture that is often tinged with arrogance and an air of superiority; learning *from* requires a high dose of humility tinged with civility. Learning *about* often produces arrogant interrogators; learning *from* requires humble listeners. [emphasis added] (p. 374)

Battiste (2013) has taken a definitive decolonizing approach to the education of FNMI students, whereby the learning spirit is nourished and culture is at the forefront of knowledge. Tippins, Mueller, van Eijck, and Adams (2010) examined eco-justice, place-based science education, and Indigenous knowledge systems as part of cultural studies and environmentalism. Sutherland and Henning (2009) addressed concern for science education as Aboriginal and western science were woven into curricula with a concern for culture, language, and the nature of science with a view to create a framework for long-term science education. Several international studies shared a similar concern for cultural responsiveness with respect to Indigenous culture: Māori culture (Bishop & Berryman, 2006; Bishop & Glynn, 1999); native science and ecology (Cajete, 1994, 2000); Hawai'ian knowledge and cultural literacy (Chinn 2006, 2007, 2008, 2010); Native American (Tlingit and Sioux) education (Demmert, McCardle et al., 2006); cultural models of education in the USA (Fryberg & Markus, 2007); culturally responsive mathematics and science education for Native students (Nelson-Barber & Estrin, 1995). However, the amalgamation of ongoing government support for Māori culture with academic educational program developers in Aotearoa/New Zealand for over a decade has provided a model for the incorporation of cultural responsiveness in their curriculum that involves the schools, communities, and parents.

Te Kotahitanga, a Culturally Responsive Example for Aboriginal Youth

The Te Kotahitanga Project has been creating Māori secondary student success stories for over a decade on the North Island of Aotearoa/New Zealand. The overall aim

of the project is to improve the educational achievement of Māori students in secondary schools. Kaupapa Māori research (involving a revitalization of Māori culture) serves to create a shared classroom learning experience where culture counts in a culturally responsive pedagogy of relations (Te Kotahitanga, n.d.):

> In its development, Te Kotahitanga is a research and teacher professional development programme that supports teachers to improve Māori students' learning and achievement, enabling teachers to create a culturally responsive context for learning which is responsive to evidence of student performance and understandings [and] enables school leaders, and the wider school community, to focus on changing school structures and organisations to more effectively support teachers in this endeavour. (para. 1)

Culturally responsive education involves three main considerations: the child and their home, the structure and educational system in place and its influence on the classroom, and the relationships and interactions within the classroom itself. All of these factors influence the educational outcomes of students and need to have a focus away from traditional methods of dealing with student disparities. Traditional methods that include remedial and behaviour modification programs serve only to perpetuate the teachers' already low expectations of Māori students' achievement and the transfer of blame on some other factor or factors outside their sphere of influence (Bishop et al., 2009). Te Kotahitanga challenges deficit thinking by espousing agentic positioning in teachers through the development of an effective teaching profile (Bishop et al., 2009) and a comprehensive support framework. The importance of the development of meaningful classroom relationships that exists beyond the walls of the classroom is central to the success of this project. In BC, and indeed Canada, such an approach would offer a way of improving our educational outcomes at a time when the former Grand Chief, along with many other Chiefs across our nation and former BC Lieutenant Governor, the Honourable Steven Point, are calling for educational reforms in the light of the current Aboriginal educational outcomes.

Other studies connecting Canada with Aotearoa/New Zealand have examined best practices in the provision of educational services to Aboriginal students both on and off-reserve across Canada (Raham, 2009, 2010). Part of this study drew upon three

comparable international educational systems — New Zealand, Australia, and Norway — that when combined will elicit future policy for Aboriginal education in Canada. Raham's (2009) summary of best practices identified language and literacy instruction, culturally based programming, student engagement and retention, partnerships of home and community, teacher preparation, instruction and support, school leadership, assessment, and governance. The focus on best practices to improve educational outcomes for Māori children and young adults was also central to *Ka Hikitia … The Māori Education Strategy 2008–2012* (Goren, 2009). Ka Hikitia means "to step up, to lengthen one's stride, to lift up with the intent of transforming the New Zealand Ministry of Education's work in the areas of early childhood education, compulsory education, and tertiary education programs." (Goren, 2009, p. v). These goals are also noted as of key importance in Canada (Martin, n.d.; Raham, 2009; Richards & Scott, 2009).

Bishop's (2010) call for effective teaching for Indigenous and minoritized students is reflected by the Assembly of Alaska Native Educators and its guidelines (ANKN, 1999) for preparing culturally responsive teachers, who should possess the following attributes:

> can describe their philosophy of education and demonstrate its relationship to their practice. … understand how students learn and develop and apply that knowledge to their practice. … teach with respect for individual and cultural characteristics. … know their content area and how to teach it; facilitate, monitor and assess student learning. … create and maintain a learning environment in which all students are actively engaged and contributing members. … work as partners with parents, families and with the community. … participate in and contribute to the teaching profession. (pp. 4–16).

Bishop (2010) identified the following actions of effective teachers in Aotearoa/New Zealand: caring for students as Māori, caring for the performance of Māori students, creating a secure well-managed learning environment, engaging in effective learning interactions with Māori students, using a range of teaching strategies, and using student performance to inform future teaching practices (pp. 59–60). Māori students in Aotearoa and Native American students in Alaska share similar educational challenges that are being addressed by educators with a common belief in culturally responsive schools and

teachers. However, both emphasize the involvement of community in student successes. In BC, this same concern is being addressed within each community via the Aboriginal EAs with the reported successes in SDs 62 and 67, where community involvement is palpable.

The SEAS project reported in Case Study 2 — TEKW & WMS also had these effective teaching dynamics with a concern for engaging the interns in their learning experiences, place-based within their territory. The interns were further supported by their community as evidenced by Elder contributions to their experiences. With WMS as a main technological focus, TEKW emerged seamlessly among the participants and coordinators, likely as a result of the study location. The interns were invested in their instructors; they gained from their interactions in the same sense as the effective teacher profiles recorded by Te Kotahitanga for Māori students and AANE for Alaskan students.

An important purpose of this study was to suggest an approach to teaching and learning for the mutual benefit of Aboriginal and non-Aboriginal students. This approach would involve an effective CRS strategy that would include: participation of Elders in K–12 schooling; involvement of professional staff with a culturally responsive pedagogy; facilities that are compatible with the community environment; provision of multiple avenues for students to access learning coupled with multiple forms of assessment for students to demonstrate the success of their learning; provision of opportunities for students to learn about their heritage language; and fostering extensive and ongoing participation, communication, and interaction between school and community personnel. The SEAS Initiative of the Heiltsuk First Nation appears to have been proactive in developing opportunities for their children and youth to succeed in areas where there is an increased demand for incorporating a WMS technology strategy with community Indigenous Knowledge (TEKW and LEK). Current concerns include protecting their endangered territories in the Great Bear Rainforest from the pressures of profit by federal and provincial governments as well as the impacts of the potential Northern Gateway Pipeline project and trophy hunting of bears within their territory.

Summary and Teaching and Learning Practices

This study has raised several research questions with an overall purpose of examining one of the most troubling issues facing education globally: (a) the observed disparity in academic performance between minority students and their dominant culture counterparts — often defined by race/ethnicity, gender, and socioeconomic status — to identify ways of increasing participation and success in secondary science courses and (b) the need to develop culturally responsive curriculum for students. The SEAS Initiative represents a concrete example of engaging students in science and mathematics to the degree of several interns considering a career in a field of science. This was achieved by paying particular attention to culture and the role that it plays in nourishing the learning spirit (Battiste, 2013). Deficit education and its Euro-western analyses do not successfully address the holistic and cultural necessities of learning for FNMI students in BC although they do serve as signposts to improvement. Aboriginal students are already successful at the tertiary level of academic institutions across Canada, but they have had to adopt an approach espoused by the dominant culture in order to achieve this level. Increased participation in science at the tertiary level could be a result of a more culturally responsive curriculum at the secondary level. With more students engaged in science that is respectful of IKW, TEKW, and LEK and responsive to Indigenous learning needs at the secondary level, the increased participation and success that could be achieved would be reflected in increased tertiary enrollments in science fields. Battiste (2013), King (2012), and many others support this notion. Currently, Aboriginal students are underrepresented in tertiary science due to a cultural mismatch (Aikenhead, 2001, 2002, 2008) that currently exists and the histories that are untold and are in need of rewriting.

In Case Study 2 — TEKW & WMS, questions were raised with respect to the inclusion of a TEKW perspective; and if included, what would it look like? The model provided by the SEAS Initiative speaks to these questions in BC. But, clearly, this needs to be translated into classroom practice for the benefit of all students. Battiste (2013) discussed the success of the 1999 *Mi'kmaw Kina'matnewey* agreement in Nova Scotia: "it is an agreement among federal and provincial governments and eleven Mi'kmaw communities that recognizes the Mi'kmaw bands' right to self-governing education

among the participating communities from pre-K through post-secondary and adult education." (p. 90). Battiste, in an interview with CBC News (Schwartz, 2013), said:

> the research shows that the system works for students, 'not only learning about themselves and their education and having better self-esteem and being better speakers and having more agency and power in the classrooms, but it also helps them to learn how to read English, which is a striking kind of thing that nobody thought would have happened.'
>
> According to the Mi'kmaw Kina'matnewey annual report released earlier this month, 88 per cent of their students graduated from high school last year, just above the number for non-aboriginal Canadians. (§ Mi'kmaq Education Act, para. 5–6)

Positive results come from the examples set in Nova Scotia and the self-esteem realized by the Heiltsuk interns in the SEAS Initiative. However, Nova Scotia's success "cannot be the system for New Brunswick or Ontario or Alberta" or British Columbia (Schwartz, 2013, § Mi'kmaq Education Act, para. 8). This culturally responsive educational system, described in Battiste's (2013) book, points the way toward decolonizing education for the benefit of all students. Details of this process will be reviewed following a brief discussion about spirituality and the WMS mind-set as they pertain to two worlds meeting in the Two-Row Wampum Belt analogy. Answering the question of "What would this look like?" will require a more enriched recommendation forward, since each FNMI authority in each Canadian province and territory will need to deal with educational change and reform on an individual basis.

A Call for Educational Reform

Battiste (2008) described trans-systemic practices as part of an Indigenous renaissance movement that "came from multiple forms of struggle, resistance, transformative action and conscientization that have evolved from many theorists and writers" (pp. 3–4). Conscientização, or critical consciousness leading to cultural emancipation (Freire, 1979), is needed to define "the limits of colonial society, its foundations and assumptive values, and the integral role Indigenous peoples have in an interdependent world" (Battiste, 2008, p. 4). Her trans-systemic practices can be

visualized as a double helix whereby each complementary strand is represented by IK on the one hand and Euro-western knowledge on the other. Battiste (2008) stated:

> it has allowed us to see the strength of a double helix of anti-racist educational strategy entwined by Indigenous knowledge — creation stories, spirituality, teachings, traditions, values — these have become building blocks for reviving the best of our civilizations and the constructing of a just enlightened and shared future. …
>
> The agenda of the Indigenous renaissance has been immensely practical and pragmatic: to transform the existing educational status quo of curriculum to more effectively include Indigenous knowledge, to effect the persistent poverty of Aboriginal peoples into a civilization of educated and prosperous peoples for the next hundred years, and finally to reform attitudes and beliefs not only about the capacity of Indigenous peoples but also about our inherent ability for participatory consciousness with our environment, ecology, and the spirits within. (p. 6)

Recommendations for Future Study

In BC, SD 67 (Okanagan-Skaha) should be more closely examined as an example of best practices in teaching and learning that is supported by the district administration and the local Aboriginal community. This district was identified by Richards et al. (2008) and Richards and Scott (2009) in their studies.

An examination of the impact of the SEAS Initiative could be conducted to determine if students in the Heiltsuk community were influenced to pursue more science studies and ascertain their current views on the nature of science. This would provide viable potential incentives for future course development at local and provincial levels.

The SEAS Initiative and similar studies should include teachers, either preservice or inservice, who would benefit from the collaborative learning between TEKW and WMS, which would benefit future generations of student learning. This approach could be informed by the work of Chinn (2006, 2007, 2008, 2014) on Hawai'ian cultural perspectives as they connect TEKS and WMS.

Exemplary work on FNMI educational and cultural issues has been undertaken by the Martin Aboriginal Education Initiative as well as the Joint Task Force on Improving

Educational and Employment Outcomes for First Nations and Métis Peoples by the Government of Saskatchewan and the Federation of Saskatchewan Indian Nations (Saskatchewan Joint Task Force, 2013), each addressing educational concerns covering: early childhood education, improved secondary education and high school completion rates, improved access and completion of postsecondary education, and improved employment outcomes. This work needs to be supported and put into practice on a wider Canadian context.

The education academy needs to look beyond providing a place at the tertiary level for Aboriginal students who have successfully negotiated the Euro-western educational prescriptions and turn its attention toward success at the primary and secondary (K–12) levels. This will require government funding and cooperation in the manner of the Te Kotahitanga, Aotearoa/New Zealand, whose operational success has been supported and is ongoing for over a decade. It will require school- and system-wide change, coordinated by Faculties of Education and various levels of government. Battiste (2013) and Pelletier, Cottrell, and Hardie (2013) have called for a move away from gaps analyses and comparisons since many root causes exist here (notably IRS, race, poverty), which suggests that both the federal and provincial systems need to address the inequities that exist in order to create an education for all students based upon truth and hope.

The research implications call for teachers to initiate and develop a culturally responsive mindset mediated by an equitable approach to teaching, whereby all students interact in a dynamic learning environment. Teachers should be prepared to adjust to change necessitated to meet school reform that will best serve all students and address the deficit approaches to learning that can be identified. In this way, the best teachers will practice with the best schools that have their overall objectives aligned with providing the best possible education for all students and that considers cultural and worldview differences as a norm to be shared and built upon.

References

Abrams, E., Yore, L. D., Bang, M., Brayboy, B., Castagno, A., Kidman, J., Lee, H., Villanueva, M. G., Wang, M. H., Webb, P., & Yen, C-F. (2014). Culturally relevant schooling in science for indigenous learners worldwide: Stressing the All in *Science Literacy for All*. In N. G. Lederman & S. K. Abell, (Eds.), *Handbook of research on science education* (Vol. II, pp. 671-696). New York, NY: Routledge.

Aikenhead, G. S. (1996). Science education: Border crossing into the subculture of science. *Studies in Science Education, 27,* 1-52.

Aikenhead, G. S. (1997). Towards a First Nations cross-cultural science and technology curriculum. *Science Education*, *81*, 217-238.

Aikenhead, G. S. (2001). Integrating western and Aboriginal sciences: Cross-cultural science teaching. *Research in Science Education, 31*(2)*,* 337-355.

Aikenhead, G. S. (2002). Cross-cultural science teaching: "Rekindling traditions" for Aboriginal students. *Canadian Journal of Science, Mathematics and Technology Education, 2,* 287-304.

Aikenhead, G. S. (2006). *Science education for everyday life: Evidence-based practice*. New York, NY: Teachers College Press.

Aikenhead, G. S. (2008). Objectivity: the opiate of the academic? *Cultural Studies of Science Education*, *3*(3), 581-585.

Alaska Native Knowledge Network. (1998). *Alaska standards for culturally responsive schools.* Retrieved from http://ankn.uaf.edu/Publications/Standards.html

Alaska Native Knowledge Network. (1999). *Guidelines for preparing culturally responsive teachers for Alaska's schools.* Retrieved from http://ankn.uaf.edu/Publications/Teachers.html

Alberta Education. (2006). *Senior high vision statement, 2006*. Edmonton, AB: Author. Retrieved from http://education.alberta.ca/teachers/program/science/programs/vision.aspx

Alberta Education. (2010). *(FNMI) Language and culture twelve-year (kindergarten to grade 12) template, 2010.* Edmonton, AB: Author. Retrieved from http://education.alberta.ca/media/6372781/fnmikto12lc.pdf

Allen, N. J., & Crawley, F. E. (1998). Voices from the bridge: Worldview conflicts of Kickapoo students of science. *Journal of Research in Science Teaching, 35,* 111-132.

American Association for the Advancement of Science. (1989). *Science for all Americans: Project 2061*. New York, NY: Oxford University Press.

Anderson, S., Medrich, E., & Fowler, D. (2007). Which achievement gap? *Phi Delta Kappan, 88*(7), 547.

Atkinson, J. L. (2010). Are we creating the achievement gap? Examining how deficit mentalities influence indigenous science curriculum choices. In D. J. Tippins, M. P. Mueller, M. van Eijck, & J. D. Adams (Eds.), *Cultural studies and environmentalism: The confluence of eco-justice, place-based (science) education, and indigenous knowledge systems* (Vol. 3, pp. 439-445). Dordrecht, The Netherlands: Springer.

Barnhardt, R. (2008). Creating a place for Indigenous knowledge in education: The Alaska Native knowledge network. In D. Gruenewald & G. Smith (Eds.), *Place-based education in the global age: Local diversity* (pp. 113-133). New York, NY: Taylor & Francis.

Barnhardt, R., & Kawagley, A. O. (2003). Culture, chaos & complexity: Catalysts for change in indigenous education. *Cultural Survival Quarterly, 27*(4). Retrieved from http://www.culturalsurvival.org/publications/cultural-survival-quarterly/united-states/culture-chaos-complexity-catalysts-change-ind

Barton, S. S. (2004). Narrative inquiry: Locating Aboriginal epistemology in a relational methodology. *Journal of Advanced Nursing, 45*, 519–526. doi:10.1046/j.1365-2648.2003.02935.x

Battiste, M. (2008, December). *Animating indigenous knowledge in education: From resilience to renaissance*. Keynote address presented to the World Indigenous Peoples Conference on Education, Melbourne, Australia.

Battiste, M. (2013). *Decolonizing education: Nourishing the learning spirit*. Saskatoon, SK: Purich.

Beebe, C. (2013). *How schools can impact student retention among First Nations students leading to higher graduation rates?* (Doctoral dissertation, University of Calgary). Retrieved from theses.ucalgary.ca/bitstream/11023/809/4/ucalgary_2013_beebe_clarice.pdf

Bishop, R. (2010). Effective teaching for indigenous and minoritized students. *Procedia-Social and Behavioral Sciences, 7*, 57-62.

Bishop, R., & Berryman, M. (2006). *Culture speaks: Cultural relationships & classroom learning*. Wellington, New Zealand: Huia.

Bishop, R., Berryman, M., Cavanagh, T., & Teddy, L. (2009). Te Kotahitanga: Addressing educational disparities facing Maori students in New Zealand. *Teaching and Teacher Education, 25*(5), 734-742.

Bishop, R., & Glynn, T. (1999). *Culture counts: Changing power relations in education*. Albany, New Zealand: Dunmore Press.

Bol, L., & Berry, R. Q. (2005). Secondary mathematics teachers' perceptions of the achievement gap. *The High School Journal, 88*(4), 32-45.

Borrows, J., & Rotman, L. I. (1997). The sui generis nature of aboriginal rights: Does it make a difference? *Alberta Law Review, 36*(9), 9-44.

