

The Integration of Traditional Ecological Knowledge in Science Curriculum in Canada:
Content analysis of grades 7 and 8 official curriculum documents

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List of Abbreviations

Canadian Provinces and Territories

AB: Alberta

BC: British Columbia

MB: Manitoba

NB: New Brunswick

NL: Newfoundland and Labrador

NS: Nova Scotia

NVT: Nunavut

NWT: Northwest Territories

ON: Ontario

PEI: Prince Edward Island

QC: Quebec

SK: Saskatchewan

YT: Yukon

Other Conceptual Terms Used in the Manuscript

BAAS: British Association of Advanced Science

EK: European Knowledge

WK: Western Knowledge

IK: Indigenous Knowledge

IQ: *Inuit Qaujimajatuqangit*

IS: Indigenous Science

STSE: Science, Technology, Society and Environment.

TEK: Traditional Ecological Knowledge

WMS: Western Modern Science

Abstract

While Western science education has always been ubiquitous in the Canadian educational system and society, many researchers have recognized the scientific and educational values of Traditional Ecological Knowledge (TEK). This study aims to contribute to the understanding of TEK and the integration of TEK into science curricula. The prevalence and representation of TEK in grades 7 and 8 official science curriculum documents used in Canada were examined. To describe TEK in the documents, both quantitative and qualitative content analyses were conducted. The results show the high variation of the prevalence and representations of TEK. Overall, Nunavut and Saskatchewan show the highest prevalence and representation of TEK in their curriculum documents, which could establish a benchmark for developing a national learning framework for integrating TEK.

Keywords: Traditional Ecological Knowledge, Science Education in Canada, Intermediate Official Curriculum Documents

Introduction

The integration of Traditional Ecological Knowledge (TEK) in science education has been in debate in the field of science education for more than two decades (van Eijck & Roth, 2007). The provincial and territorial ministries of education in Canada recognize its value and importance of TEK; they write that TEK reflecting Aboriginal perspectives, contributions, knowledge, culture and traditions should be integrated within the science curriculum (British Columbia Ministry of Education, 2005; Nunavut Ministry of Education 2005; Saskatchewan Ministry of Education, 2007). But to what degree is TEK presented in curriculum documents? Previous studies (e.g., Aikenhead, 2006; McGregor 2000; Ninnes, 2003) have shown the importance of the integration of Aboriginal perspectives in science education and the representation of these Aboriginal perspectives in curricula (Aikenhead, 2006). To date, there has been no study focusing exclusively on Canadian official science curriculum documents. Therefore, this study explores to what extent TEK is integrated into the official curriculum documents and how each provincial and territorial ministry of education perceives and treats TEK.

Based on the existing literature, Chapter One of this manuscript explores the current state of TEK, Western Modern Science (WMS) and science education in Canadian society. This chapter also explains the conceptual framework and research questions applied to this project. Most of the provincial ministries of education including Alberta (2003), Saskatchewan (2009) and Ontario (2008) mentioned the 1995 *Pan-Canadian Framework's* four foundations of scientific literacy as their goals of science education. The conceptual framework for this study was developed based on these four foundations of scientific literacy as well as the TEK characteristics listed by Manitoba Youth and Education (2003). Chapter Two explains the

general methodology including application of epistemology, data sources, data collection and procedure for this project. The compilation of the data from the analytic process is presented in Chapter Three. The main section of this manuscript is presented in Chapter Four, which includes introduction, summary of literature review from Chapter One, methodology, findings, limitations and conclusion in a full article format. Chapter Four of this manuscript is intended to be published in an educational journal.

CHAPTER ONE

Literature Review and Research Questions

In this chapter, background information on TEK in both scientific and social contexts is provided. The importance and the status of scientific knowledge in our society are also discussed in this section. To elaborate the status of science in society, the juxtaposition of *Universalism* and *Multiculturalism* in science is illustrated. Finally, through a literature review, the benefits of integrating Traditional Ecological Knowledge –otherwise known as an orally transmitted knowledge in indigenous communities – in science curriculum for both Aboriginal and non-Aboriginal students are examined.

The Experiences of Aboriginal Students in Mainstream Science Education

My goal in volunteering as a science workshop facilitator on native reserves was to promote hands-on scientific activities, thus engaging students in the learning and appreciation of science. However, many students made comments such as: “Science is boring” or “I like drawing but science has way too many words and formulas to memorize and never has anything to draw.” Such comments and the students’ attitudes towards the activities show the lack of interest Aboriginal students have in science. This lack of engagement has been mentioned as the main leading cause for low participation of Aboriginal students in school science classes (Canadian Council on Learning, 2007). Lack of science credits and general interest are believed to be some of the leading causes of these Aboriginal students’ low level of entrance to the post-secondary educational system in science. The trickle-down effect is an increase in social problems in home communities, such as the shortage of health care professionals on reserves and reduced career choices for Aboriginal students (Battiste & Henderson, 2000; Canadian Council on Learning, 2007). The British Columbia Ministry of Education (2004) examined the outcomes of this lack

of engagement of Aboriginal students in science. According to the British Columbia Ministry of Education (2004), Aboriginal students' participation and achievement in science is much lower than non-Aboriginal students. Canadian Council on Learning (CCL) (2007) also reports on the low achievement of the Aboriginal students in science:

In 2000, the Program for International Student Assessment (PISA) results for science testing [revealed that].... Non-Aboriginal Canadian students posted a mean science score of 531; however, the corresponding Aboriginal score was 489 – dramatically lower than the non- Aboriginal score and also lower than the international average (PISA scores are normed so that the international average is 500). (p. 7)

Aboriginal students scoring significantly lower in science testing may limit the number of Aboriginal students pursuing post-secondary science education. Indeed, an extremely low number of Aboriginal students pursuing science courses at post-secondary levels had been reported (Aikenhead & Huntley, 1999; CCL, 2007). Consequently, Aboriginal people are under-represented in careers in the field of science and technology. The CCL (2007) explains:

Despite the prominent role played by fisheries in Aboriginal treaty negotiations, economic activity and cultural identity, in 2002 there was not a single Ph.D. level Aboriginal fishery biologist in British Columbia.... the primary problem seems to revolve around the failure to validate and incorporate Aboriginal values and knowledge at all levels of fisheries training and education. (p. 5)

The lack of scholarly Aboriginal representation also had been observed in the medical field. *The Royal Commission on Aboriginal People* (1996) reported to parliament that 10,000 Aboriginal health professionals were needed to meet the health care needs of people on reserves.

However, the current number of Aboriginal health professionals is far short of this recommended target (King, 2005).

Having Aboriginal professionals working for Aboriginal people is important because “there are well-defined benefits to having Aboriginal health professionals deliver health services to Aboriginal people, such as cultural sensitivity and retention and probably many more less tangible benefits” (King, 2005, para. 1). Hampton (1995) underlines the importance of having Aboriginal values and knowledge in the education system when preparing Aboriginal students for careers:

If native nations are to have engineers, managers, business people, natural resource specialists, and all the other experts we need to meet non-Indians on equal terms.... we need to train our educators so that the next generation of students is more comfortable with these tools than the previous generation has been. Most Indian parents want their children to be taught those things needed for success in both the white and the Native worlds. (p. 7)

However, Poonwassie (1992) speaks of the failure of the current education system, asserting, “curricula imbued with alien values have devastated the self-confidence of Aboriginal youth....the effects of this are seen in the high drop-out rates in schools, personal disorientation, and consequent social problems” (p. 41). Aikenhead (2006) also argues that Western (i.e., Euro-American) scientific perspectives do not harmonize with Aboriginals’ own worldviews. In order to enhance the learning of students in science, *cultural border crossing* has to occur between their everyday culture (i.e., indigenous culture) and the culture of school science (Aikenhead & Huntley, 1999). For students whose worldviews differ from those of Western culture (the dominant culture in science), the process of crossing can be complicated. This idea of cultural

border-crossing can be explained by a theory called *collateral learning*, which is developed by Jegede (1999). Within the framework of collateral learning, the importance of a culturally-relevant curriculum can be observed. The collateral learning theory supports the idea that when learning material is not culturally relevant, it may impede the learning process of students because “learning something in one cultural setting that conflicts with their indigenous knowledge embedded in a different cultural setting (for example, Aboriginal students learning Western science)” could result in conflicting ideas in long-term memory of Aboriginal students (Aikenhead & Huntley, 1999, p. 5). This theory emphasizes the importance of incorporating Aboriginal knowledge and perspectives (such as TEK) into the curriculum.

Cup of Water: Interconnectedness of Knowledge and Science

In order to situate TEK in this study’s context, there is a need to explore what *Knowledge* and *Science* denote. Knowledge is a concept or a belief that is justified by community members as correct (Hunt, 2003). Goldblatt (2000) defines knowledge as “a body of skills, practices and understandings that we possess and use in practical ways” (p. 2). Science is “a human activity, a process used to investigate natural phenomena” (Metichtry, 1999, p. 274). It is “a rational perceiving of reality where perceiving means both the action of constructing reality [methods, process of science] and the construct of reality [previous existing knowledge]” (Snively & Corsiglia, 2001, p. 9). Therefore, based on the existing knowledge and the methodology used, a new set of knowledge arises.

According to Saavedra-Vargas (2012), knowledge and science are “dynamically interdependent with each other” (personal communication). Snively and Corsiglia (2001) assert that “without knowledge there can be no science, thus the definition of science should be broadened” (p. 8). Before the evolution of natural philosophy by the British Association of

Advanced Science (BAAS), science -- derived from the Latin *scientia* -- simply meant knowledge (Hatcher, Bartlett, Marshall and Marshall, 2009, p. 142). Hence, without knowledge, there is no science (Snively and Corsiglia, 2001). Saavedra-Vargas (2012) uses the analogy of a *cup of water* to explain how knowledge and science are interconnected and inseparable. According to him, knowledge is water inside of a cup when science is the cup that shapes the water. In other words, science is a set of knowledge and techniques that shapes the perception of knowledge; knowledge is perceived differently according to the shape of the science. Hatcher et al. (2009) assert, “What is defined as science is a deeply steeped cultural tradition and reflects the world view of the definer” (p. 142). Here, *tradition* is defined as “knowledge where authority is linked to antiquity and where its status is entirely accepted” (Goldblatt, 2000, p. 33). Thus, cultures, traditions and worldviews all together play a big role in shaping the *cup* (i.e., science) which then determines the shape of the *water* inside (i.e., knowledge).

This cup of water analogy supports the idea of *multiculturalism in science*. Aikenhead (2006) attests that every culture has its own form of science. The shape of a cup, (i.e., science) is molded differently according to the definer’s worldview, culture and the society in which she is embedded. Therefore, there is more than one form of science. Based on cultures and locations, science can exist in many forms and knowledge systems (Jegade, 1999). According to van Eijck and Roth (2009), multiculturalism in science suggests that science is shared amongst members from various cultural groups in which it is considered as cultural laden and “is embedded in the context of a cultural group” (p. 929). Within the framework of multiculturalism, there are multi-sciences. What is normally referred to as Western Modern Science (WMS) is anchored in the culture and the worldview of Western, European people (Aikenhead, 2006; Ogawa, 1995). Indigenous Science (IS) is anchored in the culture and the worldview of indigenous people

(Ogawa, 1995). Meichtry (1999) explains that, knowledge is “a product of human process of science[s] and its social context” (p. 274). Therefore, there are different forms of sciences based on different cultures; thus, there are different types of knowledge in different cultures (Snively and Corsiglia, 2001).

Indigenous Sciences, Indigenous Knowledge and Traditional Ecological Knowledge

Within the framework of multiculturalism, Indigenous Science (IS) and Indigenous Knowledge (IK) are anchored in the cultures and worldviews of indigenous peoples. Considering the analogy of a cup of knowledge, I propose the following model, in which IS is the cup that shapes IK (Figure I).

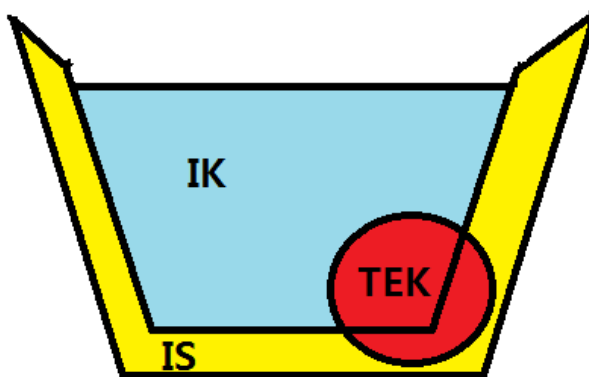


Figure I. Connections between IK, IS and TEK

In other words, IS is “a large range of coming to know process including knowledge and methods developed by Indigenous communities.... that result from human experiences in the natural world” (Hatcher et al., 2009, p. 143). IS is described as “a living knowledge”, that requires less dependence on knowledge transfer from books; it requires “knowledge gardening with living knowledge keepers” which differs from WMS (Hatcher et al., 2009, p. 15). Based on the idea of multiculturalism, the term Indigenous Sciences is a plural term rather than a singular

term because it represents the diversity of sciences related to the strongly rooted place-based traditions of their cultural foundations (Hatcher et al., 2009). IS shapes the IK which is:

an everyday rationalization that rewards individuals who live in a given [Africa, Latin America, Asia, and Oceania] locality.... [that] reflects the dynamic way in which the residents of an area have come to understand themselves in relationship to their natural environment and how they organize that folk knowledge of flora and fauna, cultural beliefs, and history to enhance their lives (Semali & Kincheloe, 1999, p. 3).

IS and IK together shape another system, what is known as Traditional Ecological Knowledge (TEK). The terms, Traditional Ecological (Environmental) Knowledge (TEK), ecological wisdom, and many others are used to describe the body of expertise and knowledge held within indigenous communities (Manitoba Education and Youth, 2003). van Eijck and Roth (2007) define TEK as “a concept that is used in the scientific community to name experience acquired over thousands of years of direct human contact with the environment” (p. 928). Snively and Corsiglia (2001) categorize TEK as both knowledge and science because TEK “uses methodology guided by traditional wisdom, disciplines of scientific knowledge all integrated in a local cultural perspective results in long-term sustainable societies, implications for resolving global environmental problems” (p. 12). Simpson (1999) states that the term TEK is transposed on the field by non-Aboriginal academics. She does not categorize TEK as knowledge or science. To explain the concept of TEK, Simpson (1999) borrows ideas from *Nuu-Chah-Nulth* that states, “Everything is one” (p. 54). Therefore, as illustrated in Figure I, TEK consists of both IS and IK in disciplines of scientific knowledge. Here, to conceptualize TEK, I have used some Aboriginal scholars’ literature and combusted with elders. However, I acknowledge that I was mainly trained under the paradigms of WMS and much of my research here is from non-Aboriginal

literature. I situate myself as a science educator and a researcher who recognizes the values of TEK in science, not a *true expert* of the particular knowledge system. Here, a true expert refers to a knowledge holder and a community member who received the teaching directly from elders and recognized by Aboriginal communities.

Scientific and educational value of TEK had been recognized in both educational and scientific communities. Despite that there is more than one science in our world, our society mainly focuses on WMS, places TEK and other sciences and knowledge from non-Western cultures on the periphery of our education system. The importance of science education and scientific knowledge in our society is deeply rooted in WMS.

The Status of Science Education in Society and the Status of WMS in Canadian Science Curricula

Scientific knowledge holds an elevated academic and social status in our society because science is important for many careers. For example, there are more than 46 occupations (e.g., doctors, scientists, engineers, nurses, teachers, etc.) where science is one of the main parts of the job (Osborne, 2003). Science also plays an important role in developing citizenship. Osborne (2000) argues that the real challenges of the future are likely to be the moral and political dilemmas set by the expansion of scientific knowledge. A healthy democratic society, therefore, requires the participation and involvement of all its citizens in the resolution of conflicts arising from the choices that contemporary science will present. In order to become an active citizen in a society, it is necessary to possess *civic scientific literacy*, which Osborne (2000) describes as the ability to understand the procedures of science (i.e., grammar of science) as well as its content (i.e., vocabulary of science). A lack of scientific knowledge, therefore, would create a social barrier for people who remain civic-scientifically illiterate (Osborne, 2000). Being scientifically

illiterate will lead to the marginalization of some people in a society. For this reason, ministries of education in Canada have greatly emphasized the development of scientific literacy for students over the past years (Osborne, 2000). The low number of professionals in the science field had been recognized as a problem in Canadian society (CCL, 2007; Johnstone, Haines and Wallace, 2001; University of Manitoba, 2009). Students' learning experiences in secondary science courses have significant impacts on the participation in post-secondary science. Thus, developing career interests in science and engineering fields has been recognized as a main goal for Canadian higher education (Johnstone et al., 2001). Scientific literacy has become an important factor for career choices, and for creating active citizenship as well (Roth & Desautel, 2008). Therefore, Canadian provincial ministries of education developed the four foundations of scientific literacy in the Pan-Canadian Framework (1995), and incorporated these scientific literacy foundations in all Canadian science curricula.