Bowers, C. A. (2007). Philosophy, language, and the Titanic mind-set. *Language & Ecology, 2*(1), 1-16. Available from http://www.ecoling.net/articles/4563035324

Bowers, C. A. (2008). *Toward a post-industrial consciousness: Understanding the linguistic basis of ecologically sustainable educational reforms*. Retrieved from https://scholarsbank.uoregon.edu/xmlui/bitstream/handle/1794/7411/Book+on+language.pdf?sequence=1

Braun, H. I., Wang, A., Jenkins, F., & Weinbaum, E. (2006). The Black-White achievement gap: Do state policies matter? *Education Policy Analysis Archives, 14*(8). Retrieved from http://files.eric.ed.gov/fulltext/EJ806027.pdf

Brayboy, B. M., & Castagno, A. (2008). How might Native science inform "informal science learning"? *Cultural Studies of Science Education, 3*, 731-750. doi:10.1007/s11422-008-9125-x

British Columbia Ministry of Education. (n.d.). *First Peoples principles of learning.* Victoria, BC: Author. Retrieved from http://www.bced.gov.bc.ca/abed/principles_of_learning.pdf

British Columbia Ministry of Education. (2005). *Science K to 7: Integrated resource package 2005*. Victoria, BC: Author. Retrieved from http://www.bced.gov.bc.ca/irp/pdfs/sciences/2005scik7.pdf

British Columbia Ministry of Education. (2006a). *English language arts kindergarten to Grade 7: Integrated resource package 2006*. Victoria, BC: Author. Retrieved from http://www.bced.gov.bc.ca/irp/pdfs/english_language_arts/2006ela_k7.pdf

British Columbia Ministry of Education. (2006b). *Science grade 8: Integrated resource package 2006*. Victoria, BC: Author. Retrieved from http://www.bced.gov.bc.ca/irp/pdfs/sciences/2006sci_8.pdf

British Columbia Ministry of Education. (2006c). *Science grade 9: Integrated resource package 2006*. Victoria, BC: Author. Retrieved from http://www.bced.gov.bc.ca/irp/pdfs/sciences/2006sci_9.pdf

British Columbia Ministry of Education. (2007). *English language arts 8 to 12: Integrated resource package 2007*. Victoria, BC: Author. Retrieved from http://www.bced.gov.bc.ca/irp/pdfs/english_language_arts/2007ela_812.pdf

British Columbia Ministry of Education. (2008a). *English 12 First Peoples: Integrated resource package 2008.* Victoria, BC: Author. Retrieved from http://www.bced.gov.bc.ca/irp/pdfs/english_language_arts/2008eng12_firstppl.pdf

British Columbia Ministry of Education. (2008b). *Science grade 10: Integrated resource package 2006*. Victoria, BC: Author. Retrieved from http://www.bced.gov.bc.ca/irp/pdfs/sciences/2008sci_10.pdf

British Columbia Ministry of Education. (2009). *Summary of key information: 2008/09*. Victoria, BC: Author. Retrieved from http://www.bced.gov.bc.ca/reporting/docs/SoK_2012.pdf

British Columbia Ministry of Education. (2013a). *Aboriginal report 2007/08 – 2011/12: How are we doing?* Victoria, BC: Author. Retrieved from http://www.bced.gov.bc.ca/abed/perf2012.pdf

British Columbia Ministry of Education. (2013b). *Aboriginal report 2008/09 – 2012/13: How are we doing?* Victoria, BC: Author. Retrieved from http://www.bced.gov.bc.ca/abed/perf2013.pdf

British Columbia Ministry of Education. (2013c). *Aboriginal education*. Victoria, BC: Author. Retrieved from http://www.bced.gov.bc.ca/abed/welcome.htm

British Columbia Ministry of Education. (2013d). *Aboriginal education enhancement agreements*. Victoria, BC: Author. Retrieved from http://www.bced.gov.bc.ca/abed/agreements/welcome.htm

Cajete, G. (1994). *Look to the mountain: An ecology of Indigenous education*. Skyland, NC: Kivaki Press.

Cajete, G. (2000). *Native science: Natural laws of interdependence*. Santa Fe, NM: Clear Light.

Cajete, G. (2005). *Native science*. Paper presented at the Cape Breton University Conference "Spirit of the East, Two-Eyed Seeing," Sydney, Nova Scotia. Retrieved from http://www.turtleisland.org/culture/twoeyed.htm

Canadian Council on Learning. (2007). *The cultural divide in science education for Aboriginal learners*. Retrieved from http://www.ccl-cca.ca/CCL/Reports/LessonsInLearning/LinL20070116_Ab_sci_edu.html

Cappon, P. (2008). Measuring success in First Nations, Inuit and Métis learning. *Policy Options-Montreal, 29*(5), 60.

Carpenter, D. M., Ramirez, A., & Severn, L. (2006). Gap or gaps challenging the singular definition of the achievement gap. *Education and Urban Society, 39*(1), 113-127.

Castro, F. G., Kellison, J. G., Boyd, S. J., & Kopak, A. (2010). A methodology for conducting integrative mixed methods research and data analyses. *Journal of Mixed Methods Research, 4*(4), 342-360.

CBC News. (2013, April 26). *Paul Martin accuses residential schools of 'cultural genocide.'* Retrieved from http://www.cbc.ca/news/politics/story/2013/04/26/truth-and-reconciliation-saganash-paul-martin.html?autoplay=true

Chigeza, P. (2011). Cultural resources of minority and marginalised students should be included in the school science curriculum. *Cultural Studies of Science Education, 6*(2), 401-412.

Chinn, P. W. (2006). Preparing science teachers for culturally diverse students: Developing cultural literacy through cultural immersion, cultural translators and communities of practice. *Cultural Studies of Science Education, 1*(2), 367-402.

Chinn, P. W. (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.

Chinn, P. W. (2008). Connecting traditional ecological knowledge and western science. In A. J. Rodriguez (Ed.), *New directions in science and mathematics education* (Vol. 11, pp. 1-27). Rotterdam, The Netherlands: Sense.

Chinn, P. W. (2010). Science, culture, education, and social-ecological systems: A study of transdisciplinary literacies in student discourse during a place-based and culture-based Polynesian voyaging program. In A. Sumi, K. Fukushi, & A. Hiramatsu (Eds.), *Adaptation and mitigation strategies for climate change* (pp. 249-265). Tokyo, Japan: Springer.

Chinn, P. W. (2014). Educating for science literacy, citizenship, and sustainability: Learning from Native Hawaiian perspectives. In D. J. Tippins, M. P. Muller, & A. J. Stewart (Eds.), *Assessing schools for generation R (Responsibility*) (pp. 321-331). The Netherlands: Springer.

Chinn, P. W., Hand, B., & Yore, L. D. (2008). Culture, language, knowledge about nature and naturally occurring events, and science literacy for all: She says, he says, they say [Special issue]. *L1 – Educational Studies in Language and Literature, 8*(1), 149-171. Retrieved from http://l1.publication-achive.com/show?repository=1&article=220

Clandinin, D. J. (2006). Narrative inquiry: A methodology for studying lived experience. *Research Studies in Music Education, 27*(1), 44-54. doi:10.1177/1321103X060270010301

Clandinin, D. J. (Ed.) (2007). *Handbook of narrative inquiry: Mapping a methodology*. Thousand Oaks, CA: SAGE.

Clandinin, D. J., & Rosiek, J. (2007). Mapping a landscape of narrative inquiry. In D. J. Clandinin (Ed.), *Handbook of narrative inquiry: Mapping a methodology* (pp. 35-75). Thousand Oaks, CA: SAGE.

Clark, J. V. (2014). Introduction. In J. V. Clark (Ed.), *Closing the achievement gap from an international perspective: Transforming STEM for effective education* (pp. 3-6). Dordrecht, The Netherlands: Springer.

Cohen, L., Manion, L., & Morrison, K. (2007). *Research methods in education* (6th ed.). New York, NY: Routledge.

Cooley, J. (2006). *Desegregation and the achievement gap: Do diverse peers help?* Unpublished manuscript, University of Wisconsin-Madison. Retrieved from http://www.niusileadscape.org/docs/FINAL_PRODUCTS/LearningCarousel/DesegregationAndAchievementGap.pdf

Council of Ministers of Education, Canada. (1997). *Pan-Canadian protocol for collaboration on school curriculum*. Retrieved from http://www.cmec.ca/Publications/Lists/Publications/Attachments/177/pancan-protocol-collaboration-1997.pdf

Crabtree, B. F., & Miller, W. L. (1999). Using codes and code manuals: A template organizing style of interpretation. *Doing Qualitative Research, 2*, 163-177.

Darlaston-Jones, D., Herbert, J., Kelleigh, R., Darlaston-Jones, W., Harris, J., & Dudgeon, P. (2014). Are we asking the right questions? Why we should have a decolonizing discourse based on conscientization rather than indigenizing the curriculum. *Canadian Journal of Native Education, 37*(1), 86-104.

Demmert, W. G. (2011). What is culture-based education? Understanding pedagogy and curriculum. In J. Reyhner, W. S. Gilbert, & L. Lockard (Eds.), *Honoring our heritage: Culturally appropriate approaches to Indigenous education* (pp. 1-9). Flagstaff, AZ: Northern Arizona University.

Demmert, W. G., Grissmer, & Towner, J. (2006). A review and analysis of the research on Native American students. *Journal of American Indian Education, 45*(3), 5-23.

Demmert, W. G., McCardle, P., Mele-McCarthy, J., & Leos, K. (2006). Preparing Native American children for academic success: A blueprint for research. *Journal of American Indian Education, 45*(3), 92-106.

Dobbie, W., & Fryer, R. G., Jr. (2009). *Are high quality schools enough to close the achievement gap? Evidence from a social experiment in Harlem* (No.w15473). Cambridge, MA: National Bureau of Economic Research.

Edis, T. (2009). Modern science and conservative Islam: An uneasy relationship. In M. R. Matthews (Ed.), *Science, worldviews and education* (pp. 237–265). Dordrecht, The

Netherlands: Springer. Retrieved from http://link.springer.com/chapter/10.1007/978-90-481-2779-5_12

Elo, S., & Kyngäs, H. (2008). The qualitative content analysis process. *Journal of Advanced Nursing*, *62*(1), 107-115.

Epp, B. A. (2007). *Examining the predictive validity of the FSA on the provincial Mathematics 10 examinations* (Master of Arts thesis). Retrieved from https://dspace.library.uvic.ca//handle/1828/2464

Erickson, G. (2007, May). *In the path of Linnaeus: Scientific literacy re-visioned with some thoughts on persistent problems and new directions for science education*. Paper presented at the 2007 Linné Scientific Symposium, Uppsala, Sweden. Retrieved from http://nadidaktik.se/MSU/sem9/Linneproceedings.pdf

Findlay, L. (2004). Always Indigenize!: The radical humanities in the postcolonial Canadian university. In C. Sugars (Ed.), *Unhomely states: Theorizing English-Canadian postcolonialism* (pp. 367-382). Peterborough, ON: Broadview Press.

Fisher, K. (2010). *Aboriginal students' high school mathematics experiences: Stories of opportunities and obstacles* (Master of Arts thesis). Retrieved from https://dspace.library.uvic.ca:8443/handle/1828/3103

Freire, P. (1979). *Education for critical consciousness.* London, England: Sheed & Ward.

Fryberg, S. A., & Markus, H. R. (2007). Cultural models of education in American Indian, Asian American and European American contexts. *Social Psychology of Education, 10*(2), 213-246. doi:10.1007/s11218-007-9017-z

Fryberg, S. A., Markus, H. R., Oyserman, D., & Stone, J. M. (2008). Of warrior chiefs and Indian princesses: The psychological consequences of American Indian mascots. *Basic and Applied Social Psychology, 30*(3), 208-218.

Gauch, H. G., Jr. (2009). Science, worldviews, and education. *Science & Education, (18)*6–7, 667–695. Retrieved from http://link.springer.com/article/10.1007/s11191-006-9059-1

Gillies, J. (2005). Is aboriginal knowledge science? *Edge 5*, (14). Retrieved from http://www.uvic.ca/knowledge/assets/issues/2005/v5n14_25sep05.pdf

Giroux, H. A., & Schmidt, M. (2004). Closing the achievement gap: A metaphor for children left behind. *Journal of Educational Change, 5*(3), 213-228.

Gordon, E. W. (2014). Preface. In J. V. Clark (Ed.), *Closing the achievement gap from an international perspective: Transforming STEM for effective education* (pp. vii–ix). Dordrecht, The Netherlands: Springer.

Goren, P. D. (2009). *How policy travels: Making sense of Ka Hikitia – Managing for success: The Māori education strategy 2008-2012*. Wellington, New Zealand: Fulbright.

Gould, S. J. (1997). Nonoverlapping magisteria. *Natural History, 106,* 16–22. Retrieved from http://jbburnett.com/resources/gould_nonoverlapping.pdf

Government of Canada, Statutes of Canada, Chapter 10. (2006). *First Nations jurisdiction over education in British Columbia*. Ottawa, ON: Minister of Public Works and Government Services Canada.

Haggan, N., Brignall, C., Peacock, B., & Daniel, R. (2002). Education for Aboriginal fisheries science and ecosystem management. *Fisheries Centre Research Reports, 10*(6). Retrieved from http://www.fisheries.ubc.ca/webfm_send/194

Haggan, N., Turner, N. J., Carpenter, J., Jones, J. T., Mackie, Q., & Menzies, C. (2004, August). *12,000+ years of change: Linking traditional and modern ecosystem science in the Pacific Northwest*. Paper presented at Society for Ecological Restoration Conference, Victoria, British Columbia, Canada. Retrieved from http://s3.amazonaws.com/academia.edu.documents/30891940/12000yrs_-_Haggan_et_al.pdf?AWSAccessKeyId=AKIAJ56TQJRTWSMTNPEA&Expires=1433983352&Signature=zqYSq%2FwM26v1wuljXPxBB3Nuwlk%3D&response-content-disposition=inline

Hammersmith, J. A. (2007). *Converging indigenous and western knowledge systems: Implications for tertiary education* (Unpublished doctoral dissertation). University of South Africa, Johannesburg.

Herring, S. (2007). A faceted classification scheme for computer-mediated discourse. *Language@Internet, 4*(1), 1-37. Retrieved from http://www.languageatinternet.org/articles/2007/761

Herring, S. (2010). Web content analysis: Expanding the paradigm. In J. Hunsinger, M. Allen, & L. Klastrup (Eds.), *International handbook of internet research* (pp. 233-249). New York, NY: Springer.

Hirsh, S. (2005). Professional development and closing the achievement gap. *Theory into practice, 44*(1), 38-44.

Hogue, M. (2012). Interconnecting Aboriginal and western paradigms in post-secondary science education: An action research approach. *Journal of the Canadian Association for Curriculum Studies, 10*(1), 77-114.

Horomia, P. (2007, April 17). *Canadian Indigenous Education Institute launch* [Speech notes]. Vancouver, BC. Retrieved from http://www.beehive.govt.nz/speech/canadian-indigenous-education-institute-launch

Horsthemke, K., & Yore, L. D. (2014). Challenges of multiculturalism in science education: Indigenisation, internationalisation, and *Transkulturalität*. In M. R. Matthews (Ed.), *International handbook of research in history, Philosophy and science teaching* (pp. 1759-1792). Dordrecht, The Netherlands: Springer. doi:10.1007/978-94-007-7654-8_55

Hsieh, H. F., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. *Qualitative Health Research*, *15*(9), 1277-1288.

Hurd, P. D. (1958). Science literacy: Its meaning for American schools. *Educational Leadership, 16*(1), 13-16.

Irzik, G., & Nola, R. (2009). Worldviews and their relation to science. *Science & Education, 18*(6–7), 729–745. Retrieved from http://link.springer.com/article/10.1007/s11191-007-9087-5

Jegede, O. (1995). Collateral learning and the eco-cultural paradigm in science and mathematics education in Africa. *Studies in Science Education, 25,* 97-137.

Johnson, R. B. (1997). Examining the validity structure of qualitative research. *Education, 118*(2), 282-292.

Kawagley, A. O., & Barnhardt, R. (1998). *Education indigenous to place: Western science meets native reality*. Retrieved from http://ankn.uaf.edu/Curriculum/Articles/BarnhardtKawagley/EIP.html

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*(2), 133-144.

King, T. (2012). *The inconvenient Indian: A curious account of Native People in North America*. Minneapolis, MN: University of Minnesota Press.

King-Hunt, K. (2013). *Report 4: Aboriginal education enhancement agreement SD 62*. Retrieved from http://www.bced.gov.bc.ca/abed/annual_reports/2012_2013/sd_62_ar_2012_2013.pdf

Kirkness, V. J., & Barnhardt, R. (1991). The four R's: Respect, relevance, reciprocity, responsibility. *Journal of American Indian Education, 30*(3), 1-15.

Krippendorff, K. (1989). Content analysis. In E. Barnouw, G. Gerbner, W. Schramm, T. L. Worth, & L. Gross (Eds.), *International encyclopedia of communication* (Vol. 1, pp. 403-407). New York, NY: Oxford University Press. Retrieved from http://repository.upenn.edu/asc_papers/226

Lacey, H. (2009). The interplay of scientific activity, worldviews and value outlooks. *Science & Education, 18*(6–7), 839–860. doi:10.1007/s11191-007-9114-6.

Laugksch, R. C. (2000). Scientific literacy: A conceptual overview. *Science Education, 84*(1), 71-94.

Lee, H., Yen, C. F., & Aikenhead, G. S. (2012). Indigenous elementary students' science instruction in Taiwan: Indigenous knowledge and western science. *Research in Science Education, 42*(6), 1183-1199.

Lee, J. (2002). Racial and ethnic achievement gap trends: Reversing the progress toward equity? *Educational Researcher, 31*(1), 3-12.

Lee, J. (2004). Multiple facets of inequity in racial and ethnic achievement gaps. *Peabody Journal of Education*, *79*(2), 51-73.

Lickers, F. H. (2007). The cultural divide in science education for Aboriginal learners. In *Canadian Council on Learning (CCL)*. Retrieved from http://www.nald.ca/library/research/ccl/lessons_learning/cultural_divide/cultural_divide.pdf.

Linder, C., Östman, L., & Wickman, P. O. (2007, May). Promoting scientific literacy: Science education research in transaction. In *Linnaeus Tercentenary Symposium*.

Lutz, J. S. (2008). *Makúk: A new history of aboriginal-white relations*. Vancouver, BC: UBC Press.

MacIvor, M. (1995). Redefining science education for Aboriginal students. In M. Battiste & J. Barman (Eds.), *First Nations education in Canada: The circle unfolds* (pp. 73-98). Vancouver, BC: UBC Press.

Makgoba, M. (2002). Politics, the media and science in HIV/AIDS: The peril of pseudoscience. *Vaccine, 20*(15), 1899-1904.

Maltese, A. V., & Tai, R. H. (2011). Pipeline persistence: Examining the association of educational experiences with earned degrees in STEM among US students. *Science Education, 95*(5), 877-907.

Manitoba Education. (1994). *Elements integrated into the curriculum*. Winnipeg, MB: Author. Retrieved from http://www.edu.gov.mb.ca/k12/cur/elements.html#aboriginal

Manitoba Education. (2008). *Bridging two worlds: Aboriginal education and action plan 2008-2011*. Winnipeg, MB: Author. Retrieved from http://www.edu.gov.mb.ca/abedu/action_plan/abed_action_plan_0811.pdf

Martin, P. (n.d.). *Martin Aboriginal Education Initiative (MAEI)*. Retrieved from http://www.maei-ieam.ca/about.html

Martin, P. (2013). *Confederation today and Aboriginal Canada*. Symons Lecture Series (speech). Charlottetown, PEI. Personal Communication.

Matthews, M. R. (2009). Science, worldviews and education: An introduction. *Science & Education*, *18*(6–7), 641–666. Retrieved from http://link.springer.com/article/10.1007/s11191-008-9170-6

McAskill, B., Holmes, G., Francis Pelton, L., & Watt, W. (2004). *WNCP mathematics research project: Final report*. Victoria, BC, Canada: Hold Fast Consultants.

McGregor, D. (2004). Traditional ecological knowledge and sustainable development: Towards coexistence. In M. Blaser, H. Feit, & G. McRae (Eds.), *In the way of development: Indigenous peoples, life projects and globalization* (pp. 73-91). Ottawa, ON: Zed Books.

McKinley, E. (2007). Postcolonialism, indigenous students and science education. In S. K. Abell & N. G. Lederman (Eds.), *International handbook of research in science education* (pp. 199–226). Mahwah, NJ: Lawrence Erlbaum.

McKinley, E., & Gan, M. (2014). Culturally responsive science education for indigenous and ethnic minority students. In N. G. Lederman & S. K. Abell (Eds.), *Handbook of research on science education* (Vol. II, pp. 284-300). New York, NY: Routledge.

McKinley, E., & Stewart, G. M. (2012). Out of place: Indigenous knowledge (IK) in the science curriculum. In B. Fraser, C. McRobbie, & K. Tobin (Eds.). *Second international handbook of science education* (pp. 541–554). New York, NY: Springer.

Mendelson, M. (2006). *Aboriginal peoples and postsecondary education in Canada*. Ottawa, ON: Caledon Institute of Social Policy.

Mendelson, M. (2008). *Improving education on reserves: A First Nations education authority act*. Ottawa, ON: Caledon Institute of Social Policy.

Milford, T. M., Jagger, S., Yore, L. D., & Anderson, J. O. (2010). National influences on science education reform in Canada. *Canadian Journal of Science, Mathematics and Technology Education, 10*(4), 370–381. doi:10.1080/14926156.2010.528827

Morrison, J. S. (2006). *Attributes of STEM education: The students, the academy, the classroom* (TIES STEM Education Monograph Series). Baltimore, MD: Teaching Institute for Excellence in STEM.

Muller, K. V. (2007). The two "mystery" belts of Grand River: A biography of the two row wampum and the friendship belt. *American Indian Quarterly, 31*(1), 129-164.

National Research Council. (1996). *National science education standards.* Washington, DC: National Academies Press. Available from http://www.nap.edu/catalog.php?record_id=4962

National Science Teachers Association. (2000). *NSTA Position statement: The nature of science.* Arlington, VA: Author. Available from http://www.nsta.org/about/positions/natureofscience.aspx

Nature Conservancy, The. (2015). *Website homepage.* Retrieved from http://www.nature.org/index.htm

Neel, K. I. (2008). *Numeracy in Haida Gwaii, BC: Connecting community, pedagogy, and epistemology* (Unpublished doctoral dissertation). Simon Fraser University, Burnaby, BC, Canada.

Nelson-Barber, S., & Estrin, E. T. (1995). *Culturally responsive mathematics and science education for Native students* [Monograph, Native Education Initiative of the Regional Educational Laboratory Network]. San Francisco, CA: Far West Laboratory for Educational Research and Development.

Newfoundland and Labrador Department of Education. (1998). *Foundation for the Atlantic Canada science curriculum.* St. John's, NL: Author. Retrieved from http://www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/sci.pdf

Nnaemeka, O. (2003). Nego-Feminism: Theorizing, practicing, and pruning Africa's way. *Signs, 29*(2), 357-385. Retrieved from http://www.jstor.org/stable/10.1086/378553

Norris, S. P., & Phillips, L. M. (2003). How literacy in its fundamental sense is central to scientific literacy. *Science Education, 87*, 224–240.

Northwest Territories Department of Education. (2004). *The NWT grades K-6 science and technology curriculum (2004).* Yellowknife, NT: Author. Retrieved from http://www.ece.gov.nt.ca/files/Early-Childhood/K-6%20Science%20%26%20Technology%20CurriculumFINAL%20.pdf

Nova Scotia Department of Education. (2008). *Increasing the effectiveness of service delivery to Mi'kmaw learners: Minister's response to the project report on the Mi'kmaq services division dialogue sessions*. Retrieved from http://www.ednet.ns.ca/files/reports/MinistersResponse-MikmawLearners.pdf

Nova Scotia Department of Education. (2015). *Education Act, Regulations*. Retrieved from http://www.novascotia.ca/just/regulations/regs/edmin.htm#TOC1_8

Nunavut Territory Department of Education. (2006). *Program of studies grades 7-9.* Iqaluit, NU: Author. Retrieved from http://www.gov.nu.ca/sites/default/files/2014-2015_nunavut_approved_curriculum_and_teaching_resources.pdf

Ogawa, M. (1995). Science education in a multi-science perspective. *Science Education, 79*, 583-593.

Ogbu, J. (1987). Variability in minority school performance: A problem in search of an explanation. *Anthropology & Education Quarterly*, *18*(4), 312-334.

Ontario Ministry of Education. (2009). *Aboriginal perspectives: A guide to the teacher's toolkit — Teaching resources and strategies for elementary and secondary classrooms.*

Toronto, ON: Author. Retrieved from http://www.edu.gov.on.ca/eng/aboriginal/toolkit.html

Organization for Economic Cooperation and Development. (2003). *The PISA 2003 assessment framework*. Paris, France: Author. Retrieved from http://www.oecd.org/dataoecd/46/14/33694881.pdf

Pacific Wild. (2008). *Website homepage.* Retrieved from http://pacificwild.org/

Pearson, P. D., Moje, E., & Greenleaf, C. (2010). Literacy and science: Each in the service of the other. *Science, 328*(5977), 459-463. doi:10.1126/science.1182595.

Peat, F. D. (2005). *Blackfoot physics: A journey into the Native American universe*. Boston, MA: Red Wheel/Weiser.

Pelletier, T., Cottrell, M., & Hardie, R. (2013). *Improving education and employment outcomes for First Nations and Métis people*. Saskatchewan Joint Task Force on improving education and employment outcomes for First Nations and Métis people. Retrieved from http://www.jointtaskforce.ca/wp-content/uploads/2013/04/Research-Report-for-the-Task-Force-March-26.pdf

Phillips, R. (2010). Forgotten and ignored: Special education in First Nations schools in Canada. *Canadian Journal of Educational Administration and Policy, 106*, 1-26.

Phillips, R. (2011). The absentee Minister of Education of Canada: The Canadian Federal Government's constitutional role in First Nations education. *McGill Journal of Education, 46*(2), 231-245.

Presmeg, N. (2007). The role of culture in teaching and learning mathematics. In F. K. Lester, Jr. (Ed.), *Second handbook of research on mathematics teaching and learning* (pp. 435–458). Charlotte, NC: Information Age.

Qqs Projects Society. (2014). *Website homepage*. Retrieved from http://www.qqsprojects.org/

Québec Ministry of Education, Leisure, and Sport. (2000). *Strategic plan of the Ministry of Education for 2000-2003*. Québec City, PQ: Author. Retrieved from http://www.education.gouv.qc.ca/en/contenus-communs/menus/piv/ministere/

Québec Ministry of Education, Leisure, and Sport. (2008). *Québec education*. Québec City, PQ: Author. Retrieved from http://www.education.gouv.qc.ca/le-ministere/presentation-du-ministere/mission/

Raham, H. (2009). *Best practices in Aboriginal education: A literature review and analysis for policy directions*. Prepared for the Office of the Federal Interlocutor, Indian and Northern Affairs Canada. Ottawa, ON: First Peoples Group. Retrieved from http://www.firstpeoplesgroup.com/mnsiurban/PDF/education/Best_Practices_in_Aboriginal_Education-2009.pdf

Raham, H. (2010, March). *Policy levers for improving outcomes for off-reserve students.* Colloquium on improving the educational outcomes of Aboriginal People living off-reserve. Saskatoon, SK. Retrieved from https://documents.sd61.bc.ca/ANED/educationalResources/StudentSuccess/Policy_Levers_for_Improving_Outcomes_for_Off_Reserve_Students.pdf

Richards, J. G. (2008). *Closing the aboriginal/non-aboriginal education gaps.* Backgrounder, No. 116. Toronto, ON: CD Howe Institute. Retrieved from http://www.cdhowe.org/pdf/Backgrounder_116.pdf#search="Backgrounder 116"

Richards, J. G. (2011). *School dropouts: Who are they and what can be done? e*-Brief*,* 1-7. Toronto, ON: CD Howe Institute. Retrieved from http://www.cdhowe.org/pdf/ebrief_109.pdf#search="e-Brief School Dropouts"

Richards, J. G. (2013a, May-June). *Assessing the role of provincial education systems and reserve "non-systems" in interprovincial variation in Aboriginal student performance.* Paper presented at the 2013 Canadian Economics Association (CEA) Conference, Montréal, Québec. Retrieved from http://www.cslscaevents.cea2013CEA2013-richards.pdf.

Richards, J. G. (2013b). *Why is BC best? The role of provincial and reserve school systems in explaining aboriginal student performance*. CD Howe Institute Commentary (390). Retrieved from http://www.cdhowe.org/pdf/Commentary_390.pdf

Richards, J. G., Hove, J., & Afolabi, K. (2008). *Understanding the Aboriginal/non-Aboriginal gap in student performance: Lessons from British Columbia* (December, 2008). CD Howe Institute Commentary (276).

Richards, J. G., & Scott, M. (2009). *Aboriginal education: Strengthening the foundations.* (Canadian Policy Research Networks Research Report 51894). Retrieved from http://www.cprn.org/doc.cfm?doc=2088&l=en

Richards, J. G., Vining, A. R., & Weimer, D. L. (2010). Aboriginal performance on standardized tests: Evidence and analysis from provincial schools in British Columbia. *Policy Studies Journal, 38*(1), 47-67.

Roberts, D. A. (1983). *Scientific literacy: Towards a balance for setting goals for school science programs*. Ottawa, ON: Minister of Supply and Services.

Roberts, D. A. (2007, May). *Opening remarks*. Paper presented at the 2007 Linné Scientific Symposium, Uppsala, Sweden. Retrieved from http://nadidaktik.se/MSU/sem9/Linneproceedings.pdf

Saskatchewan Education. (2005a). *Action plan 2000-2005: Conclusion, 2005.* Saskatoon, SK: Author. Retrieved from http://www.education.gov.sk.ca/aepac-action-plan

Saskatchewan Education. (2005b). *Core curriculum components and initiatives 2005.* Saskatoon, SK: Author. Retrieved from http://www.curriculum.gov.sk.ca/

Saskatchewan Joint Task Force on Improving Education and Employment Outcomes for First Nations and Métis People. (2013). *Voice, vision and leadership: A place for all,* Final Report. Retrieved from http://www.jointtaskforce.ca/wp-content/uploads/2013/04/Joint-Task-Force-Final-Document.pdf

Schwartz, D. (2013, November 4). *First Nations education needs fresh ideas, leaders say; Looking for the 'learning spirit' in the First Nations Education Act* (CBC News: Analysis). Retrieved from http://www.cbc.ca/news/canada/first-nations-education-needs-fresh-ideas-leaders-say-1.2255180

Science Education Assessment Resource. (2004). *Scientific literacy progress map.* Australian Council for Educational Research for the Commonwealth Department of Education, Science and Training. Retrieved from http://cms.curriculum.edu.au/repo/cms2/sear/published/3539/slprogmap.pdf

Searle, J. R. (1995). *The construction of social reality*. New York, NY: Simon & Schuster.

Shermer, M. (2002). The shamans of scientism. *Scientific American*, *286*(1), 3.

Snively, G., & Corsiglia, J. (2000). Discovering Indigenous science: Implications for science education. *Science Education, 85*, 6-34.

Snively, G., & Williams, L. (2006). The Aboriginal knowledge and science education research project. *Canadian Journal of Native Education, 29*(2), 229-244.

Snively, G., & Williams, L. (2008). Coming to know: Weaving Aboriginal and western science knowledge, language, and literacy into the science classroom [Special Issue]. L1-*Educational Studies in Language and Literature, 8*(1), 109-133.

Snow, C. E., & Biancarosa, G. (2003). *Adolescent literacy and the achievement gap: What do we know and where do we go from here?* Adolescent Literacy Funders Meeting Report. New York, NY: Carnegie Corporation.

Stake, R. E. (1995). *The art of case study research*. Thousand Oaks, CA: SAGE.

Sutherland, D. (2002). Exploring culture, language and the perception of the nature of science. *International Journal of Science Education, 24*(1), 1-25.

Sutherland, D., & Henning, D. (2009). Ininiwi-Kiskanitamowin: A framework for long-term science education. *Canadian Journal of Science, Mathematics and Technology, 9*(3), 173-190. doi:10.1080/14926150903118359

Te Kotahitanga. (n.d.). *Te Kotahitanga; Making a difference in Maori education*. Wellington, New Zealand: Ministry of Education. Retrieved from http://tekotahitanga.tki.org.nz/About

Tenning, A. (2013). *SD67 Aboriginal education program: Mid-year summary*. Retrieved from http://www.bced.gov.bc.ca/abed/annual_reports/2011_2012/SD_67_ mid_year_report_2013.pdf

Tippins, D. J., Mueller, M. P., van Eijck, M., & Adams, J. D. (Eds.). (2010). *Cultural studies and environmentalism: The confluence of ecojustice, place-based (science) education, and Indigenous knowledge systems*. New York, NY: Springer. doi:10.1007/978-90-481-3929-3

Tobin, K. G. (2008). Contributing to the conversation in science education. *Cultural Studies of Science Education, 3,* 539-540. doi:10.1007/s11422-008-9143-8

Trosper, R. (2009). *Resilience, reciprocity and ecological economics: Northwest coast sustainability.* Hoboken, NJ: Routledge.

Truth and Reconciliation Commission of Canada. (2012a). *Canada, Aboriginal peoples, and residential schools: They came for the children*. Retrieved from http://www.myrobust.com/websites/trcinstitution/File/2039_T&R_eng_web[1].pdf

Truth and Reconciliation Commission of Canada. (2012b). *Truth and Reconciliation Commission of Canada: Interim report*. Retrieved from

http://www.myrobust.com/websites/trcinstitution/File/Interim%20report%20English%20electronic.pdf

Tuhiwai Smith, L. (1999). *Decolonizing methodologies: Research and Indigenous peoples*. London, England: Zed.

Tuhiwai Smith, L. (2005). Building a research agenda for Indigenous epistemologies and education. *Anthropology and Education Quarterly, 36*(1), 93-95.

Wagner, T. (2010). *The global achievement gap: Why even our best schools don't teach the new survival skills our children need – and what we can do about it*. New York, NY: Basic Books.

West, L. H., & Pines, A. L. (Eds.). (1985). *Cognitive structure and conceptual change*. New York, NY: Academic Press.

Western and Northern Canadian Protocol. (2010). *Website homepage*. Retrieved from https://www.wncp.ca/english/wncphome.aspx

Yellowhorn, E. (2000). Strangely estranged: Native studies and the problem of science. *Native Studies Review, 13*(1), 71-96.

Yin, R. K. (2014). *Case study research: Design and methods* (5th ed.). Thousand Oaks, CA: SAGE.

Yore, L. D. (2008). Science literacy for all students: Language, culture, and knowledge about the nature and naturally occurring events [Special issue]. *L1—Educational Studies in Language and Literature, 8*(1), 5-21. Retrieved from http://l1.publicationachive.com/show?repository=1&article=213

Yore, L. D. (2012). Science literacy for all: More than a slogan, logo, or rally flag! In K. C. D. Tan & M. Kim (Eds.), *Issues and challenges in science education research: Moving forward* (pp. 5-23). Dordrecht, The Netherlands: Springer. doi:10.1007/978-94-007-3980-2_2

Yore, L. D., & Guo, C.-J. (2008, March). *Cultural beliefs and language practices in learning and teaching science–symposium: The intersection of the influence of schooling, culture, and nature on the motivation of Hawaiian and Taiwanese indigenous children Taiwanese perspective*. Paper presented at the annual meeting of the National Association for Research in Science Teaching, Baltimore, MD.

Yore, L. D., Pimm, D., & Tuan, H-L. (2007). The literacy component of mathematical and scientific literacy. *International Journal of Science and Mathematics Education*, *5*(4), 559-589.

Yore, L. D., & Treagust, D. F. (2006). Current realities and future possibilities: Language and science literacy—empowering research and informing instruction. *International Journal of Science Education, 28*(2-3), 291-314.

Yukon Department of Education. (2009a). *Curriculum, programs and services.* Whitehorse, YT: Author. Retrieved from http://www.education.gov.yk.ca/kto12/index.html

Yukon Department of Education. (2009b). *First Nations programs and partnerships.* Whitehorse, YT: Author. Retrieved from http://www.education.gov.yk.ca/kto12/first_nations_programs.html

Appendices

Appendix A
Background History Influencing the Study

This study cannot be separated from two important historical events that shaped future cultural interactions between the colonists and the colonized, (i.e., the dominant settler culture and the First Peoples' Indigenous culture). These events will be discussed; first, the Indian Residential Schools impact and, second, the Douglas Regime.

Residential Schools (1860–1996)

Discourses of the *other* have no deeper *soul wound* than the devastation of cultures wrought by the residential schools system. Appearing before the Truth and Reconciliation Commission in Montreal in April 2013, former Prime Minister of Canada Paul Martin said that education was used to assimilate Indigenous Peoples of Canada resulting in cultural genocide. It is now incumbent to provide the best education possible for FNMI Peoples. The Truth and Reconciliation Commission of Canada (TRC) was officially established on June 2, 2008, in response to the Indian Residential Schools Settlement Agreement that resulted from a class-action lawsuit brought forward in the 1990s by thousands of First Nations, Métis, and Inuit victims against the Canadian government and Christian churches (most notably, Roman Catholic, Anglican, and United) who ran the IRSs. The $1.9 billion settlement of that suit in 2007 prompted the formation of the TRC initiated by an official apology by the Government of Canada on June 11, 2008, delivered by Prime Minister Stephen Harper. In spite of this apology, the Government has clashed with the TRC over the release of IRS documents; it took an Ontario Supreme Court Order to find and return these documents from the Library and Archives Canada. This prompted Paul Martin to state that "every document is relevant. We have hid this for 50 years. It's existed for 150 [years]. Surely to God, Canadians are entitled … Aboriginal Canadians and non-Aboriginal Canadians, to know the truth. And so let the documents be released." (CBC News, 2013).

On July 1, 2009, the TRC Commissioners — Justice Murray Sinclair (Chair), Chief Wilton Littlechild, and Marie Wilson — assisted by a ten-member IRS Survivor Committee serving as an advisory board to the Commissioners, began their five-year mandate. The following points capture the essence of their Interim Report (TRC, 2012b).

- People have come before the Commission to speak of tragic loss and heroic recovery. Their message is powerful because it touches the lives of parents and children. It is important because it connects our nation's past and future. It is inspiring because those who were oppressed, victimized, and silenced have struggled to heal themselves and regain their voice. (TRC, 2012b, pp. 4 & 5)
- For many, little in the classroom related to their lives. The only Aboriginal people they could recall from their history books were savages and heathen, responsible for the deaths of priests. They told the Commission of how the spiritual practices of their parents and ancestors were belittled and ridiculed. (TRC, 2012b, p. 5)
- People spoke of being sexually abused within days of arriving at residential school. In some cases, they were abused by staff; in others, by older students. Reports of abuse have come from all parts of the country and all types of schools. The students felt they had no one to turn to for help. (TRC, 2012b, p. 5)
- Many students who came to school speaking no English lost the right to express themselves. Students repeatedly told the Commission of being punished for speaking their traditional languages. People were made to feel ashamed of their language — even if they could speak it, they would not, and they did not teach it to their children. (TRC, 2012b, p. 5)
- Many former students also expressed gratitude for the education they received, and spoke of the long-lasting relations that had been developed between some teachers and students, and especially among the students themselves, who became family away from home. (TRC, 2012b, p. 5)
- The Commission also heard about the fun that children had in school. In the presence of a dedicated teacher, some children experienced the pleasure of learning. While traditional Aboriginal games were undermined, many told of how they survived through their participation in sports or the arts. (TRC, 2012b, p. 5)

- Survivors described what happened after they left the schools. People no longer felt connected to their parents or their families. In some cases, they said they felt ashamed of themselves, their parents, and their culture. (TRC, 2012b, p. 6)
- Some said they felt useless in their community. Still others compared themselves to lost souls, unable to go forward, unable to go back. Deprived of their own sense of self-worth, people told us, they spent decades wandering in despair. (TRC, 2012b, p. 6)
- The Commission heard from proud people, people who asserted they were survivors. They had survived mental abuse, sexual abuse, physical abuse, and spiritual abuse. Many have reclaimed their culture, are relearning language, and are practising traditional spirituality. In other cases, they have remained Christians, while infusing their beliefs with a renewed sense of Aboriginal spirituality. (TRC, 2012b, p. 6)

The TRC Interim Report highlighted education as one of the requests made by the IRS survivors to have control over education of their children, whereby education will provide the needed reconciliation. This issue, along with several others presented to the Commission, were clear, urgent, important, and persistent and interim recommendations were put forward, rather than waiting for the completion of its five-year mandate. The recommendation pertaining to education reads:

> There is a need to increase public awareness and understanding of the history of residential schools. This will require comprehensive public-awareness efforts by the federal government and in-school educational efforts by provincial and territorial governments and educational institutions. (TRC, 2012b, p. 7)

Commissioner Littlechild commented at a regional event, "a new path of hope and a new path of reconciliation" is emerging; he left attendees with the rhetorical question, "How do we make things better?" (Author's session notes, April 13–14, 2012).

Accompanying its Interim Report, the TRC produced a resource designed to begin the new path of hope and reconciliation, by telling the true history of the IRS. This history is captured in the publication "They Came for the Children" (TRC, 2012a,). On the title page are the chilling words of Hector Langevin, Public Works Minister, 1883, "In order

to educate the children properly we must separate them from their families. Some people may say that this is hard but if we want to civilize them we must do that." (TRC, 2012a, p. 5). As Chief Justice Sinclair pointed out, this is a story of loss. For over a century,

> residential schools disrupted families and communities. They prevented elders from teaching children long-valued cultural and spiritual traditions and practices. They helped kill languages. These were not side effects of a well-intentioned system: the purpose of the residential school system was to separate children from the influences of their parents and their community, so as to destroy their culture. The impact was devastating. Countless students emerged from the schools as lost souls, their lives soon to be cut short by drugs, alcohol, and violence. The last of the federally supported schools and residences, of which there were at least 150, closed in the 1990s. (TRC, 2012a, p. 1)

The Douglas Regime

An Important Part of History Prior to the IRS

The IRS system was formally instituted about a decade after Canadian Confederation in 1867. However, an equally devastating and sinister plan of assimilation and annihilation was in operation during the Douglas regime in BC from 1843-1864, where relations with First Nations went from trade to colonization in a relatively short period of time. In his book, *Makúk*, Lutz (2008) provided an historical accounting of Aboriginal-White relations, beginning with Makúk's meaning of "let's trade." As he pointed out, this was probably the first word exchanged between trading partners and which the Nuu-Chah-Nulth, on the west coast of Vancouver Island, would translate "to exchange." This concept of "exchange" is seen to resonate throughout the interactions between Indigenous peoples and Europeans, worldwide; and as Lutz (2008) pointed out, these exchanges increased in complexity to include conversation, treaties, wages for labour, marriage, and biological (including viral and genetic, p. 6). It is with this focus on "work for pay" that forms a key part to the greater puzzle of colonization. In BC, it is a question that needs to be addressed, since the Indigenous population prior to 1858 (BC's formal legal creation in London) far outnumbered the settler population. But, the settler population was never legally in a position to claim such a status. The land that the long-established legitimate

governance of Lhtakot'in, Tsilhqot'in, and many other "Native Nations" occupied and had sovereignty over was never the settler's to claim, or any colonial power, for that matter. The Aboriginal peoples, in their territories, welcomed the Europeans as guests; as such, they were accorded equal power as part of the host-guest relationship.