Conventional science education has been playing a role as a transmitter of the knowledge, skills and values of the scientific community to students. This content conveys a particular Eurocentric world view since science is a subculture of Western culture that might not facilitate the learning process of students who are not from Western culture such as Aboriginal students (Aikenhead & Huntley, 1999). Aikenhead (1996) and CCL (2001) suggest that our science education is highly anchored in the traditions of WMS, focusing on Western scientific knowledge. WMS became the "officially sanctioned knowledge which can be thought of as inquiry and investigation that Western governments and [academics] are prepared to support, acknowledge, and use" and has been the dominant mode of science education (Snively & Corsiglia, 2001, p. 9; Ogawa, 1995). Science can be used to create social hierarchy. Carter et al.

(2003) and Reis and Ng-A-Fook (2010) speak about the gatekeeper existing in the scientific community:

The scientific community is like a special kind of ‘club’ that has its own rules, and if you are not willing to play by those rules you cannot become a member. Science education that is indoctrination into this club does not take into account that modern science is only one way of constructing the world. (Carter et al., 2003, p. 6)

Indeed, another name for Western Modern Science (WMS) is *White-Male-Science*. White males in scientific communities use the idea of *universalism* as a gate keeper (Reis & Ng-A-Fook, 2010; Snively & Corsiglia, 2001). van Eijck & Roth (2007) define *Universalism* as “the position that views science as knowledge that transcends cultural milieu” (as cited in Muller & Tippins, 2009, p. 994). Hence, Universalists believe that that science is gender-free, ethnicity-free, and culture-free. Western Modern Science (WMS), assumed to be universal, displaces the revelation-based knowledge such as creation science and pragmatic local indigenous knowledge (Snively & Corsiglia, 2001). According to the *Collateral Learning Theory*, within the framework of WMS, knowledge being taught in the education system facilitates the students from Western culture better; the students from Indigenous cultures experience cognitive conflicts between tenets of the two worldviews (Aikenhead, 1996; Snively & Corsiglia, 2001).

On the other side, many researchers and educators believe in the idea of *multiculturalism* in science. Within the framework of multiculturalism, Western Modern Science (WMS) is, in fact, a sub-culture of White-male Western culture; thus Indigenous Sciences (IS) can be thought of as sub-cultures of a particular culture (Aikenhead, 1996; Snively & Corsiglia, 2001).

Roth (2008) stated the re-articulation of science education is needed for the current and future Canadian society “which already is characterized by diversity and heterogeneity” (p. 96).

Many scholars have argued that historically, Canadian curriculum conveys Eurocentric content and perspectives such as WMS which perpetuates the status-quo in the scientific community (Aikenhead, 2006; Cary, 2006; Ninnes, 2003).

One might argue that WMS is dominant in our society because non-European science and knowledge such as Traditional Ecological Knowledge (TEK) are not useful in solving scientific problems that arise in our current technology-based society. However, there are many scholars who emphasize the importance of TEK in our society (Aikenhead, 2006; CCL, 2007; Tsuji & Ho, 2002).

Traditional Ecological Knowledge (TEK) and Science Education

Traditional Ecological Knowledge (TEK) is considered to be a valuable knowledge which provides both cultural and scientific knowledge that is absent in current WMS-based science education (Kimmerer, 2002). The studies done by Tsuji & Ho (2002) and Kimmerer (2002) summarize TEK as a set of empirical observations about a local environment, a system of classification, and a system of self-management which governs resource use in local communities. Since the knowledge is based on the local environment, the quantity and quality of TEK can be varied among community members depending on their gender, age, social status, intellectual capability, and professions (Tsuji & Ho, 2002; Kimmerer, 2000). Because it is based on the local environment, it brings local knowledge and local scientific issues into the classroom. Moreover, TEK is holistic; it views environmental aspects to be closely tied to social and spiritual aspects of knowledge systems. TEK is also both cumulative and dynamic. The knowledge is derived from long-term observational data and maintained through an oral tradition. TEK, therefore, builds upon the experience of earlier generations and adapts to new technological and socioeconomic changes (Ford, 2001; Tsuji & Ho, 2002; Omura, 2005). All in

all, TEK acts as a baseline of information on the local environment, and Aboriginal governments in Canada value and recognize the significance of this knowledge system. TEK could provide both scientific and other cultural aspects of knowledge that WMS lacks (Tsuji & Ho, 2002; Kimmerer, 2002).

Aboriginal people have always been in close contact with the environment (Manitoba Education and Youth, 2003). Manitoba Education and Youth (2003) suggests that the integration of TEK in the science curriculum provides “a foundation that validates local TEK along with Western science” (p. 16). Studies have shown that many Aboriginal students have a better grasp of Western science when it is complemented with Indigenous Knowledge (Aikenhead, 2006; McGregor, 2000). Therefore, in order to prepare Aboriginal students for careers in science fields and to help them become science literate, there is a need to incorporate Aboriginal knowledge and worldview in the science curriculum. Aikenhead (2006) and Snively & Corsiglia (2001) suggest that a framework of *integrative science* (including both TEK and WMS) would create a better learning environment for Aboriginal students to succeed in “both the white and the Native worlds” (Hampton, 1995, p. 7). Once Aboriginal perspectives are incorporated into the science curriculum, they would provide a means of increasing Aboriginal students’ access to scientific and technological fields (Patchen & Cox-Peterson, 2008).

Both TEK and WMS are valuable because there are some differences between two knowledge systems that complement each other (Snively & Corsiglia, 2001). From the Western perspective, knowledge is a noun whereas in indigenous view, knowledge is a verb (Hatcher et al., 2009). Thus Hatcher et al. (2009), suggest “two-eyed seeing”, integrative science, as one of the solutions for our science education. *Two-eyed seeing* refers to “learning to see from one eye with the strength of Indigenous ways for knowing and from the other eye with the strength of

Western ways of knowing and to use both of these eyes together” (Hatcher et al., 2009, p. 148). Hatcher et al. (2009) write that “using the two-eyed seeing approach means that education within integrative science incorporates a more holistic mindset and is transcultural as well as multidisciplinary, multidirectional, and multisensory, with the total environment as the laboratory” (p. 146). Two-eyed seeing about Integrative science may enhance Aboriginal students’ learning as well as avoid a clash of knowledge (Hatcher et al., 2009). Many scholars including, Aikenhead (2006), Snively (1990, 1995) and McGregor (2000) have shown how TEK can act as a bridge between Western and Indigenous science. Aikenhead (2006) claims that since our future science will become postcolonial and cross-cultural in nature, integrative science teaching should be implemented to help students move from their everyday culture into the culture of Western-science. Aikenhead (2006) conducted a study to see how cross-cultural curriculum can influence Aboriginal students’ learning in science. His study showed that when Western science content was introduced to Aboriginal students with the knowledge that had been shared by their communities, “students became more interested in their science course and no longer approached it as content to be memorized” (p. 234). McGregor (2000) developed a *coexistence model*, which is a culturally sensitive instructional strategy, which integrates Aboriginal scientific knowledge and Western science for Aboriginal students in pilot schools of northern Saskatchewan. McGregor reports that students were more involved in science classes and even stayed after school to complete projects when necessary. Considering that voluntarily staying after school was normally almost unheard of in the pilot schools of northern Saskatchewan, this shows improvement in Aboriginal students’ interest in science (Aikenhead, 2006). This integrative, two-eyed learning framework will also provide non-Aboriginal students with a synergistic vision in sciences to have a broader view of our world. TEK is “a distinct

knowledge system in its own right with its own internal consistency, diversities, and way of knowing” (Battiste, 2008, p. 85). This distinctive knowledge system contains certain characteristics that, when combined with conventional science curriculum, can benefit, not only Aboriginals but all learners (Aikenhead, 2006; Battiste, 2008).

For non-Aboriginal students, learning TEK in science could open up their minds to a heterogeneous view of the world where students come to understand scientific knowledge from non-Western cultural or traditional ways of knowing (i.e., WMS). Ahlquist and Kailin (2003) suggest that “the development of modern science needs to be understood within the context of the global contributions to its development” (p. 38). Western scientific methods have exchanged or borrowed scientific ideas from non-Western cultures. For example, Quinine, Aspirin, and Ipecac (i.e., a drug used in traumatic medicine to expel stomach contents) as well as 500 other important drugs were discovered and used by traditional Native American healers (Snively & Corsiglia, 2001). This two-eyed learning and integrative science framework also serve a purpose to facilitate a *multicultural science education* that might help reduce the existing status-quo between WMS and scientific knowledge from non-Western cultures in the scientific and educational communities. Multicultural science promotes:

Alternative ways of knowing or epistemologies that approach scientific knowledge from a first world and postcolonial framework that critically questions the empirical characteristics and ontological premise of Western science in order to emphasize the concept of ‘epistemological pluralism’. (Hadi-Tabassum, 2003, p. 188)

Multicultural science education enables a heterogeneous view of the world where students come to understand scientific knowledge from their cultural or traditional way of knowing as well as from other cultures. In order to achieve multicultural science education in a

multicultural society, teaching science in critical, global and inclusive perspectives is suggested (Ogawa, 1995). Learning non-Western knowledge would help Canadian students to make decisions that help them to solve global issues such as climate changes. TEK, in particular, as Tsuji and Ho (2002) mentioned, is land-specific and focuses on local environment. Integrating TEK would help students to develop scientific thinking and grounds within the actual world in which students live their lives (Snively & Corsiglia, 2001). The curriculum that focuses on the *local* knowledge from home communities and *cultural* knowledge to discuss global topics would act as a linking mechanism between students and educators. Therefore, TEK, developed locally, would help students to connect themselves to local and further global environmental/scientific issues.

It is not my intention to demean the value of knowledge in WMS, but to make a point that, one form of science is not more relevant than another and also to illustrate the benefits of a synergic vision of both WMS and TEK -- focusing on the similarities as well as differences and on areas where IK helps fill the gap where knowledge in WMS is lacking, and vice versa.

The Status of TEK in Canadian Science Curricula

The status of TEK in Canadian science education has been a major subject of debate (van Eijck & Roth, 2008). Based on the literature, I am aiming to explore the views on integrating TEK in science curricula. To this date, in the field of science, IS and TEK carry less prestige than WMS and European Knowledge (EK) (Omura, 2005). According to many science scholars, such as Semali & Kincheloe (1999) and Dei, Hall, & Rosenberg (2000), TEK is represented as primitive, wild, and natural, and evokes condescension from Western observers. Historically, TEK has been excluded from the school curriculum or offered a space in lower status optional courses in school programs (Alsop & Fawcett, 2010). However, the importance of

integrating Aboriginal perspectives as a way of ensuring diversity within the science education curricula has been recognized and some curricula have already adopted this approach around the world (Alsop & Fawcett, 2010). Alsop & Fawcett (2010) assert that there has been much to celebrate in instructional strategies that help learners to negotiate borders between WMS and IS. Ninnes (2003) conducted a textual analysis on two Canadian and two Australian textbooks (used in grades 7-9 classes) to explore representation of indigenous identities and knowledge. According to his study, Canadian textbooks cover very little of traditional Aboriginal knowledge and even when it is represented, it is implicated in antiquity or primitive terms and is subordinated or peripheral in relation to Western knowledge context (Ninnes, 2003). Kimmerer (2002) also describes that, in curricula we are unknowingly or knowingly, “ignoring an entire body of knowledge that has potential significance to contemporary science and policy: TEK” (p. 432). However, in Canada, there has not been any published study to describe the representation of TEK and compare its coverage in each provincial and territorial official science curriculum documents. Therefore, this study focuses on the representation and the coverage of TEK in these official curriculum documents.

Research Questions

The present thesis is meant to deepen the understanding of TEK in science educational context by examining the integration level of such knowledge in current curriculum. The overarching question guiding this research is “How are TEK topics treated quantitatively and qualitatively in grades 7 and 8 official science curriculum documents in Canada?” With this broad question in mind, this study was guided with more pointed questions that consist of quantitative and qualitative inquiries as follows:

Quantitative Questions

- How prevalent is TEK content within provincial intermediate science curriculum documents (grades 7 and 8) across Canada?
- To which learning domains (i.e., curriculum organizers, clusters: life science, physical science or earth and space sciences) are TEK content found in the studied documents?
- Based on the four foundations (e.g., organizing principles [STSE], habits of mind, skills and procedures, knowledge) from the Pan-Canadian Framework (1995), which foundations contains the most/ least TEK content?

Qualitative Questions

- How is TEK content represented in each provincial curriculum document?
- To what extent is TEK recognized (i.e., given the significance) by ministries? For this question there are sub-guiding questions:
 - a) Were there any acknowledgments to Aboriginal worldviews in science and TEK in documents?
 - b) Are elders or Aboriginal scholars encouraged to participate during the process of curriculum design or to share their knowledge with students?
 - c) Was there any other policy framework that suggests the integrating of TEK in science education?
 - d) What importance was placed on TEK in the science curriculum documents (based on the priority scale developed for this analysis, which will be discussed in the methodology section)?

The focus of this thesis project is on TEK from a Canadian (geographical-specific) perspective. Therefore, the term *Aboriginal people* is used to address the indigenous people who reside in Canada.

CHAPTER TWO

Methodology

This chapter describes the epistemological stance of the researcher, data source, collection process and analysis procedures that were undertaken to answer the research questions.

Epistemology

I define my worldview as constructivism. As a researcher, I believe in the ideas of Multiculturalism in science that all culture has its own form of science (van Eijck & Roth, 2007). This multiculturalism in Education is based on the ideas of constructivism. Constructivists hold the assumption that “individuals seek understanding of the world in which they live and work” (Creswell, 2008, p. 8). Therefore, constructivists believe that cultures play a large role in generating new knowledge, namely science (Matthews, 2000). Bentley notes that “constructivism speaks to the nature of science” (as cited in Matthews, 2000, p. 162). With the scope of constructivism, science is developed by people from the interactions between their ideas of science and their culture; both WMS and IS are sciences that were generated by people from different cultures (Matthews, 2000). According to Wiersma and Jurs (2009), the researcher who uses this paradigm does not want to test a theory; he or she wants to develop a theory from data. Being a constructivist, I am looking at the current state of the integration of TEK rather than testing any existing theory or hypothesis.

With regard to my methodology, however, I consider my perspective to be pragmatist. To determine the causes and effects of the proposed research questions for this project, I see the world in a pragmatist view. Wiersma and Jurs (2009) mentioned that the researcher within this paradigm, even though he or she describes himself/herself as a constructivist (or socio-constructivist), uses all research tools in order to find a maximum number of answers to the

research questions. He or she can, therefore, use independently quantitative and qualitative research tools if such a combination gives him/her more complete data to understand a phenomenon. As a pragmatist, I am drawing my findings from both quantitative and qualitative research tools.

Data Source

Samples for this project consist of official grades 7 and 8 science curriculum documents across Canada. Official curriculum documents have been chosen for this project because they provide a scope of the science content delivered in classrooms. In Canada, textbooks used in classrooms usually correspond with the official curriculum documents published by ministries of education (Montgomery, 2005). Moreover, teachers in Canada are expected to follow the official curriculum documents to plan their lessons and to evaluate students' learning process (Posner, 2003). Content in the curriculum documents are mandated by the provincial governments. As Reis and Ng-A-Fook (2010) state:

curriculum documents detail the knowledge and skills that students are expected to develop in each subject at each grade level as part of an effort by the government (local or federal) to set standards for schools...curricula are political texts, and as such they result from tensions among a myriad of social, political, and economic forces and movements, which battle to decide what knowledge is of most worth. (p. 1015)

Studying the official curriculum documents thus gives us the opportunity to look at each provincial government's view and priority given to TEK. The list of curriculum documents for this study is in Appendix iii.

The focus was put on intermediate science, grades 7 and 8 in particular, because intermediate science acts as a bridge between basic scientific principles from elementary science

and advanced science. Therefore, students' experiences in intermediate science classes have an impact on their perspective on pursuing further programs in science. The American College Testing (2008) discovered that the level of academic achievement that students attain by eighth grade has a large impact on their college attendance. According to the Ontario curriculum guidelines (Ontario Ministry of Education, 2008), grade 8 is the last grade where all students are introduced to same content and integrated in same science classes. Grade 8 students are expected to choose either grade 9 academic, which leads to university preparation, or grade 9 applied, which leads to work/college preparation. However, those students who decide to take grade 9 applied science course are impeded to take advanced science classes in higher grades or in post-secondary institutions (see Appendix ii). Therefore, it shows the important role of the intermediate, grades 7 and 8, science curricula in the Canadian education system.

Data Collection

Data collection was completed by obtaining official curriculum documents from the ministries of education of each province and territory, in order to get a national perspective. Because this study focuses on the current state of the issue, the only data sources collected were the official curriculum documents that are currently effective across Canada. Electronic copies of the official science curriculum documents were obtained from the websites of each provincial and territorial ministry. The implementation of documents was also confirmed by science curriculum consultants from each province and territory. The curriculum documents collected for this study are shown in Appendix iii.