A history that includes the Douglas regime and the IRS would make any population suspicious and distrustful. However, this is not the case, in my observation, of the Coast Salish Peoples and many other FNMI that I have been privileged to meet and call "friend." Resilience is an understated word to describe the continued hope that FNMI Peoples contain, along with great strength in communities that have been ravaged by the ill-will of Euro-western contacts. As a nation, we need to move beyond this ill-will to mutually benefit from each other and seek to sustain ourselves in this energy-addicted and growth-dependent world in which we live.

Appendix B Application for Ethics Approval

University of Victoria

Human Research Ethics Board

Application for Ethics Approval for

Human Participant Research

The following application form is an institutional protocol based on the

Tri-Council Policy Statement on the Ethical Conduct for Research Involving Humans

Instructions:

1. Download this application and complete it on your computer. Hand written applications will not be accepted. The ethical review process takes 4 - 6 weeks.
2. Use the *Human Research Ethics Board Guidelines* to complete this application: http://www.research.uvic.ca/Forms/. Note: This form is linked to the guidelines. Access links in blue text by hitting CTRL and clicking on the blue text.
3. Submit one (1) original and two (2) copies of this completed, signed application with all attachments to: Human Research Ethics, Administrative Services Building (ASB), Room B202, University of Victoria, PO Box 1700 STN CSC, Victoria BC V8W 2Y2 Canada
4. If you need assistance, contact the Human Research Ethics Assistant at (250) 472-4545 or ethics@uvic.ca
5. Please note that applications are screened and will be returned to the applicant if incomplete (e.g. missing required attachments, signatures, documents).
6. Once approved, a Request for Renewal must be completed annually for on-going projects for continuing Ethics approval.

A. Principal Investigator

If there is more than one Principal Investigator, provide their name(s) and contact information below in Section B, Other Investigator(s) & Research Team.

Last Name: **Neill** First Name: **Brian**

Department/Faculty: **Curriculum & Instruction/Education** Email: **briann@uvic.ca**

Phone: Fax:

Mailing Address including Postal Code:

(if different from Dept/Faculty)

Title/Position:

✓ **X** Ph.D. Candidate

Students: Provide your Supervisor's:

Name: **Leslee Francis Pelton** Email: **lfrancis@uvic.ca**

Department/Faculty: **Curriculum & Instruction/Education** Phone: **250-721-7886**

Graduate Students: Provide your Graduate Secretary's email address: **edcigrad@uvic.ca**

B. Project Information

Project Title: **Different 'Ways of Knowing' interact at the confluence of Indigenous Knowledge and Euro-Western Science Knowledge to influence outcomes in secondary science education.**

Anticipated Start Date: **August, 2012** Anticipated End Date: **August, 2013**

Geographic location(s) of study: **Heiltsuk First Nations, Bella Bella and Victoria, BC**

Keywords: 1. **Indigenous knowledge** 2. **Secondary science** 3. **Euro-Western Science** 4. **Education**

- ✓ Is this application connected/associated/linked to one that has been recently submitted? **X No**

If yes, provide further information:

Other Investigator(s) and Research Team:

(*Include co-investigators, students, employees, volunteers, community organizations. The form will expand.)*

Contact Name	Role in Research Project	Institutional Affiliation	Email or Phone

For Faculty Only: Graduate Student/Research Assistant who will use this data to fulfill UVic thesis/ dissertation/ academic requirements.

Student/Research Assistant	Email or Phone

C. Agreement and Signatures

Principal Investigator and Student Supervisor affirm that:

- *I have read this application and it is complete and accurate.*
- *The research will be conducted in accordance with the University of Victoria regulations, policies and procedures governing the ethical conduct of research involving human participants.*
- *The conduct of the research will not commence until Ethics approval has been granted.*
- *The researcher(s) will seek further HREB review if the research protocol is modified.*
- *Adequate supervision will be provided for students and/or staff.*

Principal Investigator Student's Supervisor

Signature	*Signature*

Brian W Neill	**Leslee Francis Pelton**
Print Name	Print Name
August 2, 2012	August 2, 2012
Date	Date

Chair, Director or Dean

I affirm that adequate research infrastructure is available for the conduct and completion of this research.

Signature

Print Name

Date

D. Project Funding

Have you applied for funding for this project? **X No**

Has notice of award been received? **X No**

If yes, please complete the following:

Source(s) of Project Funding	Project Title used in Funding Application(s)

Will this project receive funding from US Funders (*e.g. NIH*)? **X No**

If yes, provide further information:

E. Level of Risk

The Tri-Council Policy Statement (TCPS) definition of "minimal risk" is as follows:

> The research can be regarded as within the range of minimal risk if potential participants can reasonably be expected to regard the probability and magnitude of possible harms implied by participation in the research to be no greater than those encountered by the participant in those aspects of his or her everyday life that relate to the research. The designation of minimal or non-minimal risk affects the way the application is reviewed not the substance of the ethical review.

Based on this definition, do you believe your research qualifies as "minimal risk" research?

X Yes

Explain your answer by referring to the level of risk stated in the TCPS definition:

There will be no greater risk than those encountered by the participants in their everyday lives.

F. Scholarly Review

What type of scholarly review has this research project undergone?

☐ External Peer Review (*e.g. granting agency*)

X Supervisory Committee or Supervisor—required for all student research projects

☐ None

☐ Other, please explain:

G. Other Approvals and Consultations

Do you need to seek approval from other agencies, community groups, First Nations, local governments, etc?

X Yes ☐ No

(Attach proof of having made request for permission or approval letter. Please forward approvals upon receiving them. Be assured that ethics approval may be granted prior to receipt of external approvals.)

If **Yes**, what types of other approval will you need?

☐ School District, Superintendent, Principal, Teacher

☐ VIHA or other regional government authority. If you are planning to conduct research (including recruitment via poster placement), in a VIHA facility you must use the **Joint UVic/VIHA application form** on the ORS website. Above minimal risk applications, please contact the Ethics Office.

☐ Community Group (e.g., formal organization, informal collective)

X Indigenous Organization (e.g., Treaty Group, Tribal Council)

X Indigenous Community

Approval from an Indigenous community or organization may be required when the research involves Indigenous people in relation to their community or organizational affiliation (whether residing in urban or reserve areas), the cultural knowledge and/or resources of Indigenous people, or where individuals speak on behalf of an Indigenous community or nation.

a. Does your research specifically involve or include in the study's population sample individuals from an Indigenous community or organization?

X Yes

b. Will a particular Indigenous community, group of communities, or organization be a central focus of the research?

X Yes

c. Will the cultural knowledge, resources or heritage of an Indigenous community be a central focus of the research?

X Yes

d. If you answered "yes" to questions a), b), or c) have you consulted with the Indigenous community or communities for this study?

X Yes

e. If you answered "yes" to question d), describe the process that you have followed or will follow. Include any documentation of consultations and the role or position of those consulted, including their names if appropriate.

- Completed **Heiltsuk Nation Research Registration Form**, 9 May 2012.
- **Harvey Humchitt Sr.** Research Liaison Coordinator at Heiltsuk Integrated Resource Management Department. Contacted by phone and email to receive the Heiltsuk Nation Research Registration form.
- Contact with Diana Chan, Pacific Wild; student internship coordinator.

I HAVE RECEIVED CONDITIONAL APPROVAL FROM THE HEILTSUK FIRST NATION AND HAVE BEEN IN CONSTANT COMMUNICATION WITH THEM. I AM APPENDING (APPENDIX 2) RECENT EMAILS RECEIVED THAT INDICATES MY CONDITIONAL APPROVAL STATUS AS STATED; "*There was consenses on a conditional approval…".*

f. If you answered "no" to question c), briefly justify your decision not to seek Indigenous community approval.

☐ UVic Biosafety Committee Approval**.** Please attach Biosafety Human Materials Form to this application. Note that Ethics Approval is contingent on Biosafety Approval.

☐ Other Approval, please explain:

H. Description of Research Project

1. Purpose and Rationale of Research

Briefly describe in non-technical language:

Please use 150 words or less. The form will expand to the length of your answers.

1a. The research objective(s) and question(s)

Research Objectives

1. Gaps in secondary science and mathematics have been reported in the literature when comparisons are made between Aboriginal and non-Aboriginal populations in Canada; Aboriginal students score approximately 10% below their non-Aboriginal counterparts. This leads to an under-representation of Aboriginal students in tertiary studies of science, where Aboriginal environmental expertise is needed. ***As an initial objective, Aboriginal and non-Aboriginal scores in Grade 12 science and mathematics have been and will be statistically analyzed for the province of British Columbia.***

2. The root cause of many environmental issues facing Aboriginal communities lies in the process of colonization and subsequent policies emanating from governments representing the 'dominant' culture. To provide Aboriginal students with the skills and knowledge to address these issues is of vital importance in sustaining local economies through the empowerment of Aboriginal youth in the processes of protection, reclamation, and revitalization that nurture traditional systems of knowledge and language.

1b. The importance and contributions of the research

By observing how initiatives of the Heiltsuk First Nation Qqs Projects Society and the SEAS Community Initiatives collectively integrate necessary environmental skills to empower Heiltsuk youth to ultimately protect and nurture their traditional lands as informed stewards. This Heiltsuk initiative has the potential to engage Heiltsuk youth in western science processes while encouraging deeper environmental insights by using Indigenous knowledge 'in place'.

This is the third year of a five year initiative and the successes and interactions achieved need to be reported to the academy as a possible 'model' for First Nations' youth in their educational pursuits.

1c. If applicable, provide background information or details that will enable the HREB to understand the *context* of the study when reviewing the application.

Purpose of the Heiltsuk First Nation segment of the Research: **To record the experiences of Heiltsuk First Nation youth as they examine and study their territorial lands using Indigenous Knowledge 'in place', with the environmental 'tools' provided by Euro-Western science. *Overall Purpose of the study*: To identify ways to increase participation and success, in secondary and tertiary science courses, among Aboriginal students in British Columbia.**

Background: **The Heiltsuk First Nation Qqs Projects Society is a nonprofit organization that supports youth, culture, and environment. As part of their mandate, they have partnered with Pacific Wild, an NGO, that provides western science models and technology to monitor the environment. As a five year project, interns are selected from Heiltsuk First Nation youth to study particular aspects of the environment in their territories. It is the impact on the youth that is the focal point of this study. Does this initiative provide stimulus and understanding among the participating youth that will carry them into career paths in science as a result of studying 'in place'?**

I. Recruitment

2. Recruitment and Selection of Participants

2a. Briefly describe the target population(s) for recruitment. Ensure that all participant groups are identified (*e.g. group 1 - teachers, group 2 - administrators, group 3 - parents*).

Group 1: Heiltsuk FN Internship youth participants for years 1 &2; current interns for year 3

Group 2: Heiltsuk FN Elders with connections to the Summer Internship Program

Group 3: Coordinators of the Internship program

2b. Why is this population of interest?

This is a dynamic group of Heiltsuk FN youth that are studying the environment 'in place' in their own territories.

2c. What is the desired number of participants?

10 to 12

2d. What are the salient characteristics of the participants (*e.g. age, gender, race, ethnicity, class, position, etc*.):

Participants: Male/Female, 16-19 year old Heiltsuk FN youth; Heiltsuk FN Elders; SEAS (Supporting Emerging Aboriginal Stewards) Community Initiative Coordinators.

2e. Provide a detailed description of your exact recruitment process. Explain:

i) Who will recruit/contact participants (*e.g. researcher, assistant, third party*)

The SEAS Coordinator will contact the Heiltsuk FN Youth initially, following approval by the Heiltsuk FN Tribal Council. The researcher will contact Elders and Qqs Executive Director upon advice from Harvey Humchitt Sr., Research Liaison Coordinator at Heiltsuk Integrated Resource Management Department.

ii) List and explain any relationship between the investigator(s) and participant(s) (*e.g. acquaintances, colleagues*). Complete item 3 if there is a power over relationship (*e.g. instructor-student, manager-employee*).

The only relationship is the current one of contacting the Heiltsuk First Nation, personally, through the SEAS Coordinator, Diana Chan, based on website information

available.

iii) Describe how recruitment will be done (*e.g. in person, by telephone, letter, snowball sampling, word of mouth, advertisement*) and from what source(s) will the participants be recruited. If applicable, include how contact information for participants will be obtained.

Participant contact information will be through Diana Chan and Harvey Humchitt Sr. This will be followed by an on-site visit by the researcher following the establishment of an appropriate timeline for interviews.

iv) Describe the steps in the recruitment process.

- **SEAS Coordinator, Diana Chan, contacted by email;**
- **Heiltsuk FN Research Liaison Coordinator, Harvey Humchitt Sr., referred to the researcher by Diana Chan and then contacted via email and telephone conversations.**
- **SEAS Coordinator will contact the Heiltsuk FN youth prior to researcher arriving for interviews.**
- **Researcher will send an introductory email to participants prior to arrival in Bella Bella (Waglisla).**

v) Indicate whether the permission of other bodies is required for recruitment (*e.g. school boards*).

As part of the Heiltsuk First Nation Tribal Council acceptance of the research proposal, Heiltsuk FN youth will be approved for contact and interviews.

3. Power-Over

If you are completing this section, please refer to the:

Guidelines For Ethics in Dual-Role Research for Teachers and Other Practitioners

Are you or any of your co-researchers in any way in a position of authority or power over participants? Examples of a "power-over" situation include teachers-students, therapists-clients, supervisors-employees and possibly researcher-relative or researcher-close friend.

☐ Yes **X No** ☐ Varies

If *yes* or *varies*, describe below:

i) The nature of the relationship.
ii) Why it is necessary to conduct research with participants over whom you have power.
iii) What safeguards (steps) will be taken to minimize inducement, coercion or potential harm.
iv) How the dual-role relationship and the safeguards will be explained to potential participants.

Recruitment Materials Checklist:

Attach all documents referenced in this section *(check those that are appended):*

☐ Script(s) – in-person, telephone, 3rd party, e-mail, etc.

☐ Invitation to participate *(e.g. Psychology Research Participation System Posting)*

☐ Advertisement, Poster, Flyer

X None; please explain why *(e.g. consent form used as invitation/recruitment guide)*

The consent form will be used as an invitation to participate in the interview process.

J. Data Collection Methods

4. Data Collection

For community-based research, autobiographical or observational research, please see Appendix III of the Guidelines.

4a. Which of the following methods will be used to collect data? *Check all that apply.*

☒ **Interviewing participants:** **x in-person** **x by telephone** **x using web-based technology** (explain) **transcriptions of audio recorded interviews will be sent using 'Drop Box' for authentication; USE OF 'SKYPE' FOR INTERVIEWS OF INTERNS THAT CANNOT BE CONDUCTED FACE-TO-FACE IN BELLA BELLA.** ☐ Conducting group interviews or discussions (including focus groups)	☐ Attach draft interview questions
☐ **Administering a questionnaire or survey:** ☐ In person ☐ by telephone ☐ mail back ☐ email	☐ Attach questionnaire or survey: ☐ standardized (one with established reliability and validity)

☐ web-based ☐ Other, describe:	☐ non-standardized (one that is un-tested, adapted or open-ended)
☐ **Administering a computerized task** (*describe in 4b*)	
☐ **Observing participants** *[In 4b, describe who and what will be observed. Include where observations will take place.]*	
☒ **Recording of participants using**: **x audio** ☒ video **x photos or slides**	☒ Images used for analysis **x Images used in disseminating results** [*include release to use participant images in consent materials]*
Analyzing secondary data or secondary use of data (Refers to information/data that was originally gathered for a purpose other than the proposed research and is now being considered for use in research., *e.g. patient or school records, personal writings, lesson plans).* ☒ Secondary data involving anonymized information (Information/data is stripped of identifiers by another researcher or institution **before** being shared with the applicant*).* May be eligible for Application for a Waiver from Full Ethical Review) **x Secondary data with identifying information** (Data contains names and other information that can be linked to individuals*, e.g., student report cards, employment records, meeting minutes, personal writings).* *In item 4b describe the source of the data, and explain whether and how consent was obtained from the individuals for use of their data.*	
☐ **Using human samples** (*e.g., saliva, urine, blood, hair*) *Ensure that you apply to the Biosafety Committee for the storage and use of biological materials. Also, complete the Human Materials Form, have it signed and attach it to your application. If using human tissue **only**, skip to 7g-8, 11-end.*	
☐ **Other**, specify:	

4b. Provide a sequential description of the procedures/methods to be used in your research study. List all of the research instruments and interview/discussion questions, and in an appendix provide copies of all instruments. If not yet available, provide drafts or sample items/questions. For multi-method or other complex research, use the following sections in

ways best suited to explain your project. If you have more than one participant group, be sure to explain which participant group(s) will be involved in which activity/activities.

Research Methodology: *Narrative* Inquiry, or, the life story interview will be used to avoid debates around theoretical approaches, because it is, first and foremost, concerned with getting the entire subjective story of the life lived in the words of the person who has lived it rather than with primarily addressing a particular research agenda. The focus is therefore on *experience* identified by both the personal and the cultural along with the importance of the continuity of experience within both realms. The use of this methodology with its *life story and experiential* focus aligns well with Indigenous knowledge transmission and 'ways of knowing'. Therefore, interviews will be conducted in a semi-structured framework that will allow for individual disclosures of experiences within their internship during the SEAS initiative.

INTERVIEWS OF INTERNS WILL BE CONDUCTED AND ANALYZED USING AN OLYMPUS VN-5200 PC DIGITAL VOICE RECORDER; THERE WILL BE NO VIDEO RECORDING OF INTERN INTERVIEWS. HOWEVER, VIDEO RECORDINGS THAT ARE PUBLISHED IN THE PUBLIC DOMAIN (YOUTUBE) BY THE INTERNSHIP PROGRAM PARTICIPANTS, MAY BE USED IN ANALYSIS AND DISSEMINATION OF INFORMATION IN WRITTEN FORM ONLY. ANY PHOTO LINKAGES TO RESEARCH DATA WILL ASSIST IN DESCRIBING THE FIELD WORK OF THE INTERNS AND WILL NOT BE DIRECTLY LINKED TO AN INDIVIDUAL'S INTERVIEW ANSWERS, BUT WILL FORM PART OF THE 'RESEARCH STORY' FOR ALL PARTICIPANTS. MANY PHOTOS ARE ALREADY IN THE PUBLIC DOMAIN IN THE FORM OF 'BLOGS'; HOWEVER, OTHER PHOTOS MAY BE USED AS THEY ARE PROVIDED BY THE INTERNSHIP PROGRAM COORDINATOR. PERMISSION TO USE PHOTOS THAT SHOW DATA GATHERING TECHNIQUES USED IN THE FIELD WORK BY THE INTERNS WILL BE REQUESTED IN EITHER THE PARENT/GUARDIAN CONSENT FORM OR THE PARTICIPANT CONSENT FORM.

4c. Where will participation take place? (Provide specific location, *e.g., UVic classroom, private residence, participant's workplace*)

Waglisla (Bella Bella); Heiltsuk First Nation Territories.

4d. How much time will be required of participants?

Approximately 2 to 5 hours in total for each participant.

4e. Will participation take place during participants' office hours or instructional time? If so, indicate whether other permission (*e.g. from workplace supervisor*) is required.

Participation will take place during 'free time' for the internship students. For other participant interviews; no interruption of regular duties will occur. Participants will all be on their own time.

Data Collection Methods Checklist:

Attach all documents referenced in this section *(check those that are appended):*

☐ Standardized Instrument(s)

☐ Survey(s), Questionnaire(s)

☐ Interview and/or Focus Group Questions

☐ Observation Tools

K. Possible Inconveniences, Benefits, Risks and Harms to Participants

5. Benefits

Identify any potential or known benefits associated with participation and explain below.
Keep in mind that the anticipated benefits should outweigh any potential risks.