Procedure

Once all documents were collected, data analysis was performed. Analysis for this project consisted of different stages. The data was reviewed concurrently since the process involved

moving back and forth among the entire data set for the initial data analysis. Then, each curriculum document was analyzed. After the data analysis of all documents was completed, the results were displayed in tables before interpretation. The conclusion was drawn from the interpretation; then it was reviewed and consulted with the external auditor, Dr. Marcelo Saavedra-Vargas, a professor at the Faculty of Aboriginal Studies at University of Ottawa.

Data Analysis: Content Analysis

Krippendorff (1980) describes content analysis as “a research technique for making replicable and valid inferences from data to their context by summarizing the messages from documents” (p. 21). Using content analysis allows “a closeness to text which can alternate between specific categories and relationships” and also statistically analyze the coded form of the text (Colorado State University, 2010, para. 1). There are two traditions of content analysis: quantitative and qualitative (Bergman, 2010). The project asks both quantitative and qualitative questions, which cannot be answered by using only one type of analysis method. Therefore, a mixed methods content analysis was performed for this research project. This project expands the scope and applicability of content analysis by explicitly including the application of both quantitative and qualitative methods to non-numerical data (Bergman, 2010). By conducting a mixed methods data analysis, it was possible to explore the questions proposed in this research project. Creswell (2006) calls a content analysis that involves both qualitative and quantitative data analyses is a “mixed methods data analysis” (p. 12). This study used the sequential design as illustrated in Figure II. First of all, the sequential design reveals the result from both qualitative and quantitative analysis to serve the purpose of complimentary (Bergman, 2010).

A framework of a sequential mixed methods content analysis for this study was adopted from Bergman (2010), as illustrated in Figure II:

1. A qualitative content analysis
2. A quantitative content analysis
3. A second qualitative content analysis

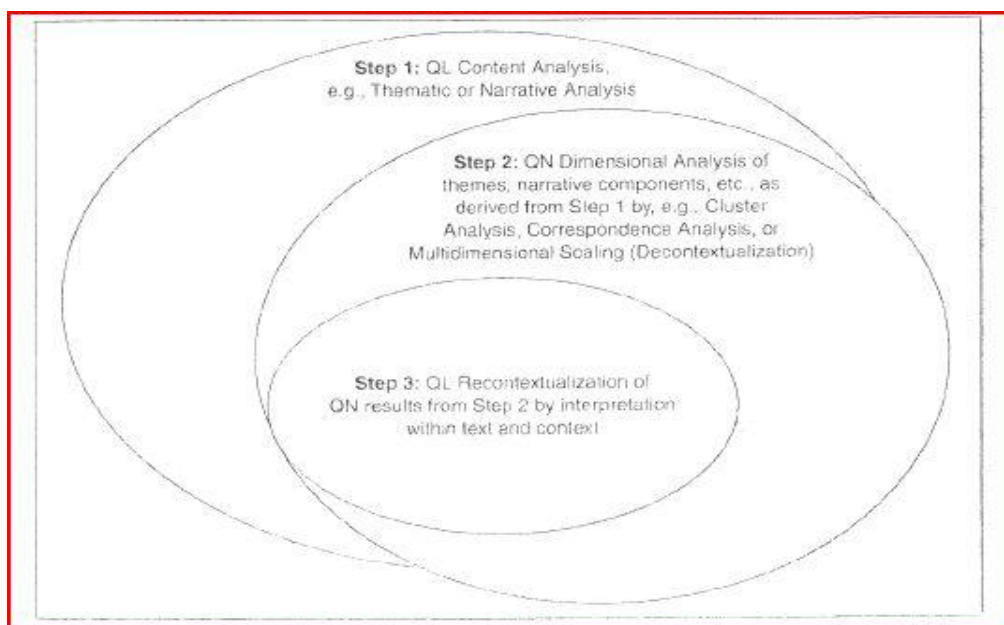


Figure II. Three-step analysis of sequential mixed methods content analysis (Bergman, 2010, p. 389).

The First Step: A Qualitative Content Analysis. An initial qualitative content analysis, thematic analysis, was performed in order to locate common themes arising from documents, and eventually to develop a framework for analyzing studied curriculum content. This thematic analysis is important in this research because Bergman (2010) asserts that even the most quantitative researchers admitted that initial stages of quantitative content analysis must rely on non-statistical methods. This non-statistical method must be used to formulate the “categories”, which are, codes, which would be subsequently submitted to statistical analysis (p. 381). Therefore, this initial qualitative analytic phase is necessary for the next quantitative analysis. Thematic analysis is a method for identifying, analyzing and reporting patterns or themes in documents (Braun & Clarke, 2006). Bergman (2010) suggests using bottom-up coding, also

known as inductive approach, for thematic analysis. By conducting an inductive approach, “relevant elements are identified inductively, [and it] eventually leads to a set of relevant themes thus themes are identified” (Bergman, 2010, p. 391). Therefore, the bottom-up coding, inductive approach is a data-driven process (Braun & Clarke, 2006). In order to develop themes, a semantic approach was undertaken for the development of theme. Braun & Clarke (2006) describe the semantic approach as “a progression from description, where the data have simply been organized to show patterns in semantic content, and summarized, to interpretation, where there is an attempt to theorize the significance of the patterns and their broader meanings and implication, often in relation to previous literature” (p. 8).

In conducting the thematic analysis, the procedure outlined by Braun & Clarke (2006) was used, as shown in Table I.

Table I

Phases of thematic analysis

Phase	Description of Process
1) Familiarizing yourself with the data	Transcribing data (if necessary), reading and re-reading the data, noting initial ideas.
2) Generating initial code	Coding interesting features of the data in a systematic fashion across the entire data set, collating data relevant to each code.
3) Searching for themes	Collating codes into potential themes, gathering all data relevant to each potential theme.
4) Reviewing themes	Checking if the themes work in relation to the coded extracts (Level 1) and the entire data set (Level 2), generating a thematic 'map' of the analysis.
5) Defining and naming themes	Ongoing analysis to refine the specifics of theme, and the overall story the analysis tells, generating clear definitions and names for each theme.
6) Producing the report	The final opportunity for analysis. Selection of vivid, compelling extract examples, final analysis of selected extracts, relating back of the analysis to the research question and literature, producing scholarly report of the analysis.

Themes and their definitions were developed during the analytic process by reviewing all documents. As Braun & Clarke (2006) state, developing themes is a continual process which requires moving back and forth all across the data. The themes for this study were developed inductively throughout and after the completion of the first analytic phase. To enhance the internal validity, memos about the themes and their definitions were written during the development of the themes and reviewing process. According to Creswell (2008), writing memos insures that there is no shift in the meaning of the themes during the process of coding. The data reviewing process was continued until I reached the saturation point where I could no longer generate a new theme.

After reviewing all documents, a priority scale was developed. This priority scale is based on the themes resulting from the first analytic phase. As shown in Table II, the priority scale indicates the importance placed on curriculum (i.e., learning concepts) in documents.

Table II

Priority scale for curriculum document analysis

Priority (5 the most important; 1 the least)	Definitions
5	The content is mandated by the ministry. Students are expected to master this content. This content (skills/knowledge) will be tested. The content is the basis of the chapter (unit); incorporated throughout the unit.
4	The content is mandated by the ministry. Students are expected to master the learning topic. This content (skills/knowledge) will be tested.
3	The content is suggested by the ministry. The content provides a basis for the assessment. However it is not mandatory.
2	The content is suggested by the ministry. Additional activities or teaching strategies can be included for this section.
1	The content is an additional material suggested for activities.

Once the priority scale (i.e., inductive themes for this study) was developed and all the curriculum documents were reviewed, then the second analysis was performed.

The Second Step: A Quantitative Content Analysis. Once the priority scale was developed, the documents underwent a quantitative content analysis phase. Frequency coding analysis was selected for this phase. Frequency coding involves coding counting “the number of occurrences of a particular code [thematic unit]” within data set (Bergman, 2010, p. 388). This quantitative content analysis followed the five processes proposed by Krippendorff (2004) (see Table III).

Table III

Five processes for the text content analysis.

Phases	Definitions
Unitizing	Identifying the units of analyses, such as words, phrases, sentences, etc.
Sampling	Selecting from a study population, those units which will be subjected to the analysis.
Reducing	The content of non-numerical data is reduced to its “essentials” by coding and statistical analysis.
Inferring	The frequency counts of the coded material and other statistical information about the phenomena under investigation are linked to the research question and the context, within which the material is located.
Narrating	The results of the study are communicated narratively in reports.

- 1) Unitizing: As Krippendorf (2004) suggests, the initial task for the second phase is to subdivide the textual material into hermeneutic units (i.e., context or analytic units). As mentioned above, our units are official curriculum documents, more specifically, curriculum contents (i.e., learning outcomes, learning expectations) in documents.
- 2) Sampling: Within the hermeneutic units, the curriculum contents are identified as a set of words such as: TEK, Aboriginal, Indigenous, Inuit, Metis, First Nations, Elders or any words that are relevant to our research questions, in context of Aboriginal perspectives or Indigenous Knowledge system. These words are referred to as thematic units. These thematic units are often described as “chunks of text that reflect a single theme” (Krippendorf, 2004, p. 32). Also, TEK related contents were written on a separate memo during this step. The descriptive indicators for TEK are shown in Appendix iii.
- 3) Reducing: Any phrases or paragraphs (depending on the structure of the documents) containing the thematic units were counted. All found phrases and paragraphs with thematic units were then put into a coding sheet.

- 4) Inferring: Contents on the coding sheet from the Reducing phase were then sorted out based on the teaching strands where thematic units were found and the conceptual framework (i.e., four foundations of scientific literacy). Tables were created to illustrate the results clearly.
- 5) Narrating: The results in the tables were interpreted in narration.

During the frequency coding analysis, the prevalence of TEK in documents, TEK content in each learning domains (e.g., life science, physical science and earth and space science) and TEK in each foundations of scientific literacy were counted. These four foundations of scientific literacy documented in the Pan-Canadian Framework (1995) are mentioned as goals of science education by both federal and provincial ministries.

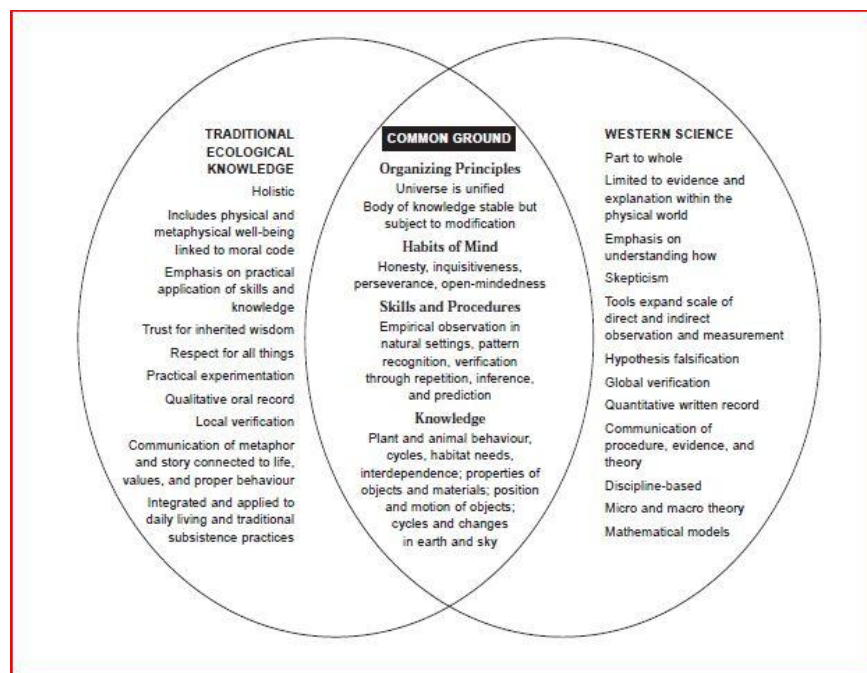


Figure III. Common ground between WMS and TEK (adapted from Manitoba Education and Youth, 2003, p. 2)

As illustrated in Figure II, these four foundations of scientific literacy are also considered to be common ground of TEK and WMS (Manitoba Youth and Education, 2003): Organizing

principles (e.g., ideas such as that the body of knowledge is stable but subject to modification or developing an understanding of the relationships between science and of the social and environmental contexts of science and technology); Habits of Mind (e.g., holistic); Skills and Procedures (e.g., observation) and Knowledge (e.g., facts). Under these four common ground dimensions, I categorized the characteristics of TEK described by various authors including Kimmerer (2002), Manitoba Youth and Education (2003), Snively and Corsiglia (2001) and Tsuji and Ho (2002). These characteristics served as a guideline for this project's content analysis (Appendix i). With this conceptual framework, curriculum documents were studied in order to examine how TEK has been integrated into provincial curriculum texts.

Posner (2003) describes official curriculum as “the curriculum described in formal documents” (p. 14). Here, *curriculum* is defined as “the content, standards, or objectives for which schools hold students.... [and] the set of instructional strategies teachers plan to use” (p. 5). The purpose of the official curriculum document is “to outline provincial requirements for grade 7 [or a particular grade] science [or a subject]; the [official] curriculum provides the intended learning outcomes that... are expected to achieve in science” (Saskatchewan Ministry of Education, 2007, p. 6). These learning outcomes are the knowledge that students acquire. Thus, curriculum studied for this project is the *Knowledge* (that is already constructed) side of TEK rather than the science side (shaping part) of TEK. The chart used for characteristics for TEK also focused on the knowledge side of TEK as well (Appendix iii).

To ensure internal validity, frequency coding was repeated three times for each document. Through the frequency coding process, patterns among documents were explained statistically. Patterns identified in frequency coding usually cannot be observed with qualitative methods. Thus, “this set of results is likely to add additional insights into the content and meaning

structure embedded in the non-numerical data” (Bergman, 2010, p. 389). In other words, some of the results from the second phase were re-interpreted in the third analytic phase in order to answer the proposed research questions.

The Third Step: A Second Qualitative Analysis. The last step of the analysis was done through a second recontextualizing qualitative analysis (Bergman, 2010). This qualitative analysis studied the representation of found TEK content from the quantitative analysis. Also, significance given to TEK by each provincial/territorial ministry was analyzed in this step. However, as Kimmerer (2002) noted in his article, in order to protect the use of TEK in a respectful and appropriate manner, “the identity of the practitioners, informants and the community should always be fully referenced and acknowledged with the same diligence that scientists apply to the contributions of their academic colleagues” (p. 437). Therefore, if there is no reference to the curriculum content that matches the characteristics of TEK mentioned in Appendix i, I did not count it as the integration of TEK.

A curriculum analysis is described as “an attempt to tease a curriculum apart into its component parts, to examine those parts and the way they fit together to make a whole, to identify the beliefs and ideas to which the developers were committed and which either explicitly or implicitly shaped the curriculum” (Posner, 2003, p. 14). In order to explore the representation and prevalence of TEK in the curriculum, there was also a search for each provincial/territorial ministry’s perception of TEK mentioned (or silenced) in documents. As Posner (2003) states, curriculum is “the product of a group of people faced with a series of technical, economic, and political decisions, guided and constrained by their own personal belief systems” (p. 33). Therefore, searching for the ministries’ perceptions on TEK and the representation and the prevalence of TEK within official curricula would provide readers with a way to understand

“different beliefs about what people should learn to do in [science classroom]” (Posner, 2003, p. 33).

This curriculum analysis looking at the TEK prevalence, representation, and ministries’ perceptions, shows the current state of integration of TEK and Aboriginal perspective in different provincial/territorial science curricula. Here, for *prevalence*, I am looking at how frequently TEK content shows up within the official curricula (i.e., amount of coverage). For *representation*, I look at the way in which TEK content has been presented in the curricula (i.e., the portrayal of TEK and Aboriginal perspective). For *perception*, I look at how each ministry views and understands TEK and Aboriginal perspectives in science. Posner (2003) states that every curriculum represents “a choice as to how to approach the education of student” (p. 43) and this approach depends on the beliefs and assumptions (often termed philosophies or perspectives) of the developer. Studying developers’ perceptions about TEK provides a background “theoretical and historical context” of the curriculum on TEK. (p. 33)

CHAPTER THREE

Results

This chapter illustrates the raw data from the analysis. Because there had been no other studies against which the data could be compared, this data is incorporated in this manuscript with the hope of providing other researchers with a detailed description of TEK coverage and representation in each Canadian provincial/territorial science curriculum documents. The data is presented by answering both quantitative and qualitative questions mentioned earlier in Chapter One. Grades 7 and 8 documents were studied separately for the analysis to answer qualitative questions. To answer the qualitative questions, both grades 7 and 8 documents were interpreted at the same time. This chapter provides readers with a detailed description of the content studied in each document. The results are presented by geographic order, west to east (Figure IV). The data presented in this chapter will then be re-interpreted for discussion in the article (Chapter Five). All TEK content studied for the purpose of this research is shown in Appendix I.



Figure IV. Map of Canada (Retrieved from Trail Canada: <http://www.trailcanada.com>)

British Columbia (BC)

Results for Quantitative Questions

- How prevalent is TEK content in the provincial intermediate science curriculum documents (grades 7 and 8) across Canada?
- With which learning domains (i.e., curriculum organizers: life science, physical science or earth and space sciences) is TEK mostly associated?

BC grade 7 science curriculum document is organized in four learning domains: *Life science*, *Physical science*, *Earth and Space science* and *Process of science*. Process of science lists a number of skills in science such as observation and classification. The following curriculum content was analyzed in the BC documents. The numbers in parentheses indicate the importance placed on the content (i.e., priority scale as shown in Table II).

- Key Elements (5): this section includes a brief description of the unit, identifying relevant vocabulary, knowledge, skills and attitudes. All key elements are mandated for students to learn.
- Prescribed Learning Outcomes (5): Prescribed Learning Outcomes (PLO) address the content standards for the unit. Achievement indicators and assessments were suggested based on the key elements and prescribed learning outcomes.
- Suggested Achievement Indicators (3): Suggested Achievement Indicators provide a basis for the assessment of PLO. It also provides additional information about the expected level or degree of student performance.
- Planning for Assessment and Assessment Activities (2): Planning and assessment activities have been included for each prescribed learning outcome and set of corresponding achievement indicators. Each suggested assessment activity directly

corresponds to a particular planning activity as indicated by the order and arrangement of these activities. However, these strategies are mentioned as suggestions only (p. 50).

Table IV

Proportion of TEK coverage in grade 7 BC curriculum

Learning domains	Key Elements [5]	Prescribed Learning Outcomes [5]	Suggested Achievement Indicators [2]	Planning for Assessment [2]	Suggested Assessment Activities [2]	Total	%
Process of science	0 (20)	0 (2)	0 (11)	N/A	n/a	0 (33)	0
Life science: Ecosystems	1 (42)	0 (4)	1 (12)	3 (24)	1 (18)	6 (100)	6
Physical science: Chemistry	0 (31)	0 (3)	0 (8)	0 (18)	0 (15)	0 (93)	0
Earth and space science: Earth's crust	0 (57)	0 (3)	0 (9)	0 (24)	0 (13)	0 (106)	0
Total content	1 (168)	0 (12)	1 (4)	3 (66)	1 (46)	6 (332)	1.81
%	0.60	0	2.50	4.55	2.17	1.81	

Note. Numbers in parentheses indicate the total number of curriculum content; numbers in square brackets indicate the priority scale.

As shown in Table IV, the BC grade 7 official science curriculum devotes 1.81% of its entire content to TEK. TEK content found in the document appeared solely in life science section. A total of six TEK content was identified within the life science section. When presented, TEK content was mostly associated with the suggested planning for activities or assessment (i.e., priority scale: 2). Three of studied TEK content was found from *Planning for assessment* section; the rest was found within *Suggested achievement indicators* and *Suggested Assessment activities*. One TEK content was found within the mandatory content-- *Key elements* (i.e., priority scale: 5).

- Based on the four dimensions (e.g., organizing principles [STSE], habits of mind, skills and procedures, knowledge) of scientific literacy, which dimension has the most/least TEK content?

Table V

TEK content from BC grade 7 categorized into the conceptual framework

	Organizing principle/ STSE	Habits of mind	Knowledge	Skills
TEK content found	0	2 e.g., show respect for the environment (p. 59)	4 e.g., Research Aboriginal practices within a specific ecosystem (p. 67)	0

Table V illustrates that two TEK contents were mentioned on the subject of developing attitudes. The majority, four, of TEK content was not described as knowledge. A suggested achievement indicator asks students to “describe, using examples, how practices of Aboriginal peoples in BC affect environmental sustainability in a specific ecosystem” (p. 67). This specific indicator focuses on the knowledge and practices of Aboriginal people, and requires students to apply this concept in problem-solving.

Table VI

Proportion of TEK coverage in grade 8 BC curriculum document

Learning domains	Key Elements [5]	Prescribed Learning Outcomes [5]	Suggested Achievement Indicators [3]	Planning for Assessment [2]	Suggested Assessment Activities [2]	Total	%
Process of Science	1 (39)	0 (6)	1 (28)	N/A	N/A	2 (73)	2.74
Life science: Ecosystem	1 (51)	0 (4)	0 (16)	0 (17)	0 (16)	1 (104)	0.96
Physical Science: Chemistry	1 (78)	0 (9)	0 (30)	0 (34)	0 (36)	1 (187)	0.53
Earth and Space Science: Earth's crust	1 (43)	0 (3)	1 (12)	1 (17)	0 (13)	3 (88)	3.41
Total content	4 (211)	0 (22)	2 (86)	1 (68)	0 (65)	7 (458)	1.53
%	1.90	0	2.33	1.47	0	1.53	

Note. Numbers in parentheses indicate the total number of curriculum content; numbers in square brackets indicate the priority scale.

Seven TEK elements were found in the grade 8 BC science document. These TEK contents appeared in all learning domains. However, the highest percentage of TEK coverage was found in the earth and space science as it devotes 3.41% of its content to TEK. Here, TEK content was mostly associated with *Key elements*, the mandated learning outcomes (i.e., priority:

5). The *Key elements* section contained four of the total TEK elements. One *Suggested Achievement Indicator* also integrated two TEK elements. *Planning for assessment section* was found to have one TEK content integrated.

- Based on the four dimensions (e.g., organizing principles [STSE], habits of mind, skills and procedures, knowledge) from the scientific literacy, which dimension has the most/least TEK content?

Table VI

TEK content from BC grade 8 categorized in the conceptual framework

	Organizing principle/STSE	Habits of mind	Knowledge	Skills
TEK content found	0	3 e.g., show respect for the environment (p. 59)	4 e.g., Research Aboriginal practices within a specific ecosystem (p. 67)	0

Among the seven TEK contents found in the grade 8 science document, four of them fall into the knowledge section from the foundations of scientific literacy. The rest, three TEK contents from the document, were on the subject of developing attitudes for scientific literacy.

Results for Qualitative Questions

- How is TEK content conceptualized in each provincial curriculum document?

As shown in Tables IV and VI, TEK was mainly represented as one of the knowledge systems which provide the knowledge and attitudes for students. For instance, there were contents asking students “to research how Aboriginal people’s practices affect ecosystems” (grade 7, p. 67) and teachers “to provide students with historical and current information on the use of aquatic resources by First Nations peoples in BC”. There was no evidence in either grade 7 or 8 documents of TEK implicated as primitive or antiquated. The TEK contents were

primarily related to the topics of life science and developing attitudes for stewardship such as “respect for the environment” (British Columbia Ministry of Education, 2005, p. 40).

- To which extent is TEK recognized by ministries (i.e., significance given by the ministry)?

Both grades 7 and 8 documents acknowledge the importance and benefits of integration of TEK in science education. Both documents include a section, *Integration of Aboriginal content in the prescribed learning outcomes*, where it states that the curriculum integrating both TEK and WMS would “provide a meaningful context for Aboriginal students and enhance the learning experience for all students” (British Columbia Ministry of Education, 2005, p. 10).

These curriculum documents also state that, for BC science education, a teaching model involving a parallel process (i.e., integrative science; two-eyed learning) which would help overcome the difficulties of incorporating indigenous knowledge and worldviews into a Western science classroom, was suggested by “the participants of the Ministry of Education Aboriginal science meetings” (British Columbia Ministry of Education, 2005, p. 10). However, they failed to report the identity of these participants present in the Aboriginal science meetings. Were there any Aboriginal elders or scholars participating in the meetings? If so, why didn’t the ministry acknowledge the identity of the participants in the documents? As mentioned previously, in indigenous communities, if the credit of information and knowledge shared is not given properly, it is not an appropriate manner of sharing their knowledge in our classroom (Kimmerer, 2002). If there were no Aboriginal scholars or elders involved in this assembly, it becomes problematic. It would be difficult for Western educators to develop a curriculum that reflects indigenous knowledge and worldviews since knowledge and worldviews are usually orally transmitted in indigenous communities (Kimmerer, 2002). Further studies on the involvement of Aboriginal

scholars and elders in curriculum designs need to be conducted in order to explore those questions.

Moreover, both documents discuss importance of the participation of local Aboriginal elders as they state that, “to address these topics [cultures and contribution of Aboriginal people] in the classroom in a way that is accurate and that respectfully reflects Aboriginal concepts for teaching and learning, teachers are strongly encouraged to seek the advice and support of local Aboriginal communities” (British Columbia Ministry of Education, 2005, p. 16). However, here again, both documents fail to provide specific information pertaining to the individuals that need to be contacted by teachers. They simply mentioned that teachers contact “Aboriginal education co-coordinators, teachers, support workers, and counsellors in district who will be able to facilitate the identification of local resources and contacts such as elders, chiefs, tribal or band councils” (p. 16). They provide a website which contains information related to the Aboriginal Education Website. Among the provided maps, resources and documents, there is no direct contact number for the district’s Aboriginal education co-coordinators or elders. Therefore, teachers that need to contact these specialists in their field so as to access valuable resources are simply left on their own in their quest for achieving this goal. Out of eight resources used in the development of two studied documents, one of them was dedicated to content related to Aboriginal knowledge and experiences. *Shared learning*, published in 1998 by the Aboriginal Education Initiative, part of the British Columbia Ministry of Education, is the sole document contributing to TEK integrated curriculum. Teachers are encouraged to implement suggestions from the *share learning* (1998) as well. Share learning provides one sample plan for grade 7 science – but it does not fit into any prescribed learning outcomes from the official curriculum documents.

Many links and contact numbers are found in the shared learning package. Overall, *Shared learning* (1998) is a good supplement document which provides a better understanding and information about Aboriginal communities in BC. However, it needs to be updated -- as this supplement document has not been revised since 1998. Also, the recommended resources listed and suggestions made for courses found in *Shared learning*, need to make a better link to the prescribed learning outcomes found in the official curriculum documents.

Nunavut (NVT)

For grades 7 and 8 science education, Nunavut adopts the curricula from Alberta (2006) and Northwest Territories (1991). To accommodate their students' learning, the ministry also developed a learning module called, *Diversity: A teacher's resource package for grades 7-9 science* in 2005. This learning module (2005) was developed based on the learning outcomes from Pan-Canadian science curriculum framework (1995) and the NWT curriculum document (1991). The learning module document was developed for grades 7, 8 and 9 science education, especially for the life science domain. This module consists of learning outcomes, activities and evaluation frameworks. Both the NWT curriculum document (1991) and the learning module (Nunavut Department of Education, 2008) are to be used "depending on the individual school, [and] may be taught in a multi-grade classroom or a single grade classroom" (Nunavut Department of Education, 2008, p. 5). Therefore, all curriculum contents from both documents were considered for analysis of Nunavut's grades 7 and 8 science curriculum. It is interesting to note that NWT has developed their own territorial curriculum from elementary grades (i.e., grades 1-6); they have adopted AB curricula for grades 7 and 8. Although they have their own science curriculum developed in 1991, which is still used in Nunavut, the current official curriculum in use in NWT is AB curriculum. Therefore, the curriculum document, *Junior High*

Science (1991), published by NWT, Ministry of Education, has been included for data analysis for Nunavut. The analysis of AB, which includes the science curriculum used in NWT for grades 7 and 8, will follow after the Nunavut section.

Junior High Science (1991). *Junior High Science* (1991) was developed based on a three-dimensional model which includes skills, science concepts/major understanding and scientific literacy. The following sections were analyzed to study TEK content in this curriculum document. The number in parentheses indicates the point from the priority scale (Table II):

- Concept/major understanding (5): concepts and theories that students need to learn in junior high school.
- Skills, attitudes and behaviour (3): lists of skills, attitudes and behaviours that the curriculum suggests students acquire in order to develop better scientific literacy.
- Common learning experience/activities (3): suggested activities which include the learning concepts of each unit. These activities were suggested to be determined locally in order to make the learning experience relevant to students.
- STSE emphasis (3): with STSE emphasis, students “will be provided with the opportunity to use solving and decision making models to explore the relationship among science, technology and societal issues relevant to them” (p. 25).
- Evaluation (2): general description of assessing the students’ learning outcomes.
- Cross-curricular referencing details to the stated goals of the junior high science curriculum (cross-curricular referencing) (2): This section describes how the curriculum details correspond to the ministries’ educational goal dimensions (e.g., intellectual, social, spiritual, physical and emotional).

Results for Quantitative Questions

- How prevalent is TEK content in the provincial intermediate science curriculum documents (grades 7 and 8) across Canada?
- To which learning domains (i.e., curriculum organizers such as life science or physical science) TEK content found in studied documents are related?

Table VII

Proportion of TEK content found in Junior High Science (1991)

Learning domains	Concept/ major understanding [5]	Skills [3]	Attitudes and behaviours [3]	Common learning experience/ activities [3]	STSE emphasis [3]	Evaluation [2]	Cross- curricular referencing [2]	Total	%
Life and the environment (life science)	2 (13)	0 (19)	1 (9)	1 (14)	0 (13)	0 (14)	8 (40)	12 (122)	9.83
Matter and Energy (physical science)	0 (16)	0 (21)	1 (9)	2 (12)	0 (7)	0 (14)	3 (37)	6 (116)	5.17
Earth, space and time. (earth and space science)	0 (13)	0 (23)	1 (9)	1 (10)	0 (7)	0 (14)	2 (39)	4 (115)	3.48
Total content	2 (42)	0 (63)	3 (27)	4 (36)	0 (27)	0 (42)	13 (116)	22 (353)	6.23
%	4.76	0	11.11	11.11	0	0	11.21	6.23	

Note. Numbers in parentheses indicate the total numbers of curriculum content; numbers in square brackets indicate the priority scale.

In *Junior High Science* (1991), a total 22 of TEK related contents were found in all three learning domains. In turn, the document consists of 6.23% of its entire content dedicated to TEK. Especially, the life science contains 12 curriculum expectations devoted to learning TEK, which contributes 9.83% of the entire content from the particular domain. Six TEK related contents were found within the physical science; the rest, four contents were found in the earth and space science.

Within this document, it is evident that TEK has been integrated throughout all four learning domains. There was no TEK content for *assessing evaluation*, or *STSE emphasis* section.

However, *Attitudes and behaviours*, and *common learning activities and experiences* each integrated TEK content, 11.11% of its entire content. *Cross-referencing the curriculum details to the stated goals of the junior high science curriculum* (cross-referencing) section included the highest number, 13% of TEK content. Therefore, with respect to the priority scale, studied TEK contents in this document generally appeared in all points (i.e., scale).

- Based on the four dimensions (e.g., organizing principles, habits of mind, skills and procedures, knowledge) from the scientific literacy, which dimension has the most/least TEK content?

Table VIII

TEK content from Junior High Science (1991) categorized into the conceptual framework

	Organizing principle/STSE	Habits of mind	Knowledge	Skills
TEK content found	8 e.g., how “we” interact with the environment: Traditional and western perception of ecological concepts (p. 21)	6 e.g., respect for one’s self, for others and for “the land” (p. 22)	4 e.g., Classifying using traditional information, knowledge and process (p. 24)	4 e.g., utilize local resources, people and field trip (p. 28)

Junior High Science (1991) was found to integrate TEK content within all four categories of the foundations of scientific literacy. Within 22 studied TEK related curriculum content, the highest number, eight of TEK content coverage, was found on the topic of Science Technology Society and Environment (STSE) interrelationship. To encourage students to develop the attitude and values from Aboriginal perspective, six TEK related contents were introduced. Both knowledge and skill sections presented four TEK related contents.

Results for Qualitative Questions

- How is TEK content conceptualized in each provincial curriculum document?

The ministry argues that in *Junior High Science* (1991), they developed their science curriculum based on the goals of science education: emotional, spiritual, intellectual, physical and social goals. When presented, the majority of TEK content from *Junior High Science* (1991)

appears to be in association with the *emotional* and *spiritual* dimensions of science education. The curriculum uses TEK as a way to help students to develop “respect for the land” and “an appreciation of the complexity and beauty in the creation of and order in our universe” (p. 34). Such curriculum that integrates both European Knowledge (EK) and TEK would encourage the development of pedagogy that appreciates and combines both Western and Indigenous ways of thinking in science (Hatcher et al., 2011). While the curriculum focuses on the Aboriginal perception (i.e., Worldview) in science, the document lacks TEK content in the *intelligent* dimension. As shown in Table VIII, there were four TEK related contents found on the subject of knowledge and skills when there are more numbers of TEK contents appeared in STSE and attitudes. The linkage between WMS and TEK were highly emphasized in this document. TEK contents were represented as “traditional”. For instance, physical science domain entails curriculum including: “Work, motion and energy in terms of traditional tools and simple machines [of Inuit]” (p. 30) and “Appreciation of the value of traditional and scientific knowledge to society” (p. 28).