☒ To the participant ☒ To society ☒ To state of knowledge

- **Benefit to the participant in articulating his/her experiential 'story' integrated with participation in the eight week internship and the potential of 'meaningful' and culturally responsive feedback and questioning. A possible outcome might be the articulation of a personal 'career path' for the participant.**
- **Benefit to the Heiltsuk First Nation by the creation of a chronology of personal student experiences connected to their territory.**
- **Benefit to society as a whole by gaining an appreciation for the work and dedication of the participants and the need for all citizens to be concerned about the conservation of Territorial lands and the environment as a whole.**
- **Benefit to the 'state of knowledge' by informing other concerned parties, such as the Canadian Association for the Study of Indigenous Education (CASIE) and many others in the 'academy'.**

6. Inconveniences

Identify and describe any known or potential inconveniences to participants:

Consider all potential inconveniences, including time devoted to the research.

The interview time followed by verification of transcribed 'stories' will be somewhat time consuming and could be an inconvenience to the participants.

7. Estimate of Risks

Could this study involve the following? Please answer each question by putting an **X** in the appropriate boxes:

7a. Could a participant feel demeaned or embarrassed during their participation in the research?

x Very unlikely ☐Possibly ☐Likely

7b. Could a participant feel fatigued or stressed due to the research?

x Very unlikely ☐Possibly ☐Likely

7c. Could a participant experience any other emotional or psychological discomfort as a consequence of participation?

xVery unlikely ☐Possibly ☐Likely

7d. Is there any social risk, possible stigmatization, loss of status, privacy and/or reputation?

x Very unlikely ☐Possibly ☐Likely

7e. Are there any physical risks?

x Very unlikely ☐Possibly ☐Likely

7f. Could a participant experience any economic risk? (e.g. job security, job loss)

x Very unlikely ☐Possibly ☐Likely

7g. Do you see any chance that participants may be harmed in any other way? (e.g. risk to community)

x Very unlikely ☐Possibly ☐Likely

PHOTOS OF INTERNS WILL BE SELECTED TO EXPLAIN THE SCIENTIFIC FIELD WORK UNDERTAKEN BY THE INTERNS. PERMISSION TO USE SELECTED PHOTOS IN THIS REGARD WILL BE REQUESTED IN EITHER THE PARENT/GUARDIAN CONSENT FORM, OR THE PARTICIPANT CONSENT FORM.

8. Possible Risks

If you indicated in Item 7 (a) to (g) that any risks are *possible* or *likely*, please explain below:

8a. What are the risks?

PHOTO RECOGNITION OF PARTICIPANT INTERNS.

8b. What will you do to try to minimize or prevent the risks?

USE PHOTOS THAT 'HIDE' THE IDENTITY OF THE PARTICIPANT, OR CHOOSE PHOTOS WHERE IDENTITY IS NOT AN ISSUE.

8c. How will you respond if the risk of harm occurs? (*e.g. what is your plan?*)

PHOTO USE WILL BE VERBALLY IDENTIFIED AND THE PARTICIPANT INTERNS WILL BE ASKED TO ADDRESS THIS ON THE PARTICIPANT OR PARENTAL/GUARDIAN CONSENT FORM.

9. Deception

Will participants be fully informed of everything that will be required of them prior to the start of the research session?

x Yes ☐ No *(If no, complete the Request to Use Deception form on the ORS website.)*

L. Compensation

10. Compensation

10a. Is there any compensation for participating in the research *(e.g. gifts, honorarium, bonus points, reimbursement for transportation, parking, childcare, etc.)*?

☐ Yes **x No**

If yes, explain the nature of the compensation and why you consider it to be necessary:
Also consider if the amount of compensation could be considered to be a form of inducement.

10b. Explain what will happen to compensation if participants withdraw during or any time after data collection *(e.g. compensation will be pro-rated, full compensation will be given, etc.).*

M. Free and Informed Consent

The following questions address the competence of participants to give consent, the process used in your research to obtain consent, ongoing consent, and the participants' right to withdraw. Consult Appendix V of the Guidelines for further information.

11. Participant's Capacity (Competence) to Provide Free and Informed Consent

Identify your prospective participants: *(Check all that apply.)*

Competent	**Non-Competent**
x Competent adults ☐ A protected or vulnerable population (e.g., *inmates, patients*)	☐ Non-competent adults: ☐ Consent of family/authorized representative will be obtained ☐ Assent of the participant will be obtained
x Competent youth ☐ Youth 13 to 18: consent of youth will be obtained, and parental consent is required due to institutional requirements (*e.g. school districts*) **x** Youth 13 to 16: consent of youth will be obtained, parents will be informed ☐ Youth 13 to 16: consent of youth will be obtained, parents will *NOT* be informed **x** Youth 17 to 18: consent of youth will be obtained, parents will not be informed	☐ Non-competent youth: ☐ Consent of parent/guardian ☐ Assent of the youth will be obtained
☐ Competent children ☐ Children under 13: consent of parent/guardian will be obtained, and child consent will be obtained ☐ Other, explain:	☐ Non-competent children: ☐ Consent of parent/guardian ☐ Assent of the child will be obtained

12. Means of Obtaining Consent:
(*Check all that apply, attach copies of all consent materials, complete item 13)*

x Signed consent. (*Attach consent script(s) and consent form(s) - see template available on ORS Website)*

☐ **Verbal** consent. (*Attach information letter(s). Explain below why written consent is not appropriate and how verbal consent will be documented*.)

☐ **Implied** consent (*e.g. anonymous, mail back or web-based survey. Attach information letter, see template)*

☐ **Other** means. (*Explain below and provide justification.)*

☐ Consent **will not be obtained**. (*Please see TCPS Article 2.1c and explain below)*

Explain consent procedure if "verbal consent," "other" or "consent will not be obtained":

13. Informed Consent

Describe the exact steps you will follow in the process of explaining and obtaining informed consent.

The participants will be given a consent form outlining the interview procedures for their signature. They will also receive a copy of this form for their records. Both copies will be signed by the participants and principal investigator.

PARTICIPANT INTERNS WHO ARE UNDER 16 YEARS OLD WILL BE GIVEN 2 COPIES OF A PARENT/GUARDIAN CONSENT FORM THAT OUTLINES THE RESEARCH AND THE REQUEST FOR THEIR DAUGHTER'S/SON'S PARTICIPATION. PARENTS/GUARDIANS WILL BE ASKED TO SIGN BOTH COPIES OF THE FORM AND RETURN IT TO THE PRINCIPAL INVESTIGATOR PRIOR TO THE INTERVIEW, AT WHICH TIME, THE PRINCIPAL INVESTIGATOR WILL SIGN BOTH COPIES AND RETURN ONE TO PARTICIPANT INTERN (TO BE RETURNED TO THE PARENT/GUARDIAN) AND RETAIN THE OTHER FOR HIS RECORDS. THESE INTERNS WILL BE IDENTIFIED BY THE SEAS COORDINATOR WHO WILL ASSIST WITH THE RECRUITMENT PROCESS. THIS FORM LETTER IS ENCLOSED AS APPENDIX 3.

PARTICIPANT INTERNS WHO ARE 16 YEARS OLD OR OLDER WILL BE GIVEN 2 COPIES OF A PARTICIPANT CONSENT FORM THAT OUTLINES THE RESEARCH AND THE REQUEST FOR THEIR PARTICIPATION. THEY WILL BE ASKED TO SIGN BOTH COPIES OF THE FORM AND RETURN IT TO THE PRINCIPAL INVESTIGATOR PRIOR TO THE INTERVIEW, AT WHICH TIME, THE PRINCIPAL INVESTIGATOR WILL SIGN BOTH COPIES AND RETURN ONE TO PARTICIPANT

INTERN AND RETAIN THE OTHER FOR HIS RECORDS. THESE INTERNS WILL BE IDENTIFIED BY THE SEAS COORDINATOR WHO WILL ASSIST WITH THE RECRUITMENT PROCESS. THE PARTICIPANT FORM LETTER IS ENCLOSED AS SECTION M: FREE AND INFORMED CONSENT.

14. Ongoing Consent

Ongoing consent is required for research that occurs over multiple occasions and/or multiple research activities and/ or extended periods of time (i.e., more than one point of contact, including second interviews, review of transcripts, etc.)

14a. Will your research occur over multiple occasions or an extended period of time?

x Yes ☐ No

14b. If yes, describe how you will obtain and document ongoing consent:

Ongoing consent will be outlined in the initial letter of 'Informed Consent'. Since Narrative Inquiry will involve the recounting of the participants experiences; the transcribed interview of each participant will need to be corroborated.

15. Participant's Right to Withdraw

Free and informed consent requires that participants have the right to withdraw at any time without consequence or explanation.

Describe what participants will be told about their right to withdraw from the research at any time.

The participants right to withdraw at any time will also be included in the 'Informed Consent' letter to be signed by all participants.

16. What will happen to a person's data if s/he withdraws part way through the study or after the data have been collected/submitted? If applicable, include information about visual data such as photos or videos.

x It will not be used in the analysis and will be destroyed.

☐ It is logistically impossible to remove individual participant data (*e.g. anonymously submitted data*).

☐ When linked to group data (*e.g. focus group discussions*), it will be used in summarized form with no identifying information. Include this agreement in the consent form.

☐ It will be used in the analysis if the participant agrees to this. Describe how this agreement will be obtained*:*

Free and Informed Consent Checklist:

Attach all documents referenced in this section *(check those that are appended):*

☐ Consent Form(s) – Include forms for all participant groups and data gathering methods

☐ Letter(s) of Information for Implied Consent

☐ Verbal Consent Script

N. Anonymity and Confidentiality

17. Anonymity

Anonymity means that no one, including the principal investigator, is able to associate responses or other data with individual participants.

17a. Will the participants be anonymous in the data gathering phase of research?

☐ Yes **x No**

17b. Will the participants be anonymous in the dissemination of results *(be sure to consider use of video, photos)*?

☒ No

PHOTOS WILL BE SELECTED TO ENSURE THAT THE INTERN/S CANNOT BE IDENTIFIED DIRECTLY; ANY PHOTOS SELECTED WILL BE FOR LINKING TO THE SCIENTIFIC FIELD WORK BEING CONDUCTED, AS A WAY OF EXPLANING THE FIELD DATA GATHERING TECHNIQUES USED BY THE INTERNS. PERMISSION TO USE SELECTED PHOTOS IN THIS REGARD WILL BE REQUESTED IN EITHER THE PARENT/GUARDIAN CONSENT FORM, OR THE PARTICIPANT CONSENT FORM.

18. Confidentiality

Confidentiality means the protection of the person's identity (anonymity) and the protection, access, control and security of his or her data and personal information during the recruitment, data collection, reporting of findings, dissemination of data (if relevant) and after the study is completed (e.g., storage).

18a. Will the confidentiality of the participants and their data be protected?

☐ No - If confidentiality will not be protected, explain why. If you are asking the participants to waive their right to confidentiality (you plan to identify them with their data), explain what steps will be taken to respect their privacy, if any.

☐ Yes, completely

Yes, with limits (*Check relevant boxes below.)*

- ☐ Limits due to the nature of group activities *(e.g. focus groups)* the researcher cannot guarantee confidentiality
- ☐ Limits due to context: The nature or size of the sample from which participants are drawn makes it possible to identify individual participants *(e.g. school principals in a small town)*
- **x** Limits due to selection: The procedures for recruiting or selecting participants may compromise the confidentiality of participants *(e.g. participants are identified or referred to the study by a person outside the research team)*
- ☐ Limits due to legal requirements for reporting
- ☐ Other:

18b. If confidentiality will be protected, describe the procedures to be used to ensure the anonymity of participants and for preserving the confidentiality of their data *(e.g. pseudonyms, changing identifying information and features, coding sheet, etc)*.

Internship students will be identified as follows: Intern #1 (male); Intern #2 (female); … etc.

18c. If there are limits to confidentiality due to the methods *(e.g. group interview)*, sample size or legal requirements *(e.g. reporting child abuse)* so that you cannot guarantee confidentiality, explain what the limits are and how you will address them with the participants.

THE LIMITS PERTAIN TO 'BLOGS' OF THE INTERNSHIP PROGRAM THAT ARE IN THE PUBLIC DOMAIN CURRENTLY AND AS SUCH, PHOTO RECOGNITION OF THE PARTICIPANTS CAN BE OBTAINED. HOWEVER, FOR THIS STUDY, PHOTOS OF INTERNS WILL BE SELECTED TO EXPLAIN THE SCIENTIFIC FIELD WORK UNDERTAKEN BY THE INTERNS. PERMISSION TO USE SELECTED PHOTOS IN THIS REGARD WILL BE REQUESTED IN EITHER THE PARENT/GUARDIAN CONSENT FORM, OR THE PARTICIPANT CONSENT FORM. IN ADDITION, INTERNS WILL BE IDENTIFIED ANONOMOUSLY, AS ABOVE.

O. Use and Disposal of Data

19. Use(s) of Data

19a. What use(s) will be made of all forms of data collected *(field notes, photos, videos, audiotapes, transcripts, etc.)*?

The data will be used for the researcher's doctoral dissertation and/or research papers and conference presentations.

19b. Will your research data be analyzed, now or in future, by yourself for purposes other than this research project?

☐ Yes **X No** ☐ Possibly

19c. If yes or possibly, how will you obtain consent for future data analysis from the participants *(e.g. request future use in current consent form)*?

19d. Will your research data be analyzed, now or in future, by other persons for purposes other than explained in this application?

☐ Yes **x No** ☐ Possibly

19e. If yes or possibly, by whom and how will you obtain consent from the participants for future data analysis by other researchers *(e.g. request future use in current consent form)*?

20. Commercial Purposes

20a. Do you anticipate that this research will be used for a commercial purpose?

☐ Yes **X No**

20b. If yes, explain how the data will be used for a commercial purpose:

20c. If yes, indicate if and how participants will benefit from commercialization.

21. Maintenance and Disposal of Data

Describe your plans for protecting data during the project, and for preserving, archiving, or destroying all the types of data associated with the research (*e.g. paper records, audio or visual recordings, electronic recordings, coded data*) after the research is completed:

21a. means of storing data (*e.g., a locked filing cabinet, password protected computer files*):

Password protected computer files and audio files transferred directly to computer from audio recorder and stored as wav.files.

21b. location of storing data:

At the principal researcher's residence.

21c. duration of data storage (if data will be kept indefinitely, explain):

One to two years past satisfactory completion of the principal investigator's doctoral program.

21d. methods of destroying or archiving data:

Audio files will be erased and transcribed data and computer files will be archived and password protected and destroyed within two years of

satisfactory completion of the principal investigator's doctoral program.

22. Dissemination

How do you anticipate disseminating the research results? (*Check all that apply)*

x Thesis/Dissertation/Class presentation

x Presentations at scholarly meetings **x** Published article, chapter or book

☐ Internet ☐ Media (*e.g. newspaper, radio, TV*)

x Directly to participants and/or groups involved. Indicate how *(e.g., report, executive summary, newsletter, information session*): **A complete dissertation copy/copies will be housed with the Heiltsuk First Nation.**

☐ Other, explain:

P. Researchers

23. Conflict of Interest

23a. Apart from a declared dual-role relationship (Section I, item 3), are you or any of the research team members in a perceived, actual or potential conflict of interest regarding this research project (*e.g. partners in research, private interests in companies or other entities*)?

☐ Yes **X No**

23b. If yes, please provide details of the conflict and how you will manage it:

24. Researcher(s) Qualifications

In light of your research methods, the nature of the research and the characteristics of the participants, what training or qualifications do you and/or your research team have (*e.g. research methods course, language proficiency, committee expertise)*?

Completion of Research Methods courses at UVic and U of Alberta; prior research and publications as well as completion of candidacy requirements at UVic.

25. Risk to Researcher(s)

25a. Does this research study pose any risks to the researchers, assistants and data collectors?

No

25b. If there are any risks, explain the nature of the risks, how they will be minimized, and how they will be responded to if they occur.

Q. Further or Special Questions

26. Multiple Site Research

26a. Does this project involve collection of data at multiple sites within Canada requiring the approval of other sites, bodies or organizations (*e.g., other ethics board(s)*)?

☐ Yes **X** No

26b. If you responded Yes to 27a. above, list the sites, bodies or organizations:

27. International Research

27a. Will this study be conducted in a country other than Canada?

☐ Yes **X** No

27b. If yes, describe how the laws, customs and regulations of the host country will be addressed:

Section J: Data Collection Methods

Interview Guide

Note: Because each participant is unique and brings a unique set of understandings, then each interview will also present a strong measure of uniqueness. Therefore, the following points will serve as a guide to the interview discussion to inform and address the general questions of the research.

Purpose for Conducting the Interviews

To establish testimonial accounts to the research questions that are representative of the participant's own experience and understandings. To record the lived experiences of Heiltsuk First Nation youth as they interact between Indigenous knowledge and western science knowledge systems in the ecosystems of their own territories.

Central Questions to be Discussed

Background to Questions outlining the Purpose of the Study

To report: the impact on Heiltsuk First Nation youth, of their participation in an environmental monitoring initiative provided by an NGO agency, 'Pacific Wild', in coordination with the Qqs Society within the Heiltsuk First Nation territories.

To examine: the participation and performance of Aboriginal students in Grade 12 secondary science and mathematics courses in British Columbia schools to determine current participation and success rates among Aboriginal students when compared to their non-Aboriginal counterparts.

Central research questions

i. Heiltsuk First Nation Internship 'in place'

- Tell me about your 'personal journey' that has brought you to this point in your education and how the internship has affected/impacted you.
- What has surprised you about your internship study? Do you have any disappointments or unexpected outcomes?

- How does the ‘science’ that you studied for the past 8 weeks relate to the ‘science’ that is/was taught in your schooling experience?
- What are your recommendations for learning school-based ‘science’? Do you see a ‘career path’ for yourself in ‘science’?
- There is an ‘achievement gap’ reported in science and mathematics in British Columbia; what do you feel are the factors contributing to this ‘gap’?
- In Canada, a Two-Row Wampum approach has been articulated (interviewer to explain): is this a viable approach to take in science and mathematics education in BC?
- What would a culturally-responsible curriculum look like that would be inclusive of Indigenous Knowledge and Euro-Western knowledge in science and mathematics? How does this relate to your Internship experience?

Appendix C Heiltsuk Approval Correspondence

Subject: Re: Heiltsuk Approval update

From: "Harvey Humchitt Sr." <harvey.l.humchitt@gmail.com>

Date: Mon, September 10, 2012 2:05 pm

To: briann@uvic.ca

Priority: Normal

Options: View Full Header | View Printable Version | Download this as a file | View as HTML

Hello Brian

Thank you for your message unfortunately I was away on other matters last week.

There was a lengthy discussion in regards about your application. There was consenses on a conditional approval and I am wording this as it is noted in the discussions,

Diffrent ways of knowing interact at confluence level of Indigenous Knowledge and Euro-Western Science Knowledge to influence outcomes in secondary science education. Comment -wording is vague Looking at educational successes and making it the project positive. It could be a study that focuses on gap analysis for strengthening programmes at the High School level. What is the desired out come of the project? Has it gone through the University of Victoria Ethical review Board since it deals with interviews and interviews minors?
Update on status as it states completion date Sept 15th 2012. Clarify wording of concepts eg."Indigenous Knowledge" why is "inplace" in quotes ? what is "environmental 'too" What is the difference between "personal" and Cultural experience? Could you provide a list of publications and educational CV there was a question of MA if so where,and wht was the title.

Just some points of the discussions I hope this helps you with your

application.

Please feel free to contact me at the office or by e-mail

Harvey

Subject: Re: Heiltsuk Approval update

From: briann@uvic.ca

Date: Mon, September 10, 2012 8:49 pm

To: "Harvey Humchitt Sr." <harvey.l.humchitt@gmail.com>

Priority: Normal

Mailer: SquirrelMail/1.4.21

Options: View Full Header | View Printable Version | Download this as a file

Hello Harvey,

Thank you for your email regarding my research application. I will answer the questions that were raised regarding my conditional approval.

1. Different ways of knowing ... my 'working title' is a bit vague, I'll admit, but what I want to assure you and the reviewers, is that it is not a 'gap' analysis for strengthening programs at the High School level.
However, that would be a nice outcome if the HS programs reflected culturally responsive curricula. This stems from my realization that differing worldviews are at play here among youth, be they First Nations youth or other youth representing many different cultures. I have looked at the statistics from the BC Ministry of Education, and there are gaps, but I also have found representative data where FN Science students scored higher than their non-Aboriginal counterparts.
The work of Maori educators informs my approach to culturally responsive curricula and what is happening with the Qqs initiative and Pacific Wild with the internship program mirrors the approach

taken in Aotearoa (New Zealand) to some degree. And, this is where 'in place' has meaning, since it is within the Heiltsuk community where the study is being conducted.

2. Currently, I have conditional approval from UVic that requires that I re-draft letters of approval for youth under 16, where parental permission will be required. Also, I need to clarify the use of video in my application. I will only use video that has been posted in the public domain (YouTube) and I will not be taking video independently. Also, the Qqs blogs will be a requested source, also in the public domain.
So, UVic approval depends upon Heiltsuk FN approval and my editing of the points already mentioned. Finally, I stated that a copy of my dissertation would be housed with the Heiltsuk FN and acceptance would be a condition of approval.