Using the term “traditional”, teachers and students might understand TEK as something that is “old”. However, allowing students to look at both traditional tools and knowledge along with simple modern machines and modern scientific knowledge promotes students to appreciate scientific ideas and technology from both TEK and WMS. Such representation that presents TEK along with modern science places TEK at the same status as WMS and promotes the two-eyed learning. By doing this, TEK representation as “traditional” in this document does not delineate the idea that traditional knowledge or technology is primitive or less important or relevant than WMS. In other words, there is no evidence of status quo between TEK and WMS perpetuating in this document.

Diversity: A Teacher's Resource Package for Grades 7 – 9 Science (2005). This teacher resource package (i.e., learning module) was published by the Nunavut Department of Education in 2005. This is so far the only curriculum document published by the NVT ministry for grades 7 and 8 science education. Since the document only covers the diversity unit – from the life science, the contents from this document are categorized under the life science domain. As mentioned earlier, this curriculum is meant to be used in all grades 7 to 9 classes (or multi-grade classes). Even though this document is also intended for grade 9, which is not the sample of the project, since there is no instruction of which curriculum content should be taught in each grade, the entire contents from the document were considered for data analysis.

For data analysis, the following eight were studied (section descriptions can be found on pages 20-22):

- Learning Competencies (5): Short statement of what the students are expected to learn.
- Language Development (3): This section contains the vocabulary focused on in the unit
- Opener (2): An interactive and fun activity designed to get students thinking about the unit and to build a classroom community.
- Connector (2): An activity to connect the unit with the previous unit, prior knowledge or with what will take place as the main activity in the unit.
- Activity (3): A main activity planned so students will learn the concept outlined in the outcomes section.
- Reflection (2): Each unit has suggestions for journal reflection.

- Classroom Reinforcement (1): Ideas on how to reinforce the concepts and what to put up in the classroom. In every unit it is suggested that the students add their new vocabulary words to a word bank.
- Follow-up (2): If time permits, a second activity is suggested to reinforce the concepts taught. This may also be used as an enrichment activity.

Results for Quantitative Questions

- How prevalent is TEK content in provincial intermediate science curriculum documents (grades 7 and 8) across Canada?
- To which learning disciplines (i.e., curriculum organizers such as life science or physical science) TEK content found in studied documents are related?

Table IX

Proportion of TEK content in Nunavut learning module

	Learning Competencies [5]	Language Development [3]	Opener [2]	Connector [2]	Activity [3]	Reflection [2]	Classroom Reinforcement [1]	Follow-up [2]	total	%
TEK content	2 (15)	4 (51)	5 (15)	4 (15)	9 (15)	12 (27)	1 (43)	5 (19)	42 (200)	21
%	13.33	7.84	33.33	26.67	60	44.44	2.32	26.32	21	

Note. Numbers in parentheses indicate the total number of curriculum content; numbers in square brackets indicate the priority scale.

This document is only catered to teach diversity section which is considered to be a part of the life science. Hence, the analysis for this document was done as a whole rather than separating them into different learning domains. The document dedicates 21% of its total contents to teach TEK. These TEK contents were evenly mentioned as main learning concepts, examples and follow-up activities in all sections (i.e., appeared in all five scales of the priority scale). However, the majority, 12, of TEK contents were found within the *Reflection* section;

second highest TEK coverage (9 TEK contents) was found within the *Activity* section. The lowest coverage was found within the *Classroom reinforcement* section. *Classroom reinforcement*, a section for suggesting classroom setting, includes 2.32% of TEK in its content. According to the results, TEK content was relatively well-integrated throughout the entire curriculum section. TEK content also appeared as main learning concepts as well as examples or evaluation section.

- Based on the four dimensions (e.g., organizing principles, habits of mind, skills and procedures, knowledge) from the scientific literacy, which dimension has the most/least TEK content?

Table X

TEK content found in Nunavut document categorized in the conceptual framework

	organizing principle/STSE	Attitudes	Knowledge	Skills
TEK content found	7 e.g., Students will appreciate the importance of observation for understanding both Western science and learning IQ from their Elders (p. 63).	25 e.g., Discuss what stewardship means. Stewardship is the responsibility humans have for care taking on the Earth. We have the unique position to be able to destroy or live sustainably on the Earth. Discuss the Nunavut Land Claims Agreement and how it strives to protect the land for future generations. You could also inform students that environmental stewardship or avatimikkamattiarniq is an IQ guiding principle (p. 85).	8 e.g., Invite the class to use Inuktitut words describing moisture level (p. 97).	2 e.g., <i>Igunaq...</i> Procedure Practice (p. 147)

Nunavut's learning module (2005) was found to incorporate TEK in all four categories of foundation of scientific literacy. However, as shown in Table XI, the most, 25, of the studied TEK contents were introduced for developing attitudes. The Knowledge section contained eight TEK contents; STSE section also consisted of seven TEK contents. Two TEK contents were covered as skills to acquire.

Results for Qualitative Questions

- How is TEK content conceptualized in each provincial/territorial curriculum document?

In this learning module (2005), TEK was conceptualized as a main learning outcome for students. This learning module highly encourages and incorporates a curriculum and pedagogy involving elders in class. Thus, it gives the opportunity to students to learn TEK directly from the knowledge holders. Moreover, many activities suggested the learning from the community. The importance of TEK in the Aboriginal cultures and survival were also emphasized. For instance, many curricula from the *Reflection* suggest the activities that promote students to think and elaborate on “what they have learned from elders” (p. 59). Such pedagogy used, along with the learning of WMS, allows students to develop the understanding that TEK and WMS are both important in our current society. Indeed, the Nunavut Department of Education (2005) states that:

Much more value, importance and significance is being assigned to traditional [ecological] knowledge. It is very important that during this module, the teacher recognize and respect the contribution of Inuit knowledge, values and beliefs as well as the concepts and methodologies of western science. It is now accepted that when used together, both western science and traditional can provide a more complete understanding or picture of the world. (p. 7)

Overall, an integrative curriculum (i.e., both TEK and WMS) and pedagogy were emphasized in this learning module.

- To which extent is TEK recognized by ministries?

Nunavut is the province with the highest Aboriginal (Inuit in particular) population in Canada. Under *Article 32 of the Inuit Land Claim Agreement*, the Nunavut Social Development Council (NSDC) is mandated to “assist Inuit to define and promote their social and cultural development goals and objectives and to encourage [the] government to design and implement social and cultural development policies and programs appropriate to Inuit” (Nunavut Department of Education, 2005, p. 8). In a discussion paper, *Towards an Inuit Qaujimajatuqangit (IQ) Policy for Nunavut*, goals, expectations and specific recommendations made for the revitalization and application of IQ (i.e., TEK) were explained. According to this paper, in order to have a better educational system that facilitates the linguistic and cultural needs of Inuit students, the department of education mandates that the curriculum and school services division is committed to create new curricula that address these needs (Nunavut Ministry of Education, 2005).

Junior High Science (1991) lists five goals of the curriculum: Intellectual, social, spiritual, physical and emotional goals. Few of these goals involve learning TEK and making connection of TEK to students’ local environment. For example, one of the intellectual goals is “to develop in the student an understanding and appreciation of traditional and local knowledge”; a spiritual goal entails “to develop and reinforce in the student a respect for ‘the land’” (p. 5). With their educational goals, to teach students these aspects and other Aboriginal perspectives, the ministry explicitly states that they have integrated TEK in their curriculum documents. In *Junior High Science* (1991), “traditional and local knowledge is considered a component of the curriculum. The similarities and differences between Western Science and Traditional science are discussed, and topic areas for the integration of traditional knowledge are identified” (p. 7). The document entails a very detailed description of TEK including the differences and similarities between

TEK and WMS, as well as the pedagogies suggested for teaching TEK. A detailed description on TEK found in *Junior High Science* (1991) depicts the prestige and values TEK carries in the science curriculum. Table VII shows that the *Junior High Science* (1991) integrated TEK in every learning domain. Especially in the life science as well as the environment domain, nearly 10% of the curriculum is related to TEK. When presented in the curriculum document, TEK appears in all four foundations of scientific literacy. A great number of TEK was presented in order to introduce the relationship between Science, Technology, Society and Environment (STSE) (i.e., organizing principles in science). For examples, the *Junior High Science* (1991) includes the learning outcome explaining “how ‘we’ interact with the environment: traditional and western perception of ecological concepts” (p. 21) or “an appreciation of both cultural and scientific ways of explaining phenomenon” (p. 30). In comparison to other provincial or territorial curriculum documents, the curriculum documents used in Nunavut show the most TEK content dedicated to the *organizing principle* foundation in grades 7 and 8 science education.

The Nunavut department of education explicitly acknowledges the value and importance of teaching *Inuit Qaujimajatuqangit* (IQ). In the learning module, *Diversity -- grades 7, 8, and 9*, (2005), IQ was mentioned as the knowledge system that is “holistic, dynamic and cumulative in its approach to knowledge, teaching and learning...the IQ principle of *pilmmaksarniq* (skill and knowledge acquisition) indicates that one learns best by observing, doing and experiencing” (p. 6). Indeed, as shown in Table IX, 21% of the entire curriculum was devoted to introducing IQ. It is the highest percentage ever found in the grades 7 and 8 science curricula in Canada. Especially the module included a full teaching unit only focusing on TEK (e.g., Unit 6: traditional knowledge of plants). This knowledge system was introduced in all domains from the conceptual framework (i.e., four foundations of science literacy). In every unit in the document, one or more

activities that involve inviting elders or Aboriginal knowledge experts into a classroom were suggested. For example, for the unit about the plants, the curriculum suggests inviting an elder or someone from local communities who is knowledgeable about the names and uses of plants (Nunavut Department of Education, 2005, p. 59). As TEK is known to be orally transmitted, such curriculum inviting elders in classrooms allows students to obtain and explore the knowledge directly from the knowledge holders. With all three documents in use, Nunavut's official curriculum documents include the most number of TEK content in Canada's grades 7 and 8 science education.

Alberta (AB)¹

The Alberta Ministry of Education published a science curriculum document for grades 7 to 9 in 2005. This document is also being used in Northwest Territories and Nunavut. This document is organized into five different units. Each unit consists of an overview, focusing questions and outcomes. The overview section was excluded for the data analysis as the section did not describe any specific learning outcomes and the contents from this section are revisited in other sections. Page 6 from the document describes each following curriculum component studied for this project:

- Focusing Questions (5): These questions frame a context for introducing the unit and suggest a focus for investigative activities and application of ideas by students.
- Key concepts (5): Key concepts identify major ideas to be developed in each unit. The intended scope of treatment of these concepts is indicated by the outcomes.
- Outcomes (STSE and Knowledge, Skill, Attitude): Two levels of outcomes are provided in this program of studies.

¹ Document also used in Northwest Territories (NWT) and Nunavut (NVT).

- General Outcomes (3): These are the major outcomes for each unit.
- Specific Outcomes (2): These are detailed outcomes that flesh out the scope of each unit.

Results for Quantitative Questions

- How prevalent is TEK content in the provincial intermediate science curriculum documents (grades 7 and 8) across Canada?
- To which learning domains (i.e., curriculum organizers such as life science or physical science) is TEK mostly related?

Table XI

Proportion of TEK coverage in AB grade 7 curriculum document

Learning domains	Focusing Questions [5]	Key Concepts [5]	STSE outcomes general [3]	STSE Specific [2]	Skill general [2]	Skill specific [2]	Attitude general [3]	Total	%
Interactions and Ecosystems (Life science)	0 (4)	0 (10)	0 (4)	2 (16)	0 (4)	0 (14)	1 (6)	3 (58)	5.17
Plants for food and fibre (Life science)	0 (4)	0 (10)	0 (4)	0 (16)	0 (4)	0 (16)	1 (6)	1 (60)	1.67
Heat and temperature (physical science)	0 (3)	0 (10)	0 (4)	0 (18)	0 (4)	0 (14)	1 (6)	1 (59)	1.70
Structures and Forces (physical science)	0 (3)	0 (10)	0 (4)	1 (17)	0 (4)	0 (15)	1 (6)	2 (59)	3.40
Planet Earth (earth and space science)	0 (3)	0 (10)	0 (4)	0 (16)	0 (5)	0 (16)	1 (6)	1 (60)	1.67
Total content	0 (17)	0 (50)	0 (20)	3 (83)	0 (21)	0 (75)	5 (30)	8 296)	2.70
%	0	0	0	3.61	0	0	16.67	2.70	

Note. Numbers in parentheses indicate the total number of curriculum content; numbers in square brackets indicate the priority scale.

There were a total of eight TEK contents found in the AB grade 7 science curriculum document. TEK content was primarily found in the life science domain. Especially, the *Interaction of ecosystem* section has the highest percentage, 5.17%, pertaining to TEK. There was no evidence of TEK introduced as a major or key learning concept. In terms of priority scale, TEK content in this document is sitting at scale 2.

- Based on the four dimensions (e.g., organizing principles [STSE], habits of mind, skills and procedures, knowledge) from the scientific literacy, which dimension has the most/least TEK content?

Table XII

TEK content found in AB grade 7 categorized into the conceptual framework

	organizing principle/STSE	Attitude	Knowledge	Skills
TEK content found	3 e.g., Appreciate that scientific understanding evolves from the interaction of ideas involving people with different views and backgrounds (e.g., appreciate Aboriginal home designs of the past and present that use locally-available materials; recognize that science and technology develop in response to global concerns, as well as to local needs; consider more than one factor or perspective when making decisions on STSE issues) (p. 22).	5 e.g., Show respect for the environment (p. 59).	0	0

The majority, five TEK contents in the grade 7 document, were related to the attitude foundation from the scientific literacy. The rest, three TEK contents, were covered within the topic of understanding the relationship between Science, Technology, Science, and Environment (i.e., organizing principle). None of the studied TEK content was included as knowledge or skills components linked to the scientific literacy.

Table XIII

Proportion of TEK coverage in AB grade 8 science curriculum document

Learning domains	Focusing Questions (5)	Key Concepts (5)	STSE outcomes main (4)	STSE Sub (2)	Skill main (2)	Skill sub (2)	Attitude (3)	Total	%
Mix and flow of Matter (Physical science)	0 (4)	0 (11)	0 (4)	0 (18)	0 (4)	0 (16)	0 (6)	0 (63)	0
Cells and Systems (Life science)	0 (3)	0 (8)	0 (4)	0 (15)	0 (4)	0 (12)	0 (6)	0 (52)	0
Light and optical system (Physical Science)	0 (3)	0 (8)	0 (3)	0 (13)	0 (4)	0 (16)	0 (6)	0 (50)	0
Mechanical Systems (Physical science)	0 (2)	0 (7)	0 (4)	0 (16)	0 (4)	0 (17)	0 (6)	0 (56)	0
Fresh water and salt water system (Earth and Space Science)	0 (3)	0 (10)	0 (4)	0 (17)	0 (4)	0 (15)	1 (6)	1 (65)	1.54
Total Content	0 (15)	0 (44)	0 (19)	0 (79)	0 (20)	0 (76)	1 (30)	1 (283)	1
%	0	0	0	0	0	0	3.33	0.35	

Note. Numbers in parentheses indicate the total number of curriculum content; numbers in square brackets indicate the priority scale.

One learning outcome found within the grade 8 academic science document was introducing TEK. It was found in the earth and space science: *Fresh water and salt water system*. It makes a total of 0.35 % of its entire grade 8 academic science curriculum document dedicated to TEK.

- Based on the four dimensions (e.g., organizing principles [STSE], habits of mind, skills and procedures, knowledge) from the scientific literacy, which dimension has the most/least TEK content?

Table XIV

TEK content from AB grade 8 documents categorized into the conceptual framework

	Organizing principle/STSE	Attitude	Knowledge	Skills
TEK content found	0	1 e.g., Show respect for the environment (p. 59).	0	0

The found TEK related learning outcome promotes students’ attitudes for respecting the environment.

Grade 8 Science: Knowledge and employability. *Grade 8 Science: Knowledge and Employability* is different from the grade 8 academic science curriculum. This course aims to “provide students who meet the criteria with opportunities to experience success and become well prepared for employment, further studies, citizenship and lifelong learning” (Alberta Ministry of Education, 2009, p. 1). The format of the document is the same as the grade 8 academic science document.

Results for Quantitative Questions

- How prevalent is TEK content in provincial intermediate science curriculum documents (grades 7 and 8) across Canada?
- To which learning disciplines (i.e., curriculum organizers such as life science or physical science) TEK content found in studied documents are related?

Table XV

Proportion of TEK coverage in AB grade 8 knowledge and employability document

Learning domains	Focusing Questions [5]	Key Concepts [5]	STSE outcomes general [4]	STSE specific [2]	Skill general [2]	Skill specific [2]	Attitude general [3]	Total	%
Mix and flow of matter (physical science)	0 (3)	0 (8)	0 (4)	0 (11)	0 (4)	0 (16)	2 (6)	2 (52)	3.85
Cells and systems (life science)	0 (2)	0 (6)	0 (4)	0 (12)	0 (4)	0 (13)	1 (6)	1 (47)	2.13
Light and optical systems (physical science)	0 (3)	0 (8)	0 (3)	0 (10)	0 (4)	0 (14)	1 (6)	1 (48)	2.08
Mechanical systems (physical science)	0 (3)	0 (5)	0 (4)	1 (17)	0 (4)	0 (13)	1 (6)	2 (52)	3.85
Fresh and salt water system (earth and space science)	0 (2)	0 (7)	0 (4)	0 (19)	0 (4)	0 (10)	1 (6)	1 (52)	1.92
Total content	0 (10)	0 (34)	0 (19)	1 (69)	0 (20)	0 (66)	6 (30)	7 (248)	2.82
%	0	0	0	1.45	0	0	20.00	2.82	

Note. Numbers in parentheses indicate the total number of curriculum content; numbers in square brackets indicate the priority

scale.

Compared to TEK coverage in the grade 8 academic science document, 0.35%, 2.82% of this grade 8 *Knowledge and employability* document included TEK. Whereas the grade 8 academic document contains one TEK learning outcome in total, there were seven TEK contents in the *Knowledge and employability*; it incorporates these TEK contents in every learning domain. This grade 8 knowledge and employability document appears to integrate some numbers of TEK in the physical science domains. Four TEK contents appeared within the physical science domains. Two units in the physical science: *Mechanical systems* and *Mix and flow of matter* were found to contain the highest, 3.85%, TEK coverage. Another physical science domain, *light and optical systems*, also dedicates 2.08% of its contents to introduce TEK. TEK contents were also found in other learning domains. The life science domain included 2.13% and the earth and space science contained 1.92% of TEK as well. Moreover, out of total seven TEK contents studied in this document, six TEK contents were categorized under the attitude foundation from the scientific literacy. One TEK content appeared as a specific expectation for

STSE outcomes. Similar to academic grade 8 curriculum, there was no evidence of the TEK introduced as a main learning outcome or concept in grade 8 knowledge and employability as well (i.e., priority scale: 2).

- Based on the four dimensions (e.g., organizing principles [STSE], habits of mind, skills and procedures, knowledge) from the scientific literacy, which dimension has the most/least TEK content?

Table XVI

TEK content from AB grade 8 knowledge and employability document categorized in the conceptual framework

	Organizing principle/STSE	Attitude	Knowledge	Skills
TEK content found	1 e.g., Mutual Respect Students will be encouraged to: appreciate that scientific understanding evolves from the interaction of ideas involving people with different views and backgrounds (e.g., show awareness that knowledge of fluid characteristics has developed in many societies and cultures, including Aboriginal cultures) (p. 9).	6 e.g., Students will be encouraged to: demonstrate sensitivity when pursuing a balance between the needs of humans and the requirements for a sustainable environment (p. 9).	0	0

With regard to the foundations of scientific literacy, out of a total seven TEK contents in grade 8 *Knowledge and Employability*, six TEK contents were devoted to teach attitude; one TEK content was dedicated to promote Aboriginals' way of understanding nature and science (i.e., organizing principle). None was found in the knowledge and skills section.

Results for Qualitative Questions

- How is TEK content conceptualized in each provincial curriculum documents?

TEK is represented as an example of the understanding or view from the “different cultures”. For instance, for developing mutual respect attitude, there was a curriculum stating, “Students will be encouraged to; appreciate that scientific understanding evolves from the interaction of ideas involving people with different views and backgrounds (e.g., show

awareness of and respect for Aboriginal perspectives on the link between humans and the environment)” (p. 14). When presented as knowledge, or a learning concept, TEK was also mentioned as an understanding system “involving people with different views and backgrounds” (p. 14). Emphasizing TEK as a knowledge system from “different” cultures might lead students to “other” the concepts of TEK from the other concepts of science (i.e., constructing otherness). The meaning of “othering” will be discussed in the article.

➤ To which extent is TEK being recognized by ministries?

There is no acknowledgment or reference to the curriculum committees or on integrating Aboriginal cultures and knowledge in science in AB grades 7 and 8 official curriculum documents. It was not possible to find any information on whether there had been any Aboriginal scholars’ or elders’ involvement in curriculum designing or reviewing process. The ministry also does not give out information on the identity of the curriculum committee members to the public. A representative (who wants to remain anonymous) from the ministry, however, mentioned that the ministry confirmed that experts from every field were involved in designing Alberta’s curriculum to ensure the diversity in the curriculum. Indeed, the Alberta Ministry of Education website (2011) includes a section: *First Nations, Métis and Inuit Education*. This section states that, “At Alberta Education, we work together with First Nations, Métis and Inuit (FNMI) communities, Elders, parents, teachers and other education stakeholders throughout the province to learn from each other to best meet the needs of FNMI learners” (para. 6). The FNMI education site contains documents and curricula for the Aboriginal education in Alberta. However, no particular document for curriculum and pedagogy used for implementing TEK and cultures in science curricula was offered on the website. The grade 8 *knowledge and employability*

document is the only document that had acknowledgment of integrating the Aboriginal cultures and knowledge in science curriculum:

For historical, constitutional and social reasons, an understanding of First Nations, Métis and Inuit (FNMI) experiences and perspectives, and recognition that First Nations, Métis and Inuit students have particular needs and requirements, it is necessary to enable all students to be respectful and responsible citizens. Knowledge and Employability courses serve to facilitate positive experiences that will help Aboriginal students better see themselves in the curriculum and assist non-Aboriginal students to develop a better understanding of Alberta's First Nations, Métis and Inuit peoples. (2009, pp. 2-3)

TEK content found in AB grades 7 and 8 science curriculum documents was mainly on the subject for developing attitudes in science. All in all, there are evidences of TEK integration in AB grades 7 and 8 science curriculum documents.

Saskatchewan (SK)

There were two components for grades 7 and 8 science curriculum documents in SK: *Outcomes* and *Indicators*. Outcomes describe the knowledge, skills, and understandings that students are expected to attain by the end of a particular grade. Indicators are a representative list of the types of things a student should know or be able to do if they have attained the outcome (Saskatchewan Ministry of Education, 2009). In other words, outcomes are the general expectations, and indicators are specific expectations.

Results for Quantitative Questions

- How prevalent is TEK content in the provincial intermediate science curriculum documents (grades 7 and 8) across Canada?

- To which learning disciplines (i.e., curriculum organizers such as life science or physical science) is TEK mostly associated with?

Table XVIII

Proportion of TEK coverage in SK grade 7 science curriculum document

	Organizing principle/STSE	Attitude	Knowledge	Skills
TEK content found	2 e.g., Describe the ways that traditional Indigenous knowledge about respect and responsibility for the land, self, and others has been transmitted over many years, including the oral tradition (p. 30).	1 e.g., Students will be encouraged to: demonstrate sensitivity when pursuing a balance between the needs of humans and the requirements for a sustainable environment (p. 9).	6 e.g., Provide specific examples of Indigenous knowledge in understanding the components of their ecosystems (p. 30).	0

SK grade 7 curriculum document dedicates 5.63% of its curriculum to TEK related topics. As shown in Table XVIII, the life science included the highest number, six, of TEK relating contents. One of these TEK contents was presented as an *outcome* in earth and space science domain. There was no TEK related *outcome* found in physical science section. There were two outcomes suggested in *Connecting to Other Subjects*, relating TEK to cross-curricular activity. These TEK contents appeared both as outcomes and indicators.

- Based on the four dimensions (e.g., organizing principles, habits of mind, skills and procedures, knowledge) from the scientific literacy, which dimension has the most/least TEK content?

Table XVII

TEK content from SK grade 7 categorized into conceptual framework

Learning domains	Outcomes [5]	Indicators [3]	Total	%
Life science: Interaction within ecosystems	1 (4)	5 (34)	6 (38)	15.79
Physical Science: Mixtures and solutions	0 (3)	0 (31)	0 (34)	0
Physical science: Heat and temperature	0 (3)	0 (25)	0 (28)	0
Earth and Space Science: Earth's Crust and Resources	0 (3)	1 (32)	1 (35)	2.86
Connections with Other areas of study^a	0 (0)	2 (25)	2 (25)	8
Total content	1 (13)	8 (147)	9 (160)	5.63
%	7.69	5.44	5.63	

Note. Numbers in parentheses indicate the total number of curriculum content; numbers in square brackets indicate the priority scale.

^aThis part has been included for the analysis because SK addressed the importance of the cross-curricular competencies; the indicators and examples contained outcomes/indicators suggested in the core curriculum.

Six of the studied TEK contents were related to the knowledge aspect from the scientific literacy. Two TEK contents were dedicated to promoting the Indigenous way of understanding STSE (i.e., organizing principle in scientific literacy). Finally, one of these TEK contents was encouraging learning attitudes from the Aboriginal perspective (Table XIX).

Table XVIII

Proportion of TEK coverage in SK grade 8 science curriculum document

Learning domains	Outcomes [5]	Indicators [3]	Total	%
Life science: Cells, Tissues, Organs and System	0 (4)	2 (34)	2 (38)	5.26
Physical Science: optics and vision	0 (4)	0 (31)	0 (35)	0
Physical science: Forces, Fluids, and density	0 (4)	0 (38)	0 (42)	0
Earth and Space Science: Water systems on Earth	0 (3)	3 (26)	3 (29)	10.34
Connections with Other areas of study^a	0 (0)	0 (21)	0 (21)	0
Total Content	0 (15)	5 (150)	5 (165)	3.03
%	0	3.33	3.03	

Note. Numbers in parentheses indicate the total number of curriculum content; numbers in square brackets indicate the priority scale.

^aThis part has been included for the analysis because SK addressed the importance of cross-curricular competencies; the indicators and examples contained outcomes/indicators suggested in the core curriculum.

Table XX shows that 3.03% of SK grade 8 official science curriculum was dedicated to introducing TEK (i.e., a total of five curriculum contents were related to topics of TEK). Earth

and space science appears to contain the most TEK content from the document. The life science section also integrated TEK into 5.26% of its curriculum. The physical science and *connections with other areas of study* did not suggest any curriculum or activities related to TEK. All studied TEK content was mentioned as an *indicator* (i.e., priority scale: 3). TEK in this document mainly was mentioned as a key learning concept rather than shown as an example (see Appendix I).

- Based on the four dimensions (e.g., organizing principles, habits of mind, skills and procedures, knowledge) from the scientific literacy, which dimension has the most/least TEK content?

Table XIX

TEK content from SK grade 8 document categorized into the conceptual framework

	Organizing principle/STSE	Attitude	Knowledge	Skills
TEK content found	0	1 e.g., Examine the ways in which First Nations and Métis people traditionally valued, depended upon, and cared for aquatic wildlife and plants in Saskatchewan and Canada (p. 41).	4 E.g., Examine the significance of water to First Nations and Métis people of Saskatchewan, including water as an essential element of life, transportation, water quality, fishing practices, and treaty rights regarding fishing (p. 39).	0

As shown in Table XXI, most of TEK contents were on the subject of representing TEK as knowledge to learn. One TEK content was dedicated to promoting attitudes to acquire. There was no TEK content found on the subject of STSE outcomes or skills.

Results for Qualitative Questions

- How is TEK content conceptualized in each provincial curriculum documents? (i.e., is it implicated in primitive or in modern/constructive ways?)

In SK's grades 7 and 8 science documents, contributions of TEK in Canadian society and science were emphasized. For example, one of the grade 8 indicators suggests students to

“examine the ways in which First Nations and Métis people traditionally valued, depended upon, and cared for aquatic wildlife and plants in Saskatchewan and Canada” (p. 41). Similar to grade 8, grade 7 life science domain also consists of various indicators which entail to TEK. One of the indicators was to “examine key aspects of Indigenous knowledge and First Nations and Métis people’s practices that contribute to understanding of ecosystems and the interactions of their components” (p. 30). Such representations facilitate students’ understanding of TEK in STSE context.

- To what extent is TEK recognized by the ministry?

Saskatchewan is one of the provinces that explicitly acknowledges the importance of teaching TEK in their official science curriculum documents in detail. Many Aboriginal scholars and indigenous knowledge experts from the science field and school boards were involved in the curriculum design and review process (Saskatchewan Ministry of Education, 2009). Other provinces in Canada such as British Columbia also acknowledge the need of implementing the cultures and experiences of Canada’s Aboriginal people. With this acknowledgement of the values of TEK in science education, Saskatchewan, also greatly emphasizes the two-eyed learning that includes both “first nations and Métis cultures [Indigenous knowledge] and Euro-Canadian cultures [science]” (Saskatchewan Ministry of Education, 2009, p. 20). Not only did they suggest the importance that TEK carries in science education, Saskatchewan’s grades 7 and 8 science curriculum documents also clearly state their view of TEK as a knowledge system and as a main learning component for developing scientific literacy. Indeed, regarding teaching TEK, the ministry asserts that “a strong science program recognizes that modern science is not the only form of empirical knowledge about nature and aims to broaden student understanding of

traditional and local knowledge system” and “[TEK] enables all Saskatchewan students to develop scientific literacy” (Saskatchewan Ministry of Education, 2009, p. 5).

The ministry lists three broad areas of learning which incorporated the knowledge, skills and attitudes that Saskatchewan science education is focusing on: *Developing lifelong learners*; *Developing a sense of self and community*; and *Developing engaged citizens* in their grades 7 and 8 science curriculum documents. Each of the learning areas shows how TEK needs to be taught in order for students to “develop and strengthen their personal identity as they explore connections between their own understanding of the natural and constructed world” (p. 4). Based on the results, the ministry’s efforts to implement (actualize) Aboriginal content is evident in both grades 7 and 8 science curriculum documents.

As shown in Tables XVII and XIX, grade 7 consists of a total 5.63%, and 3.03% in grade 8, of TEK related content. Categorized within the foundations of scientific literacy, more than 50% of these TEK contents found in these documents were mentioned as knowledge in both grades when TEK content usually is prominent in attitude section from other provinces’ curricula. TEK content also has been mentioned as a main learning outcome in the life science of grade 8’s curriculum document (2009) rather than presented just as examples of a main learning outcome. It clearly shows that Saskatchewan understands the importance of TEK in science education and that “widespread knowledge of Aboriginal peoples and their histories will benefit all Saskatchewan students” (Saskatchewan Ministry of Education, 2009, p. 7).

The Saskatchewan Aboriginal Education Advisory Committee Action plan (2005) states that 17 recommendations were made to create an equitable educational environment for Aboriginal students. However, they mentioned that these recommendations “pertain not only to Aboriginal students, but to all students in the province” (p. 7). To do so, the action plan (2005)

suggests the *Actualization of Indigenous knowledge in Curriculum*; the action plan describes the need of actualization as it states,

Now, many teachers – especially those involved in the implementation of new curricula – express their desire to know more about Aboriginal content and perspectives, and their willingness to participate in in-service programs. Although this increased awareness is only a beginning, we see it as a major step forward and the foundation for progress in the future. (p.8)

In turn, both grades 7 and 8 science curriculum documents were published in 2009 (which is after the action plan was developed); it is evident that curricula implemented the actualization of TEK in their science curricula.

Manitoba (MB)

Manitoba has three official curriculum documents for their grades 7 and 8 science education: *Grades 5 to 8 Science: Manitoba Curriculum Framework of Outcomes*; *Grades 5 to 8 Science: A Foundation for Implementation*, and *Grades 5 to 8 Topic Chart*. All three documents were published in 2000. *Curriculum Framework of Outcomes* explains the ministry's goal of science education as well as Manitoba's foundations for scientific literacy. The following contents were analyzed:

- General Learning Outcomes (5): General student learning outcomes (GLOs) for Manitoba, based on the five foundation areas, define overall expectations for scientific literacy (p. 5). There are 28 general learning outcomes for grades 5-8.
- Prescribed Learning Outcomes (Specific Learning Outcomes) (5): Specific Learning Outcomes are mandatory. *Grades 5 to 8 Science: A Foundation for Implementation* provides planning tools, as well as suggestions for instruction and

assessment. The Overall Skills and Attitudes SLOs for each grade are also presented as part of a grades 5 to 8 chart (separate attachment). The purpose of this chart is to assist teachers in tracking the development of skills and attitudes across several grades.

- Suggestions for Instruction, Assessment, and Learning Resources (3): Grades 5 to 8—this four-column section contains the prescribed student learning outcomes, suggestions for instruction, suggestions for assessment, and suggested learning resources. It is organized by grade and is further divided into clusters or thematic units. Each grade is accompanied by Blackline Masters (supplement resource) to support and enhance learning.
- Teachers' notes (2): This section contains pedagogical suggestions for teachers. They are not mandatory teaching materials; this section, however, allows teachers to have a better understanding of students.

Results for Quantitative Questions

- How prevalent is TEK content in the provincial intermediate science curriculum documents (grades 7 and 8) across Canada?
- To which learning disciplines (i.e., curriculum organizers such as life science or physical science) is TEK content mostly associated with?