3. The completion date should read September 15, 2013.

4. Indigenous knowledge currently replaces TEKW (Traditional Ecological Knowledge and Wisdom) in its use, but it has the same intent ... respect for Mother Earth and a very real connection to Mother Earth. With respect to personal and cultural experience; I would expect this to vary somewhat among the interns, since they each bring their own respective worldviews, however, there would be commonalities as a result of their place within the Heiltsuk First Nation community.

5. I am sending my CV along to clarify degrees and publications ... I hold a B.Sc. and M.Sc. from the University of Toronto; an M.Ed. from the University of Alberta.

6. Finally, I would like to repeat the words of Grand Chief Shawn Atleo when he said that; "... in the past education was used as a tool of oppression --- now it has become a tool of emancipation and liberation" (private conversation with him at TRC hearings in April this year in Victoria). It is from this position that I centre my work as I approach it from an anti-colonial stance.

I hope this clarifies your's and the committee's questions regarding my research application.

Best regards, Harvey

Brian

Subject: TEKW

From: "Jennifer Carpenter" <hcec04@yahoo.com>

Date: Wed, September 12, 2012 4:37 pm

To: "briann@uvic.ca" <briann@uvic.ca> (more)

Cc: "HIRMD DIRECTOR" <HDIRECTOR@heiltsuknation.ca> (more)

Priority: Normal

Mailer: YahooMailWebService/0.8.121.416

Options: View Full Header | View Printable Version | Download this as a file | View as HTML

Hello Brian,

Thanks for the information you provided the the questions arising from our Research Advisory Committee's preliminary review of your Research proposal.

Without prejudice to the outcome of the committee's review of your answers, I wanted to share our definition of TEK that is included in the Heiltsuk Guiding Principles for Scientific Research (1995-2011) policy document.

There is an opportunity for learning and better understanding of FN relationship to"nature". My department has researched definitions of TEK and LEK and associated research methodologies and strategies. As you are a curriculum developer there should be a concern not to inadvertently, however well-meaning, continue to perpetuate Western

notions of indigenous knowledge. Here is our working definition,from the Dene Cultural Institute, a leader in early and continuing TEK research:

"TEK...can generally be defined as a body of knowledge built up by a group of people through generations of living in close contact with nature. It includes a system of classification, a set of empirical observations and concepts or understandings about the local environment (often referred to as "the land"), and a system of rules or ethics that governs human behaviour and use of resources. The quantity and quality of this knowledge varies among community members, depending upon gender, age, social status, intellectual capability, and profession (hunter / trapper, spiritual leader, healer, etc.) With its roots firmly in the past, traditional environmental knowledge is both cumulative and dynamic, building upon experience of earlier generations, adapting to socio-economic and environmental changes and adopting useful aspects of technological innovation."

Of course there is much more to it than that from a cultural perspective.

A definition is not an intent. Any framing TEKW simply or fundamentally as "respect for Mother Earth and a very real connection to Mother Earth" says very little, and can perpetuate what some have termed as the Myth of the Ecological Indian--which is really a construct of Western thought. So is "TEK good—Wastern science bad which is a false dichotomy that David Suzuki used to promote. There is a lot more to indigenous knowledge including resource management systems than just being close to nature (who isn't who lives off the land?).

There was a system of resilience, resource enhancement, and many cultural dimensions of "respect" that reinforced certain attitudes and practices toward other living beings(human and non-human). Part of respect also includes social obligations.

You are on the right track in not wanting to prejudice or preclude insight into contemporary world views, but "close to Mother Earth" is a simplistic Western construct. A challenge will be to ask non-leading productive questions that don't convey a preconception of the answer.

Suggest you might want to check out Ronald Trosper, Resilience, Reciprocity, and Ecological Economics, Routledge Studies in Ecological Economics, 2009, if it is in the U.Vic Library, specifically the chapter (2) titled "The 'noble savage' spin game."

Here is part of a longer review of this book that can be found on-line in a link to BC Studies Quarterly: http://www.bcstudies.com/reviews.php?id=838718 Formerly a University of British Columbia professor and a member of he Confederated Salish and Kootenai Tribes of the Flathead Indian Reservation in Montana, Trosper first pierces an enduring myth that stalls any conversation about how some human cultures lived within nature's boundaries – the myth of the Noble Savage. The myth was debunked almost 100 years ago, and again by anthropologist Ter Ellingson in his 2001 book The Myth of the Noble Savage. Trosper further eviscerates the myth's "spin game" by methodically dissecting how First Nations from northern California to southern Alaska exploited a common pool of resources for the collective good. He devotes over half the book to revealing how First Nations' societal regulations protected their resources from overexploitation.

Sincerely,
Jennifer Carpenter, MA Anthropology UBC
Culture & Heritage Manager, HIRMD
Bella Bella, BC V0T 1Z0

Appendix D Consent Forms

University of Victoria
British Columbia • Canada

Department of Curriculum & Instruction

Parent/Guardian Consent Form

Indigenous Knowledge and Secondary Science Education

Your daughter/son is invited to participate in a study entitled "Different 'Ways of Knowing' interact at the confluence of Indigenous Knowledge and Euro-Western Science Knowledge to influence outcomes in secondary science education" that is being conducted by Brian W. Neill.

Brian W. Neill is a doctoral candidate in the Department of Curriculum and Instruction at the University of Victoria and you may contact HIM if you have further questions by email at briann@uvic.ca.

As a GRADUATE student, I am required to conduct research as part of the requirements for a degree in Doctor of Philosophy (Ph.D.). It is being conducted under the supervision of Dr. Leslee Francis Pelton. You may contact my supervisor at 1-250-721-7886 or at lfrancis@uvic.ca.

Purpose and Background

Purpose of the Heiltsuk First Nation segment of the Research: To record the experiences of Heiltsuk First Nation youth as they examine and study their territorial lands using Indigenous Knowledge 'in place', with the environmental 'tools' provided by Euro-Western science. ***Overall Purpose of the study***: To identify ways

to increase participation and success, in secondary and tertiary science courses, among Aboriginal students in British Columbia.

Background: The Heiltsuk First Nation Qqs Projects Society is a non-profit organization that supports youth, culture, and environment. As part of their mandate, they have partnered with Pacific Wild, an NGO, that provides western science models and technology to monitor the environment. As a five year project, interns are selected from Heiltsuk First Nation youth to study particular aspects of the environment in their territories. It is the impact on the youth that is the focal point of this study. Does this initiative provide stimulus and understanding among the participating youth that will carry them into career paths in science as a result of their experience?

Importance of this Research

The root cause of many environmental issues facing Aboriginal communities lies in the process of colonization and subsequent policies emanating from governments representing the 'dominant' culture. To provide Aboriginal students with the skills and knowledge to address these issues is of vital importance in sustaining local economies through the empowerment of Aboriginal youth in the processes of protection, reclamation, and revitalization that nurture traditional systems of knowledge and language. By *observing how initiatives of the Heiltsuk First Nation Qqs Projects Society and the SEAS Community Initiatives collectively integrate necessary environmental skills to empower Heiltsuk youth to ultimately protect and nurture their traditional lands as informed stewards*. This Heiltsuk initiative has the potential to engage Heiltsuk youth in western science processes while encouraging deeper environmental insights by using Indigenous knowledge.

This is the third year of a five year initiative and the successes and interactions achieved need to be reported to the academy as a possible 'model' for First Nations' youth in their educational pursuits.

Participants Selection

Your daughter/son is being asked to participate in this study because of her/his involvement as an intern in the SEAS Community Initiative. This experience enables participants to reflect on ways that western science methods can be used to advantage in the community and perhaps enable the participant to pursue future studies in science-related fields.

What is involved?

Participants who agree to voluntarily participate in this research will be interviewed for approximately one (1) hour using a digital voice recorder, during which time they will be able to express their own storied experience of their internship. A transcript of the interview will be generated and submitted to participants for approval prior to the completion of any written accounting by the principal investigator.

Inconvenience

Participation in this study may cause some inconvenience, including the time taken for the interview and subsequent review of the transcript for approval. To minimize this inconvenience, interviews will be conducted at Bella Bella (Waglisla) in a convenient location to the participant.

Risks

There are no known or anticipated risks to participants by this research.

Benefits

The potential benefits of participation in this research include:

Benefit to the participant in articulating his/her experiential ‘story’ integrated with participation in the eight week internship and the potential of ‘meaningful’ and culturally responsive feedback and questioning. A possible outcome might be the articulation of a personal ‘career path’ for the participant;

Benefit to the Heiltsuk First Nation by the creation of a chronology of personal student experiences connected to their territory;
Benefit to society as a whole by gaining an appreciation for the work and dedication of the participants and the need for all citizens to be concerned about the conservation of Territorial lands and the environment as a whole;
Benefit to the 'state of knowledge' by informing other concerned parties, such as the Canadian Association for the Study of Indigenous Education (CASIE) and many others in the 'academy'.

Voluntary Participation

Participation in this research must be completely voluntary. Participants may withdraw at any time without any consequences or any explanation. Withdrawal from the study will result in personal data removal and destruction.

Anonymity

Although photos and written blogs are in the public domain, as part of the SEAS initiative, this study will select only those photos that are descriptive of the science collection techniques involved, with little direct 'face recognition'. There is a place on this form to sign for any photo use where 'face recognition' cannot be avoided. Audio portions, only, of any public domain videos will be included where needed. Participants will be identified by suitable numbers such as: Intern 1 (male); Intern 2 (female) etc.

Confidentiality

Participant confidentiality and the confidentiality of the data will be protected by erasure of the Audio-taped interviews after the process of transcription approval has been vetted and is agreeable to the participant and principal researcher.

Dissemination of Results

It is anticipated that the results of this study will be shared with others in the following ways: PUBLISHED ARTICLE; and THESIS/DISSERTATION, a copy of which will be housed with the Heiltsuk First Nation.

Disposal of Data

Data from this study will be used in part or whole in the principal researchers' doctoral dissertation and/or any research papers that may arise from the study. Recorded audio data will be destroyed as outlined above.

Contacts

Individuals that may be contacted regarding this study include the principal researcher and/or supervisor cited at the beginning of this form.

In addition, you may verify the ethical approval of this study, or raise any concerns you might have, by contacting the Human Research Ethics Office at the University of Victoria (250-472-4545 or ethics@uvic.ca).

Your signature below indicates that you understand the above conditions of participation in this study and that you have had the opportunity to have your questions answered by the principal investigator and approve the participation of your daughter/son who participated as an intern in the SEAS initiative.

Visually Recorded Images/Data Parent/Guardian to provide initials:

- Photos may be taken for: Analysis _____ Dissemination* _____

*Even if no names are used, the participant may be recognizable if visual images are shown in the results. This pertains to the use of photos in the public domain that are informative of the scientific methods used by the interns. Although every attempt will be made to avoid recognition of interns, this may not be possible in all cases.

Name of Participant	*Signature of Parent/Guardian*	*Date*

Signature of Principal Investigator

A copy of this consent will be left with you, and a copy will be taken by the researcher.

Section M: Free and Informed Consent

University of Victoria
British Columbia • Canada

Department of Curriculum & Instruction

Participant Consent Form

Indigenous Knowledge and Secondary Science Education

You are invited to participate in a study entitled "Different 'Ways of Knowing' interact at the confluence of Indigenous Knowledge and Euro-Western Science Knowledge to influence outcomes in secondary science education" that is being conducted by Brian W. Neill.

Brian W. Neill is a doctoral candidate in the Department of Curriculum and Instruction at the University of Victoria and you may contact HIM if you have further questions by email at briann@uvic.ca.

As a GRADUATE student, I am required to conduct research as part of the requirements for a degree in Doctor of Philosophy (Ph.D.). It is being conducted under the supervision of Dr. Leslee Francis Pelton. You may contact my supervisor at 1-250-721-7886 or at lfrancis@uvic.ca.

Purpose and Background

Purpose of the Heiltsuk First Nation segment of the Research: To record the experiences of Heiltsuk First Nation youth as they examine and study their territorial lands using Indigenous Knowledge 'in place', with the environmental 'tools' provided by Euro-Western science. ***Overall Purpose of the study***: To identify ways to increase participation and success, in secondary and tertiary science courses, among Aboriginal students in British Columbia.

Background: The Heiltsuk First Nation Qqs Projects Society is a non-profit organization that supports youth, culture, and environment. As part of their mandate, they have partnered with Pacific Wild, an NGO, that provides western science models and technology to monitor the environment. As a five year project, interns are selected from Heiltsuk First Nation youth to study particular aspects of the environment in their territories. It is the impact on the youth that is the focal point of this study. Does this initiative provide stimulus and understanding among the participating youth that will carry them into career paths in science as a result of their experience?

Importance of this Research

The root cause of many environmental issues facing Aboriginal communities lies in the process of colonization and subsequent policies emanating from governments representing the 'dominant' culture. To provide Aboriginal students with the skills and knowledge to address these issues is of vital importance in sustaining local

economies through the empowerment of Aboriginal youth in the processes of protection, reclamation, and revitalization that nurture traditional systems of knowledge and language. By *observing how initiatives of the Heiltsuk First Nation Qqs Projects Society and the SEAS Community Initiatives collectively integrate necessary environmental skills to empower Heiltsuk youth to ultimately protect and nurture their traditional lands as informed stewards*. This Heiltsuk initiative has the potential to engage Heiltsuk youth in western science processes while encouraging deeper environmental insights by using Indigenous knowledge.

This is the third year of a five year initiative and the successes and interactions achieved need to be reported to the academy as a possible 'model' for First Nations' youth in their educational pursuits.

Participants Selection

You are being asked to participate in this study because of your involvement as an intern in the SEAS Community Initiative. This experience enables participants to reflect on ways that western science methods can be used to advantage in the community and perhaps enable the participant to pursue future studies in science-related fields.

What is involved?

Participants who agree to voluntarily participate in this research will be interviewed for approximately one (1) hour using a digital voice recorder, during which time they will be able to express their own storied experience of their internship. A transcript of the interview will be generated and submitted to participants for approval prior to the completion of any written accounting by the principal investigator.

Inconvenience

Participation in this study may cause some inconvenience, including the time taken for the interview and subsequent review of the transcript for approval. To

minimize this inconvenience, interviews will be conducted at Bella Bella (Waglisla) in a convenient location to the participant.

Risks

There are no known or anticipated risks to participants by this research.

Benefits

The potential benefits of participation in this research include:

Benefit to the participant in articulating his/her experiential 'story' integrated with participation in the eight week internship and the potential of 'meaningful' and culturally responsive feedback and questioning. A possible outcome might be the articulation of a personal 'career path' for the participant;

Benefit to the Heiltsuk First Nation by the creation of a chronology of personal student experiences connected to their territory;

Benefit to society as a whole by gaining an appreciation for the work and dedication of the participants and the need for all citizens to be concerned about the conservation of Territorial lands and the environment as a whole;

Benefit to the 'state of knowledge' by informing other concerned parties, such as the Canadian Association for the Study of Indigenous Education (CASIE) and many others in the 'academy'.

Voluntary Participation

Participation in this research must be completely voluntary. Participants may withdraw at any time without any consequences or any explanation. Withdrawal from the study will result in personal data removal and destruction.

Anonymity

Although photos and written blogs are in the public domain, as part of the SEAS initiative, this study will select only those photos that are descriptive of the science collection techniques involved, with little direct 'face recognition'. There

is a place on this form to sign for any photo use where 'face recognition' cannot be avoided. Audio portions, only, of any public domain videos will be included where needed. Participants will be identified by suitable numbers such as: Intern 1 (male); Intern 2 (female) etc.

Confidentiality

Participant confidentiality and the confidentiality of the data will be protected by erasure of the Audio-taped interviews after the process of transcription approval has been vetted and is agreeable to the participant and principal investigator.

Dissemination of Results

It is anticipated that the results of this study will be shared with others in the following ways: PUBLISHED ARTICLE; and THESIS/DISSERTATION, a copy of which will be housed with the Heiltsuk First Nation.

Disposal of Data

Data from this study will be used in part or whole in the principal researchers' doctoral dissertation and/or any research papers that may arise from the study. Recorded audio data will be destroyed as outlined above.

Contacts

Individuals that may be contacted regarding this study include the principal researcher and/or supervisor cited at the beginning of this form.

In addition, you may verify the ethical approval of this study, or raise any concerns you might have, by contacting the Human Research Ethics Office at the University of Victoria (250-472-4545 or ethics@uvic.ca).

Your signature below indicates that you understand the above conditions of participation in this study and that you have had the opportunity to have your questions answered by

the principal investigator and agree to participate as an intern in the SEAS initiative program.

Visually Recorded Images/Data Parent/Guardian to provide initials:

- Photos may be taken for: Analysis _____ Dissemination* _____

*Even if no names are used, the participant may be recognizable if visual images are shown in the results. This pertains to the use of photos in the public domain that are informative of the scientific methods used by the interns. Although every attempt will be made to avoid recognition of interns, this may not be possible in all cases.

_____	_____	_____
Name of Participant	*Signature of Participant*	*Date*

_____

Signature of Principal Investigator

A copy of this consent form will be left with you, and a copy will be taken by the researcher.

Appendix E Heiltsuk Research Registration

Approval from external organizations: Heiltsuk First Nation

Heiltsuk Nation Research Registration

Name: **Brian William Neill**

Address: **2100 Cook Street, Victoria, BC, V8T 3R1**

Telephone, email: **250-383-0810;** briann@uvic.ca

Title of Research Project*: Dissertation (Working Title)*

Different 'Ways of Knowing' interact at the confluence of Indigenous Knowledge and Euro-Western Science Knowledge to influence outcomes in Secondary Science Education.

Project Description *(based on the principle of full disclosure)*

i. ***Purpose of the Heiltsuk First Nation segment of the Research***: To record the experiences of Heiltsuk First Nation youth as they examine and study their territorial lands using Indigenous Knowledge 'in place', with the environmental 'tools' provided by Euro-Western science. ***Overall Purpose of the study***: To identify ways to increase participation and success among Aboriginal students in British Columbia who are enrolled in secondary science and mathematics courses.

Research Objectives

1. Gaps in secondary science and mathematics have been reported in the literature when comparisons are made between Aboriginal and non-Aboriginal populations in Canada; Aboriginal students scoring approximately 10% below their non-Aboriginal counterparts. This leads to an under-representation of Aboriginal students in tertiary studies of science, where Aboriginal environmental expertise is needed to defend and protect Aboriginal territories. *As an initial objective, Aboriginal and non-Aboriginal scores in Grade 12 science and mathematics will be statistically analyzed for the province of British Columbia*.

2. The root cause of many environmental issues facing Aboriginal communities lies in the process of colonization and subsequent policies emanating from governments representing the 'dominant' culture. To provide Aboriginal students with the skills and knowledge to address these issues is of vital importance in sustaining local economies through the empowerment of Aboriginal youth in the processes of protection, reclamation, and revitalization that nurture traditional systems of knowledge and language. *A second, and more important, objective is to observe how initiatives of the Heiltsuk First Nation Qqs Projects Society and the SEAS Community Initiatives collectively integrate necessary environmental skills to empower Heiltsuk youth to ultimately protect and nurture their traditional lands as informed stewards*.

ii. Research Methods

1. **Research Methodology**: *Narrative* Inquiry, or, the life story interview will be used to avoid debates around theoretical approaches, because it is, first and foremost, concerned with getting the entire subjective story of the life lived in the words of the person who has lived it rather than with primarily addressing a particular research agenda. The focus is therefore on *experience* identified by both the personal and the cultural along with the importance of the continuity of experience within both realms. The use of this methodology with its *life story and experiential* focus aligns well with Indigenous knowledge transmission and 'ways of knowing'. Therefore, interviews will be conducted in a semi-structured framework that will allow for individual disclosures of experiences within their internship during the SEAS initiative.
2. **Project Phases**:
    a. Interview students who have completed the eight week summer internship program; that is students from 2010 and 2011.
    b. Interview students completing the 2012 summer internship program.
    c. Interview key organizers of the internship program: Diana Chan and Jess Housty.
    d. Interview Brenda Humchitt, Principal BBCS (retired) about the internship program and student achievement in general as it relates to the overall purpose of the study.

e. Possible interview with Larry Jorgenson, Qqs Executive Director; related to the Qqs Projects Society and relationships developed with The Nature Conservancy, Coastwatch and Pacific Wild.
f. Transcribe all interviews, followed by authentication and approval by all interviewees.
g. Obtain permission to use blog posts as they relate to the student internship experiences.
h. Complete writing phase of my dissertation and submit it in its entirety to Heiltsuk First Nation for approval.
i. Consult with Heiltsuk First Nation for approval of all written and/or orally transmitted information (conferences) concerning the internship program described.

iii. Proposed Application of Research Results

Data from this study will be used in part or whole in the principal researcher's doctoral dissertation and/or any research papers that may arise from the study. It is anticipated that the results of this study will be shared with others in the following ways:

- Completion of a doctoral dissertation at the University of Victoria
- Possible published article/s in the Canadian Journal of Native Education
- Conference presentation/s.

iv. Benefits and Potential Risks

- Benefit to the participant in articulating his/her experiential 'story' integrated with participation in the eight week internship and the potential of 'meaningful' and culturally responsive feedback and questioning. A possible outcome might be the articulation of a personal 'career path' for the participant.
- Benefit to the Heiltsuk First Nation by the creation of a chronology of personal student experiences connected to their territory.
- Benefit to society as a whole by gaining an appreciation for the work and dedication of the participants and the need for all citizens to be concerned about the conservation of Territorial lands and the environment as a whole.