Table XX

Proportion of TEK coverage in MB grade 7 science curriculum document

Learning domains	Prescribed learning outcomes [5]	Suggestions for instruction [3]	Suggestion for assessment [3]	Teachers' notes [2]	Total	%
Cluster 0: Overall Skills and Attitudes	0 (50)	n/a	n/a	n/a	0 (50)	0
Cluster1: Interactions with in ecosystem (life science)	0 (15)	1 (29)	0 (10)	1 (6)	2 (60)	3.33
Cluster 2: Particle theory of matter (Physical science)	0 (23)	0 (30)	0 (31)	0 (10)	0 (94)	0
Cluster 3: Forces and Structures (physical science)	0 (12)	1 (20)	1 (13)	0 (5)	2 (50)	4
Cluster 4 : Earth's Crust (earth and space science)	0 (15)	0 (23)	0 (12)	0 (4)	0 (54)	0
Total	0 (115)	2 (102)	1 (66)	1 (25)	4 (309)	1.30
%	0	1.96	1.52	4	1.30	

Note. Numbers in parentheses indicate the total number of curriculum content; numbers in square brackets indicate the priority scale.

As shown in Table XXII, there are four TEK contents found in MB's grade 7 science official curriculum. The life science domain includes two TEK contents. The other two contents were found in the physical science: *cluster 3, forces and structures*. For example, quinzhee, canoe and tipi were shown as examples of structures along with other structures such as the Great Wall of China and dam (p. 4). These studied TEK contents were found within the *teachers' notes and suggestions for instruction and assessment sections*.

- Based on the four dimensions (e.g., organizing principles [STSE], habits of mind, skills and procedures, knowledge) from the scientific literacy, which dimension has the most/least TEK content?

Table XXIII

TEK content from MB grade 7 categorized into the conceptual framework

	Organizing principle/STSE	Attitude	Knowledge	Skills
TEK content found	2 e.g., What can Aboriginal perspectives contribute to society's goal of sustainability? (p. 16).	0	2 e.g., How can environmental knowledge from Aboriginal people be accessed and included in a decision-making process? (p. 16).	0

As shown in Table XXIII, two of the studied TEK contents were on the topic of STSE interrelationship of the foundation of scientific literacy. The other two contents were categorized in the knowledge section.

Table XXI

Proportion of TEK coverage in MB grade 8 science curriculum documents

Cluster	Prescribed learning outcomes [5]	Suggestions for instruction [3]	Suggestion for assessment [3]	Teachers' notes [2]	Total	%
Cluster 0: Overall Skills and Attitudes	0 (50)				0 (50)	0
Cluster1: Cells and Systems (life science)	0 (19)	0 (32)	0 (18)	0 (10)	0 (79)	0
Cluster 2: Optics (physical science)	0 (14)	0 (28)	0 (15)	0 (11)	0 (68)	0
Cluster 3: Fluids (physical science)	0 (14)	0 (24)	0 (17)	0 (9)	0 (64)	0
Cluster 4 : Water systems on Earth (earth and space science)	0 (19)	0 (34)	0 (18)	0 (7)	0 (78)	0
Total content	0 (66)	0 (118)	0 (68)	0 (37)	0 (289)	0
%	0	0	0	0	0	

Note. Numbers in parentheses indicate the total number of curriculum content; numbers in square brackets indicate the priority scale.

As shown in Table XXIV, there was no TEK content found in the science curriculum documents of grade 8

- Based on the four dimensions (e.g., organizing principles [STSE], habits of mind, skills and procedures, knowledge) from the scientific literacy, which dimension has the most/least TEK content?

Table XXII

TEK content from MB grade 8 science categorized into the conceptual framework

	Organizing principle/STSE	Attitude	knowledge	Skills
TEK content found	0	0	0	0

As shown in Table XXV, there is no TEK content found in the document.

Results for Qualitative Questions

- How is TEK content conceptualized in each provincial curriculum documents?

The representations of the four studied TEK contents within Manitoba's grade 7 science curriculum documents are varied. One TEK content from the grade 7 (2000) life science domain describes the contributions of TEK to Canadian society. It was mentioned that the "Aboriginal perspectives" was suggested for teachers to assess students' understanding of how "environmental knowledge from Aboriginal people be accessed and included in a decision making process" (p. 16) or their contributions to society's goal of sustainability. On the other hand, the remaining three TEK contents were represented as "other culture". TEK often was presented as an example along with other structures from the world: the Eiffel Tower, the Great Wall of China, or "other views" (p. 8). TEK is developed locally in Canada and provides relevant data and information to all Canadian students. However, linking TEK with these non-Canadian originated structures and views such as the Great Wall of China, and represent as "other view", constructs "otherness" within the curricula.

- To which extent is TEK recognized by ministries?

From all documents analyzed, there was no mention of any Aboriginal scholars' or elders' involvement in the curriculum design or review process. There was also no curriculum content on the subject of TEK in grade 8's documents. Based on the results, 1.30% of the entire grade 7

science curriculum reflects the Aboriginals' worldview, culture and knowledge. These TEK contents are presented as examples or suggested learning outcomes rather than main learning outcomes which students require to master. For example, the Aboriginal people's traditional building structure such as *tipi*, *quinzhee* and *igloo* were introduced as examples to learn about forces and structure (grade 7, implementation document: Cluster 3, p. 4). When these contents were introduced, they were suggested as an example along with non-Canadian originated structures, such as the Eiffel Tower and the Great Wall of China. Such representation of TEK brings the cultural awareness into learning but it implicates that TEK and other Aboriginal scientific contributions are not necessarily required for students to learn. For example, teachers were suggested to have students read the article called, "*Aboriginal Perspective (BLM 7-A)*" for introducing two TEK contents in grade 7 *Cluster 1: Interaction within ecosystem*. This article integrates the ideas of the seven generation, respect for the environment, respect for the mother earth and interconnectedness and interdependence of all life forms (Manitoba Education and Learning, 2000, p. 16). This article, *Aboriginal Perspectives*, also acknowledges the contributions of the Aboriginal people and knowledge in society. The document states, "Traditionally, Aboriginal people have exemplified the qualities of good stewardship in their interactions with the environment.... Aboriginal people are rich in environmental knowledge and can provide important perspectives when considering the impact of economic decisions on the environment" (p. 16). After reading this article, teachers are then suggested to broaden a classroom discussion into how TEK can contribute to society's goal of sustainability or how it can be accessed and included in a decision making process. This particular example shows the ministry's effort to introduce Aboriginals' contributions to society and environment.

Based on the results, an obvious pattern was found across the documents, through which TEK is associated with certain learning topics in curriculum, such as sustainability and stewardship. Despite the fact that TEK could have been easily integrated into introducing other concepts such as learning about the ecosystem as suggested in NVT and SK (e.g., different types of biotic or abiotic faunas, ecological succession or observing ecosystems), there was no evidence of relating TEK with other various topics, except for sustainability and stewardship.

Cluster 1 of the grade 7 curriculum states that “the terms living and non-living are problematic for some cultural groups, particularly Aboriginal group” (p. 8). This note informs teachers that the Aboriginal views on living things are different from the Western science and other cultural views, which can be seen as reflecting the ministry’s view on the educational values of TEK. Based on the results from the analysis, however, there was no specific acknowledgment of the importance of TEK in science or teaching the Aboriginal cultures in science. Instead, learning Aboriginal perspective was mentioned as pedagogy that helps insure the “inclusiveness in education” (grade 7 Cluster 1, p. 8). This particular curriculum content exemplifies that the ministry views TEK as something that they need to integrate in order to accommodate *multicultural* classes.

Manitoba has the fourth largest Aboriginal population residing in the province (the first three are Nunavut, the Northwest Territories and Yukon) (Human Resources and Skills Development Canada, 2011). Despite the high population of Aboriginal students, the results show a comparatively low level of TEK integrated in grades 7 and 8 science curricula. In comparison to Nunavut and SK, Manitoba seems to be unsuccessful in introducing TEK content in grades 7 and 8 curriculum cohesively with other curriculum contents.

Ontario (ON)

Ontario Science Curriculum: Grades 1 to 8: Science and Technology (2007) identifies the expectations for each grade. This document describes the knowledge and skills that students are expected to acquire, demonstrate, and apply in their class work and investigations, on tests, and in various other activities on which their achievement is assessed and evaluated. *Ontario Science Curriculum* (2007) consists of two sets of expectations -- overall expectations and specific expectations. Overall expectations describe “in general terms the knowledge and skills that students are expected to demonstrate by the end of each grade” (p. 11). Taken together, both overall and specific expectations are official mandated science curriculum. Specific expectations, built on overall expectations, describe “the expected knowledge and skills in greater details” (p. 11). These expectations are categorized into three different components: Basic concepts, Skills and Science Technology Society and Environment (STSE). Specific expectations are usually accompanied by suggested examples, sample issues or guiding questions in parentheses. These examples, however, are not mandated curriculum but rather help the teachers to elaborate their pedagogies to teach the curriculum expectations.

Results for Quantitative Questions

- How prevalent is TEK content in provincial intermediate science curriculum documents (grades 7 and 8) across Canada?
- To which learning disciplines (i.e., curriculum organizers such as life science or physical science) TEK content found in studied documents are related?

Table XXIII

Proportion of TEK coverage in ON grade 7 science curriculum document

Learning domains	Overall expectation[5]	STSE [3]	Skills [3]	Basic concepts[3]	Total	%
Understanding life systems: Interactions in the environment (Life science)	0 (3)	0 (2)	0 (5)	1 (9)	1 (19)	5.26
Understanding structures and mechanisms: Form and Function (physical science)	0 (3)	0 (2)	0 (7)	0 (7)	0 (19)	0
Understanding Matter and Energy: Pure substances and mixtures (physical science)	0 (3)	0 (2)	0 (6)	0 (10)	0 (21)	0
Understanding earth and space system: Heat in the environment	0 (3)	0 (2)	0 (6)	0 (8)	0 (19)	0
Total content	0 (12)	0 (8)	0 (24)	1 (34)	1 (78)	1.28
%	0	0	0	2.94	1.28	

Note. Numbers in parentheses indicate the total number of curriculum content; numbers in square brackets indicate the priority scale.

As shown in Table XXVI, there was one curriculum expectation related to TEK content in ON's grade 7 science curriculum. This was found in the life science domain. 5.26% of this life science domain was on the subject of TEK which consists, 1.28% of the entire grade 7 science curriculum.

- Based on the four dimensions (e.g., organizing principles [STSE], habits of mind, skills and procedures, knowledge) from the foundation of scientific literacy, which dimension has the most/least TEK content?

Table XXIV

TEK content from ON grade 7 categorized into the conceptual framework

	Organizing principle/STSE	Attitude	Knowledge	Skills
TEK content found	0	0	1 e.g., Describe Aboriginal perspectives on sustainability and describe ways in which they can be used in habitat and wildlife management (e.g., the partnership between the Anishinabek Nation and the Ministry of Natural Resources for managing natural resources in Ontario) (p. 123).	0

A TEK relating content was presented in the knowledge within the foundations of scientific literacy.

Table XXV

Proportion of TEK coverage in ON grade 8 science curriculum document

Learning domains	Overall expectation [5]	STSE [3]	Skills [3]	Basic concepts [3]	Total	%
Understanding life systems: Cells (Life science)	0 (3)	0 (2)	0 (6)	0 (6)	0 (17)	0
Understanding structures and mechanisms: Systems in action (physical science)	0 (3)	0 (2)	0 (7)	1 (9)	1 (21)	4.76
Understanding Matter and Energy: Fluids (physical science)	0 (3)	0 (2)	0 (8)	0 (8)	0 (21)	0
Understanding earth and space system: Water (earth and space science)	0 (3)	1 (3)	0 (7)	0 (5)	1 (18)	5.56
Total content	0 (12)	1 (9)	0 (28)	1 (28)	2 (77)	2.60
%	0	11.11	0	3.57	2.60	

Note. Numbers in parentheses indicate the total number of curriculum content; numbers in square brackets indicate the priority scale.

According to Table XXVIII, there were two curriculum expectations that include TEK. Both were found in the physical, and earth and space science domain. As a result, 2.60% of grade 8 curriculum expectation was dedicated to TEK. Both TEK contents appeared as specific expectation from STSE and basic concepts.

- Based on the four dimensions (e.g., organizing principles [STSE], habits of mind, skills and procedures, knowledge) from the foundation of scientific literacy, which dimension has the most/least TEK content?

Table XXVI

TEK content from ON grade 8 categorized into the conceptual framework

	Organizing principle/STSE	Attitude	Knowledge	Skills
TEK content found	1 e.g., assess how various media sources (e.g., Canadian Geographic; the science section in newspapers; Internet websites; local, national, and international news on television and radio) address issues related to the impact of human activities on the long-term sustainability of local, national, or international water systems Sample issues: (c) The Protocol for Safe Drinking Water in First Nations Communities addresses drinking water concerns in First Nations communities. Various government agencies, news agencies, and interest groups have different perspectives on its development and release (p. 150).	0	1 e.g., identify various types of systems (e.g., mechanical systems, body systems, optical systems, mass transit systems, Aboriginal clan systems, healthcare systems) (p. 145)	0

From the two TEK contents analyzed, one curriculum content was on the subject of STSE (i.e., organizing principle); the other content was found in the knowledge section.

Results for Qualitative Questions

- How is TEK content conceptualized in each provincial curriculum documents?

In ON's grades 7 and 8 official curriculum documents, TEK content seems to be related with current social issues. TEK content found within the grade 7 science curriculum asks students to "describe Aboriginal perspectives on sustainability and describe ways in which they can be used in habitat and wildlife management" (2007, p. 123). TEK content found in the grade 8 also presents the Aboriginal perspective along with current environmental issues. For instance, a specific expectation suggests students to "research about Aboriginal communities' views on water issues while they need to research other various government agencies and environmental groups' view learning about long-term sustainability issues" (p. 150). When represented in these documents, TEK is implicated as a knowledge system that is effective and useful for our society.

➤ To which extent is TEK recognized by ministries?

Along with the Aboriginal Education Office in Ontario, the Ontario Ministry of Education published a policy framework document for Aboriginal education (2007). In order to enhance Aboriginal students' success in educational system, the document suggests a "curriculum that reflects First Nation, Métis, and Inuit cultures and perspectives" (p. 7). Such curriculum is also needed for non-Aboriginal students in Ontario. Indeed, the ministry states their vision of policy framework as, "All students in Ontario will have knowledge and appreciation of contemporary and traditional First Nation, Métis, and Inuit traditions, cultures and perspective" (Ontario First Nation, Métis and Inuit Education Policy Framework, p. 7).

In turn, the ministry is committed to "provide a curriculum that facilitates learning about contemporary and traditional First Nations, Métis and Inuit cultures, histories and perspectives among all students and that also contributes to the education of school board staff, teachers and elected trustees" (Ontario First Nation, Métis and Inuit Education policy framework, p. 8). Indeed, the ministry argues that, in Ontario science curricula, they have integrated contents reflecting Aboriginal perspectives, culture, knowledge and histories as "they relate to science and technology" (Ontario Ministry of Education, 2007, p. 37). With all due respect, there are three expectations (i.e., learning outcomes) reflecting TEK in grades 7 and 8 science curricula. When integrated, they are listed as a main knowledge or organizing principle for students to learn whereas many other provinces integrated TEK and other Aboriginal perspectives as suggested examples for key learning concepts (e.g., NB).

Ontario Ministry of Education (2007) states in their policy framework for Aboriginal Education that, "as part of the curriculum review process, First Nation, Métis, and Inuit content has been integrated into the revised curriculum as appropriate in consultation with Aboriginal

organizations” (p. 28). Other subjects such as social science were mentioned as the curricula which underwent the review process by Aboriginal organizations. However, it is not mentioned that the review for their science curricula has been completed (Ontario First Nation, Métis and Inuit Education Policy Framework, 2007, p. 28). This could be the reason why there is a lack of TEK coverage in the ON science curriculum documents despite the recognition given by the ministry, which was evident in both curriculum documents policy framework.

Quebec (QC)

There are four documents being used in QC for grades 7 and 8 science:

1. Quebec education program: Secondary School Education, Cycle one (2004)
2. Progression of Learning in Secondary School Science and Technology Cycle one: Environmental Science and Technology (August, 2011) (i.e., general path)
3. Progression of Learning in Secondary School Science technology Cycle one: Applied Science and Technology (August, 2011) (i.e., applied path)
4. Framework of evaluation – No TEK related content found.

Table XXVII

Proportion of TEK coverage in QC Secondary school education cycle one (2004)

Learning domains	Total number of outcomes (orientations + compulsory concepts + possible cultural references)	%
The Material World (physical science)	0 (44)	0
The living world (life science)	0 (60)	0
The Earth and Space (Earth and space science)	0 (60)	0
Technological world (physical science)	0 (45)	0
Techniques	0 (15)	0
Strategies	0 (12)	0
Attitudes	1 (21)	4.76
Total	1 (257)	0.39
%	0.39	

Note. Numbers in parentheses indicate the total number of curriculum content.

Table XXVIII

Proportion of TEK coverage in QC Progression of Learning in Secondary School Science and Technology cycle one

Learning domains	Total number of outcomes	TEK	%
The Material World (physical science)	181 (165)	0	0
The living world (life science)	107 (122)	0	0
The Earth and Space (Earth and space science)	88 (62)	0	0
Technological world (physical science)	122 (127)	0	0
Techniques	68 (72)	0	0
Strategies	35 (35)	0	0
Total	601 (583)	0	0
%	100	0	0

Note. Numbers in parentheses indicate the total number of curriculum content.