- Benefit to the 'state of knowledge' by informing other concerned parties, such as the Canadian Association for the Study of Indigenous Education (CASIE) and many others in the 'academy'.
- Any social, physical or economic risks, possible in other research of this type, would be minimal due to the level of community relationships that would already be in place and not at risk.
- Any risk to the community, that is, Heiltsuk First Nation would be nil, since all published and presented representations of this research would be vetted by Heiltsuk First Nation representatives prior to and written or spoken transmission of the results of the interview process.
- A final note concerning risks resides in the 'informed consent' that will be signed by participants and the principal investigator, outlining the interview procedures, each receiving a personal copy. Participants will be informed of their right to withdraw from the research at any time upon their choosing. Participants in the study will be referred to by number, such as 'Intern # …', to afford anonymity of all participants.

v. Anticipated Date of Completion

September 14, 2012 at the latest, pending any changes to the interview schedule.

Sponsoring Agency

The University of Victoria, Victoria, British Columbia

Funding Agency

The principal investigator, Brian W. Neill, will fund his own personal needs for travel to Waglisla (Bella Bella) and any other expenses incurred by the research.

References

1. **Rebecca V.R. Atleo** (Hai-yu-chis-tulth-axa), MA
   Ahousaht First Nation Director of Education
   rvratleo@gmail.com 250-670-9662
2. **Lynne E. Young**, RN, PhD leyoung@uvic.ca
   Professor; Coordinator of PhD Program
   Associate Director Graduate Education
   University of Victoria School of Nursing, HSD A422

PO Box 1700 STN CSC

Victoria, BC, V8W 2Y2

250-472-5678

3. **Leslee Francis Pelton**, PhD lfrancis@uvic.ca

Department of Curriculum and Instruction

University of Victoria

PO Box 3010

Victoria, BC, V8W 3N4

250-721-7886

Publications

- Neill, B.W. and Wright, K.A. Spermatogenesis in the Hologonic Testis of the Trichuroid Nematode, *Capillaria hepatica* (Bancroft, 1893). **Journal of Ultrastructure Research**, 1973, **44**: 210-234.
- Neill, B.W. and Thompson, M. A Trek Through Time. Newspapers in Education Series, **Edmonton Journal**, 1984. {National Award Winner}.
- Neill, B.W. and Thompson, M. Journey to the Pole ('A Modern Odyssey on Ice'). Newspapers in Education Series, **Edmonton Journal**, 1985.
- Neill, B.W. and Author Team. Water Literacy Series, S.E.E.D.S. for **Alberta Environment**, July 1986.
- Neill, B.W. and Author Team. Grades 7 & 8 Texts, Journeys in Science. **Collier-MacMillan Publishers**, Toronto, 1986 and 1989.
- Neill, B.W. Teacher Guides for **High School Science Series**:
    - Program 6: Moving Mountains
    - Program 7: The Athabasca: A Case Study
    - Program 8: Back to the Sun
    - Program 9: Choosing Science

  For **ACCESS Network** and **Alberta Education**, 1990.

- Neill, B.W. Biology 20 Modules
  Alberta Distance Learning, July 1992.

- Neill, B.W. Created Scripts and edited scripts written by teacher presenters for the telecourse series, BiologiX, which produced 43 curriculum-related videos. Produced for **Alberta Education** and **ACCESS, the Education Station**, 1995, 1996.
- Neill, B.W. Created Scripts and edited scripts written by teacher presenters for the telecourse series, Chemistry Connections, which produced 50 curriculum-related videos. Produced for **Alberta Education** and **ACCESS, the Education Station**, 1995, 1996.
- Neill, B.W. Developed four Interactive Multi-Media presentations for Science 20 on-line course. For **Critical Fusion** and **Alberta Distance Learning**, 1998.

- Neill, B.W. Creation of On-Line course material for Biology, Chemistry, Physics and Science. Produced for **Edmonton Public School Board**, **LearnNET**, 1997 to 2001.
- Neill, B., Francis Pelton, L., and Pelton, T. (2012). Performance of Aboriginal Students in British Columbia's Science and Mathematics Curricula articulates a need to 'indigenize' science at the secondary level. *Canadian Journal of Native Education* (**pending**).

A Final Note: Any errors or omissions deemed necessary by the Heiltsuk Tribal Council will happily be corrected. I would also welcome any suggestions that would make this study a meaningful contribution to the Heiltsuk First Nation and to the Academy in general.

Signed & Dated:

Brian W. Neill 9 May 2012

Appendix F Offensive Article shared at Heiltsuk Meeting

Educate First Nations to be modern citizens

Don Olsen, The Daily News

Published: Wednesday, March 27, 2013

It was only 12,000 years ago, or less and this should be considered: In all those years the so called First Nations:

- Never “discovered” the wheel
- Never had a written language
- Never discovered astronomy
- Had no science or scientific discoveries
- Had no mathematics
- Made no medical discoveries
- Never had written music
- Only “figured out” a drum and a rattle for musical instruments
- Had no metallurgy
- Had no sails for boats (only had canoes)
- Created virtually no mechanical devices
- Possessed almost nothing that required hard manual labour over a period of time, i.e.: building with or carving out of stone
- Made almost no inventions
- Are just in the last 200 years getting caught-up to most of the rest of the world
- Have a history that is notable only for underachievement. Are these people in trouble? Yes.

Do they need help? Yes.

Are they responsible enough to look after themselves and efficiently spend the billions the tax payers give them? Certainly not.

The only way to fix this situation is to bring them into society as equals. They should be getting jobs and paying taxes like the rest of us because in reality, they are no more special than any of the other hundred or more cultures that call Canada home.

Turn off the taps. Do away with this “traditional use” and “cultural” nonsense. Educate their children to become modern citizens.

Instead of finding their identity and source of pride in some folks who occupied the land 15,000 years ago. Let them stand or fall on their own account.

Just like the rest of us have to do.

Don Olsen Nanaimo

Appendix G Science and Mathematics Data

Science and Mathematics Data for 2001–07 provided by the British Columbia Ministry of Education

		Aboriginal Students						Non-Aboriginal Students					
School type	Course	Exam mark A count	Exam mark B count	Exam mark C+ count	Exam mark C count	Exam mark C- count	Exam mark F count	Exam mark A count	Exam mark B count	Exam mark C+ count	Exam mark C count	Exam mark C- count	Exam mark F count
2001/2002													
Independent	Applications of Mathematics 12 Comb	0.	0.	0.	0.	0.	22.	0.	0.	8.	6.	2.	16.
Independent	Biology 12 Comb	2.	2.	0.	0.	0.	22.	716.	824.	314.	404.	648.	478.
Independent	Chemistry 12 Comb	2.	0.	2.	2.	0.	0.	774.	708.	242.	218.	236.	268.
Independent	Principles of Mathematics 12 Comb	2.	0.	0.	0.	4.	8.	1,056.	1,256.	406.	392.	376.	328.
Independent	Physics 12 Comb	0.	0.	0.	0.	0.	0.	368.	376.	144.	154.	146.	138.
Public	Applications of Mathematics 12 Comb	0.	0.	4.	2.	2.	12.	14.	88.	182.	240.	130.	226.
Public	Biology 12 Comb	58.	124.	72.	84.	182.	236.	5,772.	6,698.	3,298.	3,854.	6,384.	6,036.
Public	Chemistry 12 Comb	20.	64.	30.	52.	52.	64.	7,344.	6,000.	2,370.	2,444.	2,660.	2,536.
Public	Principles of Mathematics 12 Comb	36.	96.	62.	84.	88.	98.	8,920.	10,322.	4,236.	4,396.	4,134.	4,006.
Public	Physics 12 Comb	18.	34.	14.	28.	32.	24.	3,420.	4,088.	1,472.	1,780.	2,112.	2,098.
2002/2003													
Independent	Applications of	0.	0.	0.	0.	2.	6.	0.	4.	10.	24.	22.	36.

		Aboriginal Students						Non-Aboriginal Students					
School type	Course	Exam mark A count	Exam mark B count	Exam mark C+ count	Exam mark C count	Exam mark C- count	Exam mark F count	Exam mark A count	Exam mark B count	Exam mark C+ count	Exam mark C count	Exam mark C- count	Exam mark F count
	Mathematics 12 Comb												
Independent	Biology 12 Comb	0.	2.	0.	0.	2.	34.	908.	788.	374.	424.	674.	636.
Independent	Chemistry 12 Comb	0.	0.	0.	0.	0.	0.	880.	784.	372.	220.	262.	218.
Independent	Principles of Mathematics 12 Comb	0.	0.	0.	0.	0.	8.	1,442.	1,328.	466.	476.	474.	452.
Independent	Physics 12 Comb	0.	0.	0.	0.	0.	0.	470.	432.	150.	172.	214.	156.
Public	Applications of Mathematics 12 Comb	4.	10.	14.	22.	14.	28.	48.	202.	238.	250.	312.	280.
Public	Biology 12 Comb	76.	98.	88.	130.	208.	246.	6,560.	6,964.	3,316.	3,848.	6,840.	7,370.
Public	Chemistry 12 Comb	40.	64.	52.	46.	62.	68.	7,496.	7,138.	3,150.	2,260.	3,014.	2,618.
Public	Principles of Mathematics 12 Comb	54.	112.	74.	88.	106.	130.	11,278.	10,402.	4,404.	4,650.	4,870.	4,600.
Public	Physics 12 Comb	14.	30.	16.	16.	44.	40.	3,902.	3,616.	1,548.	1,626.	2,636.	1,978.
2003/2004													
Independent	Applications of Mathematics 12 Comb	0.	0.	2.	4.	4.	2.	0.	10.	16.	18.	14.	2.
Independent	Biology 12 Comb	0.	0.	0.	0.	4.	24.	1,030.	848.	414.	294.	606.	460.
Independent	Chemistry 12 Comb	0.	0.	0.	0.	0.	2.	672.	812.	306.	324.	378.	300.
Independent	Principles of Mathematics 12 Comb	0.	0.	0.	0.	2.	0.	1,352.	1,134.	542.	508.	500.	506.
Independent	Physics 12 Comb	0.	0.	0.	0.	0.	0.	368.	476.	204.	168.	236.	156.
Public	Applications	16.	16.	12.	34.	20.	28.	120.	218.	296.	372.	368.	388.

		Aboriginal Students						Non-Aboriginal Students					
School type	Course	Exam mark A count	Exam mark B count	Exam mark C+ count	Exam mark C count	Exam mark C- count	Exam mark F count	Exam mark A count	Exam mark B count	Exam mark C+ count	Exam mark C count	Exam mark C- count	Exam mark F count
	of Mathematics 12 Comb												
Public	Biology 12 Comb	84.	122.	86.	64.	244.	252.	7,342.	6,896.	3,212.	2,452.	7,216.	5,834.
Public	Chemistry 12 Comb	50.	62.	40.	34.	114.	88.	5,750.	6,792.	2,978.	2,448.	3,806.	2,908.
Public	Principles of Mathematics 12 Comb	48.	122.	54.	84.	94.	146.	9,170.	9,656.	4,330.	4,936.	5,314.	5,238.
Public	Physics 12 Comb	30.	32.	20.	16.	68.	36.	3,422.	3,756.	1,778.	1,548.	2,226.	2,134.
													2004/2005
Independent	Applications of Mathematics 10 Comb	2.	0.	2.	14.	2.	6.	14.	56.	22.	42.	20.	6.
Independent	Applications of Mathematics 12 Comb	0.	0.	0.	0.	0.	8.	2.	2.	0.	8.	6.	4.
Independent	Biology 12 Comb	0.	2.	4.	0.	4.	12.	1,210.	884.	382.	350.	622.	446.
Independent	Chemistry 12 Comb	0.	0.	0.	0.	0.	0.	664.	660.	528.	442.	426.	304.
Independent	Essentials of Mathematics 10 Comb	0.	6.	6.	30.	30.	22.	44.	118.	124.	122.	140.	56.
Independent	Principles of Mathematics 10 Comb	2.	4.	4.	16.	24.	10.	1,760.	1,582.	992.	1,142.	1,120.	360.
Independent	Principles of Mathematics 12 Comb	0.	0.	0.	2.	0.	2.	1,324.	1,626.	504.	534.	460.	574.
Independent	Physics 12 Comb	0.	0.	0.	0.	2.	0.	478.	544.	200.	188.	192.	132.
Public	Applications of Mathematics	12.	58.	106.	152.	160.	106.	146.	788.	1,236.	1,406.	1,338.	840.

		Aboriginal Students						Non-Aboriginal Students					
School type	Course	Exam mark A count	Exam mark B count	Exam mark C+ count	Exam mark C count	Exam mark C- count	Exam mark F count	Exam mark A count	Exam mark B count	Exam mark C+ count	Exam mark C count	Exam mark C- count	Exam mark F count
Public	10 Comb Applications of Mathematics	4.	12.	12.	12.	42.	42.	74.	212.	336.	416.	500.	520.
Public	12 Comb Biology 12 Comb	118.	156.	106.	94.	282.	250.	8,170.	6,852.	3,216.	2,812.	6,786.	5,890.
Public	Chemistry 12 Comb	20.	70.	72.	60.	102.	78.	5,996.	5,886.	4,122.	3,106.	3,384.	2,510.
Public	Essentials of Mathematics 10 Comb	32.	236.	362.	476.	668.	426.	296.	1,210.	2,260.	2,970.	3,288.	1,790.
Public	Principles of Mathematics 10 Comb	118.	278.	360.	636.	888.	602.	10,504.	10,864.	8,544.	12,262.	13,146.	5,724.
Public	Principles of Mathematics 12 Comb	42.	158.	98.	122.	148.	138.	9,852.	11,876.	4,192.	4,242.	4,782.	4,764.
Public	Physics 12 Comb	18.	42.	52.	44.	32.	38.	3,624.	4,042.	1,932.	1,584.	1,814.	1,420.
2005/2006													
Independent	Applications of Mathematics 10 Comb	0.	4.	14.	8.	8.	12.	6.	40.	48.	40.	32.	24.
Independent	Applications of Mathematics 12 Comb	0.	0.	0.	0.	4.	4.	6.	12.	4.	4.	4.	6.
Independent	Biology 12 Comb	0.	0.	0.	2.	8.	18.	868.	950.	468.	366.	388.	368.
Independent	Chemistry 12 Comb	0.	0.	0.	0.	4.	2.	664.	720.	446.	486.	362.	234.
Independent	Essentials of Mathematics 10 Comb	4.	4.	4.	16.	30.	20.	50.	118.	176.	190.	148.	36.
Independent	Principles of Mathematics 10 Comb	2.	6.	2.	22.	36.	22.	1,750.	1,596.	1,106.	1,304.	1,548.	516.

		Aboriginal Students						Non-Aboriginal Students					
School type	Course	Exam mark A count	Exam mark B count	Exam mark C+ count	Exam mark C count	Exam mark C- count	Exam mark F count	Exam mark A count	Exam mark B count	Exam mark C+ count	Exam mark C count	Exam mark C- count	Exam mark F count
Independent	Principles of Mathematics 12 Comb	2.	0.	0.	0.	6.	4.	862.	1,106.	620.	592.	482.	428.
Independent	Physics 12 Comb	0.	0.	0.	0.	0.	0.	438.	540.	234.	254.	138.	94.
Public	Applications of Mathematics 10 Comb	16.	70.	140.	182.	198.	190.	186.	990.	1,618.	1,594.	1,450.	1,056.
Public	Applications of Mathematics 12 Comb	14.	20.	42.	36.	30.	22.	124.	424.	778.	276.	298.	286.
Public	Biology 12 Comb	78.	176.	140.	144.	170.	242.	6,448.	7,044.	3,890.	3,818.	4,506.	4,874.
Public	Chemistry 12 Comb	42.	60.	58.	110.	82.	46.	5,292.	5,578.	3,336.	3,448.	2,938.	1,874.
Public	Essentials of Mathematics 10 Comb	68.	278.	478.	626.	938.	512.	452.	1,622.	2,606.	3,270.	4,428.	1,910.
Public	Principles of Mathematics 10 Comb	94.	212.	282.	624.	1,294.	776.	9,648.	10,030.	8,464.	13,528.	17,958.	8,002.
Public	Principles of Mathematics 12 Comb	28.	114.	136.	120.	134.	128.	6,536.	8,242.	5,292.	4,622.	4,058.	3,848.
Public	Physics 12 Comb	24.	40.	32.	42.	22.	12.	3,746.	4,092.	2,238.	1,948.	1,142.	876.
2006/2007													
Independent	Applications of Mathematics 10 Comb	0.	0.	2.	4.	10.	10.	18.	42.	34.	34.	44.	20.
Independent	Applications of Mathematics 12 Comb	0.	0.	0.	0.	0.	0.	0.	2.	0.	0.	0.	0.
Independent	Biology 12 Comb	0.	0.	0.	0.	0.	2.	22.	28.	26.	22.	24.	50.

		Aboriginal Students						Non-Aboriginal Students					
School type	Course	Exam mark A count	Exam mark B count	Exam mark C+ count	Exam mark C count	Exam mark C- count	Exam mark F count	Exam mark A count	Exam mark B count	Exam mark C+ count	Exam mark C count	Exam mark C- count	Exam mark F count
Independent	Chemistry 12 Comb	0.	0.	0.	0.	0.	0.	48.	80.	40.	64.	40.	48.
Independent	Essentials of Mathematics 10 Comb	8.	14.	12.	16.	26.	28.	56.	180.	168.	114.	122.	54.
Independent	Principles of Mathematics 10 Comb	6.	2.	12.	14.	20.	40.	1,708.	1,562.	1,044.	1,428.	1,570.	558.
Independent	Principles of Mathematics 12 Comb	0.	0.	0.	0.	2.	0.	88.	134.	84.	52.	40.	80.
Independent	Physics 12 Comb	0.	0.	0.	0.	0.	0.	44.	62.	36.	42.	20.	16.
Public	Applications of Mathematics 10 Comb	16.	88.	184.	212.	226.	180.	168.	984.	1,576.	1,796.	1,782.	1,360.
Public	Applications of Mathematics 12 Comb	2.	0.	0.	0.	0.	0.	0.	8.	6.	4.	6.	8.
Public	Biology 12 Comb	4.	10.	10.	8.	12.	26.	376.	600.	376.	406.	482.	592.
Public	Chemistry 12 Comb	0.	6.	6.	6.	0.	6.	402.	462.	302.	286.	230.	240.
Public	Essentials of Mathematics 10 Comb	98.	378.	558.	718.	1,026.	744.	708.	2,044.	2,896.	3,282.	4,124.	2,422.
Public	Principles of Mathematics 10 Comb	82.	154.	276.	620.	1,368.	936.	9,382.	9,556.	8,242.	13,038.	18,468.	8,484.
Public	Principles of Mathematics 12 Comb	4.	2.	4.	4.	6.	18.	574.	816.	512.	578.	478.	568.
Public	Physics 12 Comb	2.	2.	8.	0.	2.	0.	270.	434.	278.	230.	154.	106.

Appendix H Qqs Project Society Permission for Vlog and Blog Use

IVa. Approvals to Use SEAS Community Initiative Blogs

Subject: Re: Presentation June5th
From: "Jessie Housty" <JHousty@heiltsuknation.ca>
Date: Fri, April 19, 2013 3:32 pm
To: "briann@uvic.ca" <briann@uvic.ca>
Priority: Normal
Options: View Full Header | View Printable Version | Download this as a file

Brian,
Thanks for the reminder. My apologies - I am in the midst of my busiest time of year.

You can absolutely use the blog content but we'd love where possible and appropriate for questions about the program to be directed back to us (different from questions about your presentation if you know what I mean?)

Unfortunately, I'll just be returning from four weeks out of office (teaching a field course and then attending a conference in Australia) and can't afford to stay down to co-present - but thanks for the offer!

If I can help in any way with your preparations, do let me know -

Best,
Jess

Sent from my iPhone

On 2013-04-18, at 10:31 PM, "briann@uvic.ca" <briann@uvic.ca> wrote:

> Hi Jess,
>
> Just thought I'd "re-connect" to see what your thoughts are regarding this > presentation coming soon. I have attached the original, dated March 31st, for your review.
>
> I'm looking forward to hearing from you.
>
> Take good care~
> Brian

Subject: Re: Qqs and SEAS

From: "Jessie Housty" <JHousty@heiltsuknation.ca>

Date: Fri, May 24, 2013 9:18 pm

To: "briann@uvic.ca" <briann@uvic.ca>

Priority: Normal

Options: View Full Header | View Printable Version | Download this as a file

Brian,
Apologies - I've been out in the field teaching a course for the last couple of weeks and I've been away from my desk. I'm about to board a flight overseas for a conference and intensive meetings. There's a short bio of me on the Qqs staff page and a long one on the Ecotrust Indigenous Leadership page (should be easy to find on Google). My LinkedIn profile should be public. Feel free to highgrade whatever info fits your bill. Sorry I can't do more at the moment but this month is so busy I can hardly keep up. Hope the presentation goes very well!
J

Sent from my iPhone

On 2013-05-22, at 1:04 PM, "briann@uvic.ca" <briann@uvic.ca> wrote:

> Hi Jess,
>
> I know you must be terrifically busy at the moment, however, I need to ask for clarification on use of the following website;
>
> http://www.qqsprojects.org/projects/seas_internship.html
>
> As part of my presentation, I would like to cite this website and put some of the key information about SEAS into my presentation on June 5th. I will ensure that all questions are referred to Qqs Society and not to myself.

>
> As we have previously discussed, I am happy to be a "voice" for the great work that is happening in Waglisla. I will be using your name and title to reference any further questions.
>
> In order to introduce you, and respectfully identify the unceded Heiltsuk territories within which the SEAS initiative is conducted, could you provide a Personal Biography with your contact information, so that I can incorporate it in the presentation?
>
> I will send along my completed presentation, once I have finalized all that needs to be included, pending you approval of my foregoing request. I would be most happy for any additions that you might wish to make. I leave this with you and wish you ...
>
> All the best, Jess ...
>
> Looking forward to hearing from you.
>
> Take good care~
> Brian
>
>
> Brian Neill
> Ph.D. Candidate
> CSSE-CASIE (Canadian Association for the Study of Indigenous Education)
> Faculty of Education
> University of Victoria
> Victoria, BC, Canada
>

Appendix I Pacific Wild Permissions

Subject: Re: Some blog and other questions for you ...

From: "Diana Chan" <diana@pacificwild.org>

Date: Wed, May 29, 2013 8:46 am

To: briann@uvic.ca

Priority: Normal

Mailer: Apple Mail (2.1503)

Options: View Full Header | View Printable Version | Download this as a file | View as HTML

Pacific Wild Feedback

Hi Brian,
It's nice to hear from you. I'll just type my answers below, next to your questions.
Cheers,
Diana

On 2013-05-28, at 3:25 PM, briann@uvic.ca wrote:

> Hi Diana,
>
> Well, I'm underway with my presentation that is coming up on June 5th. I have received permission to use Qqs Society info and blogs from Jess and will be including a video clip also. I have also checked Pacific Wild blogs to make sure I'm not missing anything. However, the inception year 2010 seems to be missing from both blogs. Were there any blogs written in 2010? No, there weren't any blogs written the first year.
>
> From my searches, I'm getting the impression that "The Nature Conservancy" needs to be mentioned in particular for 2010, as the "Virtual Rainforest Initiative" with interviews of yourself, Jaymyn LaVallee and Isiah Dundas. TNC is one of the major funders of the

SEAS program and should be mentioned as a partner.
>
> If I'm interpreting this correctly, 2010, the first year of the SEAS Initiative was not named that until 2011. Also, in spite of other support participants, such as Raincoast, SEAS is primarily Qqs and Pacific Wild now. Is this correct? ***The program that is now SEAS began in 2010 under the name the Virtual Rainforest Initiative. In 2011 it briefly became called Coastal Youth Connections, before settling on the name SEAS Community Initiative. In Bella Bella, SEAS is primarily a partnership between the Bella Bella Community School, Pacific Wild, and Qqs Projects Society. The summer internship (run by Pacific Wild and Qqs) is just a part of the SEAS program. The school has a full-time SEAS coordinator during the school year who organizes locally-relevant lesson plans and activities. Pacific Wild supports this school-year work by streaming live wildlife cameras into the school, visiting classrooms and giving presentations, and leading students on field trips and job shadowing opportunities. There are also SEAS programs in Klemtu, Hartley Bay, and, as of the past few months, Bella Coola. I don't have a full list of the entities involved in the other communities, though I know that the local schools play a large role. This summer Pacific Wild will be leading a sail training program to bring a few of the interns from different communities together to share their experiences and learn skills.***
>
> Here are the SEAS Initiative Partners that I have;
> The Nature Conservancy, Pacific Wild, Bella Bella Community School, Hartley Bay Community School (not active in 2011, 2012?)I believe they are still active, Qqs Projects Society, Gitga'at Land and Resources Stewardship Society, and Cetacea Lab (not active in 2011, 2012?).Kitasoo Community School, Kitasoo Band Council
>
> Interns to date:
> 2010 ... Jaymyn LaVallee (Bella Bella) & Isiah Dundas (Hartley Bay);
> 2011 ... Dennine Reid, Louis Shaw, Christina Campbell, and Richard
> Wilson-Hall; ***I believe there were interns in Hartley Bay, but I don't have their names***

> 2012 ... Jenna Starr, Richard Wilson-Hall, Louis Shaw, Gene Larsen, and William Boss.Blake Carpenter Was Cassandra Innes also an intern?
No. There were also interns in Klemtu (8 of them, I believe) and Hartley Bay, but I do not have their names.
>
> In my writing, the above student names will not be used, so anonymity will be preserved (just necessary for me to keep things straight).
>
> Diana, I would like to ask your permission to use your interview footage from 2010, "The Virtual Rainforest Initiative". I may not use all of it, but certainly enough to introduce you and the coordinator of the program. ***You're welcome to use it.***
>
> I will also be having Heiltsuk representation, Angela Mason, as a co-presenter, so that this topic "Strengthening Science Capacity among First Nation Youth in Bella Bella, B.C." will be delivered with the "appropriate voice" and message.
>
> Diana, my apologies for the great number of questions that I have asked, and my thanks for your understanding and willingness to help get this important message out to a wider audience in the "academy".
>
> I look forward to hearing from you ... I know you must be very busy ~
I hope this helps! Let me know if you have any other questions.
>
> Take good care~
> Brian
>
> Brian Neill
> Ph.D. Candidate
> CSSE-CASIE (Canadian Association for the Study of Indigenous Education)
> Faculty of Education
> University of Victoria
> Victoria, BC, Canada

Pacific Wild Confirmation of Approval and Science Additions

Subject: Re: SEAS Science
From: "Diana Chan" <diana@pacificwild.org>
Date: Wed, November 6, 2013 10:32 am
To: briann@uvic.ca
Priority: Normal
Options: View Full Header | View Printable Version | Download this as a file | View as HTML

Hi Brian,
It's nice to hear from you! Yes, I'm pleased to report that the wolves haven't chewed the cables anymore recently, but that might be partly because there aren't any fish left in the river. We had a great spawning season though!
I've made a couple comments/additions in the document, but it looks good.
And yes, feel free to use my bio.
Best of luck!
Cheers,
Diana

On Tue, Nov 5, 2013 at 12:08 PM, <briann@uvic.ca> wrote:

> Hi Diana,
>
> I am in the final phase of advocating for a "culturally responsive" education, using the SEAS Initiative as a model to move forward.
>
> I have attached a document where I have identified the "science" involved in SEAS Initiative. I realize that the program runs for the full year, but my focus is directed towards the summer interns only.
>
> When you have time could you please look at it and if there are any omissions/corrections to be made, I would be grateful if you would suggest them.
>
> All students have anonymity and I have redacted any names that have appeared in any communication.
>
> Finally, is it still O.K. for me to use your bio info in my writing? I know you said to go ahead previously, but I just want to make sure.
>
> Well, that covers it for now. I hope you're not too busy with the wolves chewing through cables now, but I'm sure you're still very busy.
>
> I look forward to hearing from you!
>
> Best regards,
> Brian

>
>
> Brian Neill
> Ph.D. Candidate
> CSSE-CASIE (Canadian Association for the Study of Indigenous Education)
> Faculty of Education
> University of Victoria
> Victoria, BC, Canada

Appendix J Confirmation of Eduardo Sousa, Greenpeace Blog Entry

Subject: Re: Permission request

From: "Eduardo Sousa" <esousa@greenpeace.org>

Date: Thu, November 21, 2013 4:04 pm

To: briann@uvic.ca

Cc: "Jessie Housty" <jess.housty@gmail.com>

Priority: Normal

Options: View Full Header | View Printable Version | Download this as a file | View as HTML

Hi Brian, absolutely - happy to assist in any way I can.

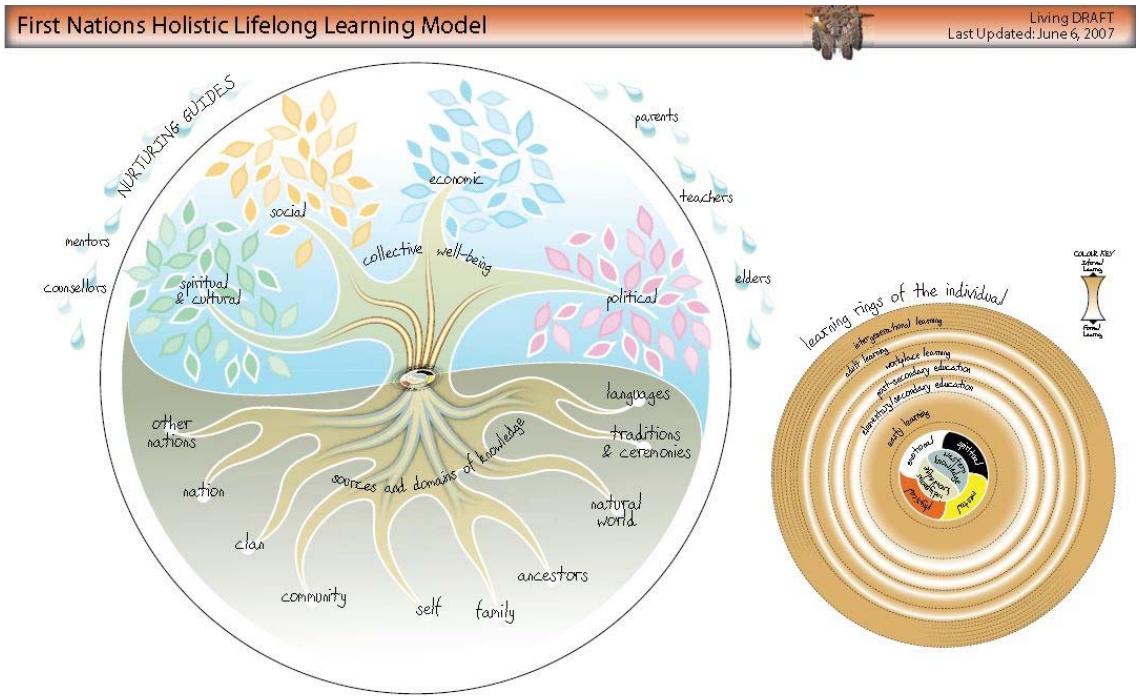
I had planned to write another blog from my experiences at koeye this past summer but still haven't carved the time. It would've been more recent and perhaps more topical than the 2011 piece but in any case feel free to use the 2012 blog post...

On 2013-11-21 3:44 PM, <briann@uvic.ca> wrote:

> Hello Eduardo,
>
> I would like to request your permission to use your blog remarks of July 2011 when you attended the Baxvala Camp in Koeye as a Greenpeace participant in the Qqs Project Society's SEAS Initiative.
>
> Jessie has kindly provided your email address to enable me to communicate this request to you. Jessie is also assisting me with the SEAS intern blogs as part of my study.
>
> I am seeking to bring awareness and reform to the BC Science Education curriculum, whereby Indigenous Knowledge and Euro-western science work together in using these shared knowledges, not only to enhance participation in secondary science courses, but also to empower First Nation students as stewards in guiding this interaction. Using the SEAS initiative as a "model", I believe that

inclusive curriculum development will benefit all students taking science in a process of decolonizing the curriculum.
>
> I am very grateful for Jessie's help with my passion for science education reform and I hope that I can include you, Eduardo, in this endeavor also.
>
> Kindest regards,
> Brian>

Appendix K First Nations Lifelong Learning Model



From Cappon (2008).

Appendix L NSTA Position Statement

NSTA Position Statement

The Nature of Science

Preamble

All those involved with science teaching and learning should have a common, accurate view of the nature of science. Science is characterized by the systematic gathering of information through various forms of direct and indirect observations and the testing of this information by methods including, but not limited to, experimentation. The principal product of science is knowledge in the form of naturalistic concepts and the laws and theories related to those concepts.

Declaration

The National Science Teachers Association endorses the proposition that science, along with its methods, explanations and generalizations, must be the sole focus of instruction in science classes to the exclusion of all non-scientific or pseudoscientific methods, explanations, generalizations and products.

The following premises are important to understanding the nature of science.

- Scientific knowledge is simultaneously reliable and tentative. Having confidence in scientific knowledge is reasonable while realizing that such knowledge may be abandoned or modified in light of new evidence or reconceptualization of prior evidence and knowledge.
- Although no single universal step-by-step scientific method captures the complexity of doing science, a number of shared values and perspectives characterize a scientific approach to understanding nature. Among these are a demand for naturalistic explanations supported by empirical evidence that are, at least in principle, testable against the natural world. Other shared elements include observations, rational argument, inference, skepticism, peer review and replicability of work.
- Creativity is a vital, yet personal, ingredient in the production of scientific knowledge.
- Science, by definition, is limited to naturalistic methods and explanations and, as such, is precluded from using supernatural elements in the production of scientific knowledge.
- A primary goal of science is the formation of theories and laws, which are terms with very specific meanings.
    1. Laws are generalizations or universal relationships related to the way that some aspect of the natural world behaves under certain conditions.
    2. Theories are inferred explanations of some aspect of the natural world. Theories do not become laws even with additional evidence; they explain laws. However, not all scientific laws have accompanying explanatory theories.
    3. Well-established laws and theories must
        - be internally consistent and compatible with the best available evidence;
        - be successfully tested against a wide range of applicable phenomena and evidence;
        - possess appropriately broad and demonstrable effectiveness in further research.

- Contributions to science can be made and have been made by people the world over.
- The scientific questions asked, the observations made, and the conclusions in science are to some extent influenced by the existing state of scientific knowledge, the social and cultural context of the researcher and the observer's experiences and expectations.
- The history of science reveals both evolutionary and revolutionary changes. With new evidence and interpretation, old ideas are replaced or supplemented by newer ones.
- While science and technology do impact each other, basic scientific research is not directly concerned with practical outcomes, but rather with gaining an understanding of the natural world for its own sake.

References

Moore, J. (1993). *Science as a Way of Knowing: The Foundation of Modern Biology*. Cambridge, MA: Harvard University Press.

American Association for the Advancement of Science. (1993). Benchmarks for Science Literacy: Project 2061. New York: Oxford University Press.

National Science Teachers Association. (1997). *The Teaching of Evolution—A Position Statement of NSTA*. Washington, DC.

National Academy of Sciences. (1998). *Teaching About Evolution and the Nature of Science*. Washington, DC: National Academy Press.

McComas, W., Clough, M., & Almazroa, H. (1998). The role and character of the nature of science. In W. F. McComas (Ed.), *The Nature of Science in Science Education: Rationales and Strategies* (pp. 3–39) Boston: Kluwer Academic Publishers.

National Association of Biology Teachers. (1987). *Scientific Integrity—A Position Statement*.

—Adopted by the NSTA Board of Directors, July 2000

Appendix M BC Aboriginal Content Science

ABORIGINAL CONTENT IN THE SCIENCE CURRICULUM

The science curriculum guide integrates Prescribed Learning Outcomes within a classroom model that includes instructional strategies, assessment tools and models that can help teachers provide all students with an understanding and appreciation of Aboriginal science. Integration of authentic Aboriginal content into the K to 10 science curriculum with the support of Aboriginal people will help promote understanding of BC's Aboriginal peoples among all students.

INTRODUCTION TO SCIENCE 8 TO 10

SCIENCE GRADE 10

The incorporating of Aboriginal science with western science can provide a meaningful context for Aboriginal students and enhance the learning experience for all students. The inclusion of Aboriginal examples of science and technologies can make the subject more authentic, exciting, relevant and interesting for all students.

Traditional Ecological Knowledge and Wisdom (TEKW) is defined as the study of systems of knowledge developed by a given culture. It brings the concept of wisdom to our discussion of science and technology. TEKW tends to be holistic, viewing the world as an interconnected whole where humans are not regarded as more important than nature. It is a subset of traditional science, and is considered a branch of biological and ecological science. This knowledge with its characteristic respect for sustaining community and environment offers proven conceptual approaches which are becoming increasingly important to all BC residents.

Examples of TEKW science may be accessed through living elders and specialists of various kinds or found in the literature of TEKW, anthropology, ethnology, ecology, biology, botany, ethnobiology, medicine, horticulture, agriculture, astronomy, geology, climatology, architecture, navigation, nautical science, engineering, and mathematics.

Recognition of the importance of incorporating TEKW into environmental planning is evident in science-based reports and agreements in Canada and internationally. The Brundtland Commission report, Our Common Future (World Commission on

Environment and Development, 1987), drew our attention to the contributions of traditional knowledge. In British Columbia, the report of the scientific panel for sustainable forest practices in Clayoquot Sound emphasizes TEKW and the importance of including indigenous knowledge in planning and managing traditional territories. The recognition of TEKW globally is explicitly addressed in international agreements including the Convention on Biological Diversity, Agenda 21, and UNCED ‘92, or the Earth Summit at Rio de Janeiro.

Appendix N First Peoples Principles of Learning

First identified in relation to English 12 First Peoples, the following First Peoples Principles of Learning generally reflect First Peoples pedagogy.

Learning ultimately supports the well-being of the self, the family, the community, the land, the spirits, and the ancestors.
Learning is holistic, reflexive, reflective, experiential, and relational (focused on connectedness, on reciprocal relationships, and a sense of place).
Learning involves recognizing the consequences of one's actions.
Learning involves generational roles and responsibilities.
Learning recognizes the role of indigenous knowledge.
Learning is embedded in memory, history, and story.
Learning involves patience and time.
Learning requires exploration of one's identity.
Learning involves recognizing that some knowledge is sacred and only shared with permission and/or in certain situations.

Because these principles of learning represent an attempt to identify common elements in the varied teaching and learning approaches that prevail within particular First Peoples societies, it must be recognized that they do not capture the full reality of the approach used in any single First Peoples society.

Appendix O Enhancement Agreements for School Districts

ENHANCEMENT AGREEMENTS
as of November 2014

54 SDs have signed an EA

05	Southeast Kootenay *	54	Bulkley Valley *
08	Kootenay Lake *	58	Nicola-Similkameen *
10	Arrow Lakes	59	Peace River South *
19	Revelstoke	60	Peace River North
20	Kootenay-Columbia	61	Greater Victoria *
23	Central Okanagan *	62	Sooke
27	Cariboo-Chilcotin	63	Saanich *
28	Quesnel	64	Gulf Islands *
33	Chilliwack	67	Okanagan Skaha
34	Abbotsford	68	Nanaimo-Ladysmith **
35	Langley *	69	Qualicum *
36	Surrey *	70	Alberni
37	Delta *	71	Comox Valley **
38	Richmond	72	Campbell River **
39	Vancouver	73	Kamloops-Thompson **
40	New Westminster *	74	Gold Trail *
41	Burnaby *	75	Mission *
42	Maple Ridge-Pitt Meadows **	78	Fraser-Cascade *
43	Coquitlam *	79	Cowichan Valley
44	North Vancouver *	81	Fort Nelson
45	West Vancouver	83	North Okanagan-Shuswap *
47	Powell River *	84	Vancouver Island West
48	Sea to Sky *	85	Vancouver Island North *
49	Central Coast *	87	Stikine
50	Haida Gwaii	91	Nechako Lakes
51	Boundary *	93	Conseil Scolaire Francophone
52	Prince Rupert *		Education Authority
53	Okanagan Similkameen *		

2 SDs have a draft EA

06	Rocky Mountain	46	Sunshine Coast

4 SDs are in the planning stage of EA Development

(presentation by Ministry staff, active Advisory Committee, holding community meetings)

22	Vernon	82	Coast Mountains
57	Prince George	92	Nisga'a

* second EA signed
** third EA signed

*Second EA signed

**Third EA signed