As shown in Table XXXI, there is one learning outcome that relates to TEK, found in *Quebec Secondary Education Program Cycle One* (2004). This learning outcome promotes attitude in science education, which encourages students' "respect for life and the environment" (p. 248). Other than that, there is no evidence of the integration of Aboriginal perspectives or TEK within the analyzed documents. Mr. Pierre Reid, the former Quebec Minister of Education, asserts that the aim of the Quebec education program in secondary cycle one (grades 7-8) is "the success of all students" (2004). However, so far there is no published official document for accommodating Aboriginal students' learning or a policy framework for the integration of TEK or other Aboriginal perspective in Quebec curricula.

The ministry argues that "in the early twenty-first century there is so much artistic, philosophical and scientific work of all origins that it is not possible to choose to introduce students to a single cultural universe" (2004, p. 7). Albeit mentioned as an aim for education, there was only tenuous introduction of TEK in curriculum. Quebec science official curriculum seems to be based on European-Western science (i.e., WMS) primarily.

As mentioned by the Quebec ministry, it is impossible to teach only one single cultural universe or knowledge system. Especially many of environmental issues are becoming major concerns in our contemporary society. TEK is mentioned as a knowledge system that may help all students when making a decision around their local and global environmental issues. Indeed, the ministry argues that the program for secondary cycle “integrates all the subjects into a coherent whole focused on the major issues of contemporary life” (2004, forward). Based on the results, however, the ministry fails to introduce the major issues of the contemporary life as well as its possible solution, including TEK.

The Atlantic Provinces: New Brunswick (NB), Nova Scotia (NS), Prince Edward Island (PEI) and Newfoundland and Labrador (NL)

The curriculum described in *Foundation for the Atlantic Canada Science Curriculum* was planned and developed collaboratively by regional committees and is being used in the Atlantic provinces for grades 7 and 8 science education. The process of developing a common science curriculum for Atlantic Canada involved regional consultations with stakeholders in the education systems in each Atlantic province. The following components of the curriculum were analyzed:

- Outcomes (5): The outcomes form the basis of the outcomes framework. They also identify the key components of scientific literacy. Four general curriculum outcomes have been identified to delineate the four critical aspects of students’ scientific literacy (e.g., STSE, skills, knowledge and attitude).
- Elaborations—Atlantic Science Curriculum (2): describes learning environments and experiences that will support students’ learning.

- Tasks for instruction and/or assessment (3): These are suggestions for ways that students' achievement of the outcomes could be assessed. These suggestions reflect a variety of assessment techniques and materials.

Results for Quantitative Questions

- How prevalent is TEK content in provincial intermediate science curriculum documents (grades 7 and 8) across Canada?
- To which learning disciplines (i.e., curriculum organizers such as life science or physical science) TEK content found in studied documents are related?

Table XXIX

Proportion of TEK coverage in grade 7 the Atlantic Provinces science document

Learning domains	Curriculum outcomes STSE [5]	Skills [5]	Knowledge [5]	Attitude ^a [5]	Elaboration-strategies for learning and teaching ^b [2]	Tasks for instruction and/or assessment [3]	Total	%
Interaction within ecosystems (Life science)	0 (9)	0 (11)	0 (7)	n/a	0 (28)	0 (52)	0 (107)	0
Earth's Crust (Earth and space science)	0 (9)	0 (9)	0 (10)	n/a	1 (35)	0 (54)	1 (117)	0.85
Heat (physical science)	0 (6)	0 (9)	0 (6)	n/a	0 (19)	0 (26)	0 (66)	0
Mixtures and solutions (physical science)	0 (7)	0 (10)	0 (5)	n/a	0 (26)	0 (39)	0 (87)	0
Total content	0 (31)	0 (39)	0 (28)	0 (14)	0 (108)	0 (171)	1 (377)	1
%	0	0	0	0	0	0	0.27	0.27

Note. Numbers in parentheses indicate the total number of curriculum content; numbers in square brackets indicate the priority scale.

^aTotal 14 attitudes are intended to integrate throughout the curriculum.

^bNumbers in the table represent the numbers of paragraphs counted in the document; a paragraph that contains IK was counted

There is one TEK content found in this document. It was presented as an example suggested in grade 7's earth and science domain. This TEK content covers 0.85% of the domain

and 0.27% of the entire grade 7 science curriculum. The studied TEK content was presented as an example for *elaboration-strategies for learning and teaching* section. *Elaboration-strategies for learning and teaching* “describes learning environments and experience that will support students’ learning” (New Brunswick Ministry of Education, 2002, p. 16). In other words, this section is created in order to provide example lesson plans for learning outcomes. Each learning outcome may or may not contain elaboration-strategies. The importance placed on these elaboration-strategies is hence less than other contents in the curriculum document (i.e., priority scale: 1). The fact that there is only one TEK content and that it is provided as an elaboration strategy rather than main learning outcome reflects the small weight TEK carries within the science document.

- Based on the four dimensions (e.g., organizing principles [STSE], habits of mind, skills and procedures, knowledge) from the scientific literacy, which dimension has the most/least TEK content?

Table XXX

TEK content from the Atlantic Provinces grade 7 categorized in the conceptual framework

	Organizing principle/STSE	Attitude	Knowledge	Skills
TEK content found	0	0	1 e.g., Different cultures throughout history have had ideas and theories about the origins and causes of volcanic and earthquake activity and mountain formation. Students can be challenged to investigate a particular group or culture in order to learn about peoples’ ideas about these events in the past. Some possible research ideas might include: - Pele (Hawaiian goddess who makes the mountains shake and lava flow at Kilauea, Hawaii). - Glooscap (Mi’kmaq legend about the Sugarloaf Mountains) (pp. 36-38).	0

TEK content was categorized as knowledge section for foundation of scientific literacy.

Table XXXI

Proportion of TEK coverage in the Atlantic Provinces grade 8 science curriculum document

Learning domains	Curriculum outcomes STSE [5]	Skills [5]	Knowledge [5]	Attitude ^a [5]	Elaboration-strategies for learning and teaching* [2]	Tasks for instruction and/or assessment [2]	total	%
Water systems on earth (earth and space science)	0 (7)	0 (11)	0 (6)	n/a	0 (23)	0 (39)	0 (86)	0
Optics (physical science)	0 (6)	0 (8)	0 (5)	n/a	0 (22)	0 (39)	0 (80)	0.85
Fluid (physical science)	0 (4)	0 (9)	0 (10)	n/a	0 (24)	0 (39)	0 (86)	0
Cells, Tissues, Organs and systems (life science)	0 (6)	0 (7)	0 (7)	n/a	0 (19)	0 (37)	0 (76)	0
Total content	0 (23)	0 (35)	0 (28)	0 (14)	0 (88)	0 (154)	0 (328)	0
%	0	0	0	0	0	0	0	0

Note. Numbers in the table represent the numbers of paragraphs counted in the document; a paragraph that contains IK was counted; the numbers in square brackets indicate the priority scale.

^aA total of 14 attitudes are intended to be integrated throughout the curriculum.

As shown in Table XXXIV, there was one TEK content found within grade 8 science curriculum document.

Results for Quantitative Questions

- How is TEK conceptualized in each provincial curriculum documents?

There was no sufficient amount of data found for the analysis.

- To which extent is TEK recognized by ministries?

Based on the results, Atlantic curriculum shows a lack of the content related to TEK. Especially in grade 8, there is no evidence of any curriculum or teaching strategies containing TEK or Aboriginal perspectives in the Atlantic regions. Only TEK content, found in the grade 7 document, is presented as an example of a key learning concept.

There is no mention of Aboriginal people or elders' involvement in curriculum development or review process. There is also no acknowledgment of the importance of TEK in science. However, in the document, *Foundation for the Atlantic Canada science curriculum for K-12* (1998), a paragraph describes the importance of teaching culture and knowledge of Aboriginal people in science:

The history of science needs to be part of a balanced science curriculum so students can see that all cultures have made great contributions to science. The Native people of Atlantic Canada, for example, developed an advanced understanding of naturally occurring compounds found in plants and animals before Europeans colonized the region. This type of knowledge has assisted the development of medicine, and many of these compounds are used in modern pharmaceuticals. (p. 41)

This document suggests the incorporation of the Aboriginal perspectives and knowledge in order to pursue “science programs for a multicultural society” rather than presenting them as the knowledge system that would benefit all students (p. 41). For instance, the contributions of Native people in science were followed up by how “other cultures” -- such as Ancient Egypt, India, and Aztecs and Mayan -- also contributed to science (1998, p. 42). Indeed, the only TEK content found in the curriculum was mentioned along with “other cultures” such as Hawaiian, Greek and Roman. Such curriculum, contextualizing Indigenous knowledge and people's contribution solely in multicultural context is not promoting the idea that TEK is a specific knowledge system that all students need to learn, but rather, TEK was suggested as an example of a traditional, non-innovative view which “teachers should acknowledge that there are many views of the origin of life” (1998, p. 42).

Discussion and Conclusion

The study explored the representation of TEK content in grades 7 and 8 Canadian official science curriculum documents. The scientific and educational values of TEK were explained in previous chapters. Because of the importance that TEK carries in the scientific and educational communities, TEK should be taught in Canadian schools, particularly in science subjects (Kimmerer, 2002). TEK is a knowledge system that contains both IS and IK (Figure I, Chapter One). TEK focuses on the scientific disciplines (e.g., biology, ecology, earth and space science, etc.) and can be taught with WMS in the science classroom (Snively & Corsiglia, 2001). TEK provides some scientific information that WMS lacks, such as long-term observation data as well as other holistic and spiritual aspects of science. TEK also provides a cultural framework which may facilitate Aboriginal students' learning in science; it also provides non-Aboriginal students with a synergic vision in sciences that offers a broader view of our world, thus introducing non-WMS way of thinking (Kimmerer, 2002; Hatcher et al., 2009). The significance of developing scientific literacy among students is emphasized by many educational ministries in Canada. Hence, the government of Canada developed a *Pan-Canadian Framework* (1995), which introduces the four foundations of scientific literacy. These foundations are now incorporated into all Canadian official science curricula, playing a role as foundations of science education in Canada. TEK emerges from the local environment and communities, allowing students to get to know their local environment. It also provides a pedagogy for teaching in STSE context suggested by the Pan-Canadian Framework (1995). Despite the recognition given to TEK in science education, there has been no published study on how TEK has been integrated into the Canadian official science curricula. Therefore, this study was conducted in the hope of providing

a basis of understanding the integration of TEK in the official science curricula as well as data to compare, for future researchers.

For this study, grades 7 and 8 provincial/territorial science documents were collected from the ministries' websites. Both quantitative and qualitative content analyses were conducted. As a result of the first qualitative analysis, a priority scale for curriculum content was developed. This priority scale implicates the importance placed on curriculum content in each document and is used to explore the significance given to TEK by each educational ministry in Canada. Any curriculum content that reflects TEK were counted and categorized into the four different scientific literacy foundations for a further qualitative analysis.

The results show that there are significant differences concerning TEK coverage among different provinces and territories. Nunavut and Saskatchewan had the most TEK content integrated in their grades 7 and 8 science curriculum documents while Quebec and the Atlantic provinces were found to have the least TEK content integrated. The results suggest that the representation of TEK also varies a lot among the studied documents, and some documents represented TEK as primitive, focusing only on its antiquity and constructing otherness when introducing concepts of TEK. This study suggests that, as shown in NVT and SK, more involvement of Aboriginal scholars and elders in the curriculum development process is needed in order to avoid wrong representations of TEK. NVT and SK could provide examples of good representation of TEK in science curricula. TEK found in the NVT and SK documents were introduced in all four foundations of scientific literacy and gave appropriate credits to the knowledge holder and its local Aboriginal communities. Also, they provided holistic curricula that include the local Aboriginal elders' involvement as well as many units integrating both WMS and TEK, thus promoting the two-eyed learning in science.

Since it is the first study conducted on grades 7 and 8 official science curriculum documents, focusing on TEK content in particular, it is hoped that the results of this mixed methods will provide data for future researches to be done. This study focused on the official curriculum documents. Thus the actual pedagogy and classroom environment where the curriculum content is delivered were not considered for this study. A future study could compare how TEK content in science classrooms is being delivered as well as teachers' and students' (both Aboriginal and non-Aboriginal) views on learning TEK content.

CHAPTER FOUR

Thesis Article:

The Place of Traditional Ecological Knowledge in Grades 7 and 8

Canadian Science Curriculum

Abstract

Questions and debates about integrating Traditional Ecological Knowledge (TEK) in the science curriculum have been arising since the 1980s. Why should we incorporate TEK into Canadian science education? If TEK is necessary, how is it being treated in our science education curricula currently? Despite the debates on the surface, TEK has been recognized as an important teaching source in science education (Kimmerer, 2002). Recognizing the validity of TEK, this study explores the prevalence and representation of TEK in official science curriculum documents for grades seven and eight in Canada. To illustrate the current state of the integration of TEK in provincial and territorial official curriculum documents, a content analysis was conducted. In general, results were highly varied in reference to the prevalence, representation and conception of TEK across the Canadian science curriculum. A detailed discussion on each provincial and territorial ministry's perception of TEK and the implications of teaching TEK are also presented in this work.

Literature Review

Science holds an elevated academic status in the education field because it is important for many careers. For example, for more than 46 occupations (e.g., doctors, scientists, engineers, nurses, teachers, etc.), science is a main part of the job or at least a critical part (Osborne, 2003). Science, as Osborne (2000) argues, also plays an important role in developing citizenship as well because the real challenges of the future are likely to be the moral and political dilemmas set by

the expansion of scientific knowledge (Osborne, 2000). A healthy democratic society, therefore, requires the participation and involvement of its citizens in the resolution of the decisions emerging from the choices that contemporary science will present. In order to become an active citizen in society, it is necessary to possess *civic scientific literacy* which Osborne (2003) describes as the ability to understand the procedures of science (i.e., grammar of science) as well as its content (i.e., vocabulary of science). For these reasons, a lack of scientific knowledge would create a social barrier for people who are *civic-scientifically illiterate* and arguably results in the marginalization of these people in the society. The education ministries in Canada have been putting a great emphasis on developing scientific literacy of students over the years (Osborne, 2000).

The Aboriginal students in Canada were argued as to be subjected to the illiteracy in these civic-scientific topics and continue to be marginalized in science education on the basis of cultural identities (Aikenhead, 2006; Canadian Council on Learning, 2007). The high numbers of civic-scientifically illiterate among these Aboriginal students also emanated the marginalization in society and the diminished job opportunities for these Aboriginal students (Alsop & Fawcett, 2010). Indeed, the low engagement and participation of Aboriginal students in school science classes had been reported as one of many educational problems in their communities (Aikenhead, 2006; CCL, 2007). This low participation is argued as one of the leading factors in a low number of Aboriginal students pursuing studies in post-secondary level of science, thus leading to a shortage of Aboriginal professionals in the scientific field (e.g., doctors, nurses, engineers and science teachers) working on the reserves.

Researchers including Aikenhead (2006) and CCL (2007) suggest that a science curriculum that is anchored in the tradition of Western Modern Science (WMS) is one of the key

factors impeding Aboriginal students' learning in science. Using the idea of *collateral learning*, Aikenhead and Huntley (1999) explain how the euro-centric science curriculum influences the Aboriginal students' learning process in science. According to the collateral learning theory, learning something in a different cultural setting from students' own cultures, which conflicts with students' indigenous knowledge (for example, Aboriginal students learning Western science), could result in conflicting ideas in long-term memory of the students. Therefore, this theory suggests the need of the science curricula that integrate culturally relevant knowledge and topics for students. Consequently, Aikenhead (2006) suggests that this culturally relevant curriculum, which integrates the Aboriginal perspectives in mainstream science education, is one way to create a better science educational setting for Aboriginal students and possibly resolve a problem arising from the low civic-scientific literacy standing within the Aboriginal students. Especially, integrating Traditional Ecological Knowledge (TEK) into science curricula has been suggested in order to create a bridge between Western Modern Science (WMS) and TEK as well as a more interactive science classroom for all students (Kimmerer, 2002).

What is TEK and how might the integration of such knowledge system affect both Aboriginal and non-Aboriginal students' learning in science classes? TEK is described as an Indigenous knowledge system, derived from Indigenous Science (IS) and Indigenous Knowledge (IK) that is orally transmitted (Snively & Corsiglia, 2001; Tsuji & Ho, 2002). The definitions of TEK, IS and IK will be further discussed in the conceptual framework section of this article.

TEK is currently used in many fields in our contemporary society. According to Snively and Corsiglia (2001), numerous Indigenous peoples' scientific and technological contributions have been incorporated into modern applied science such as medicine, architecture, engineering, pharmacology, agronomy, animal husbandry, fish and wildlife management, nautical design,

plant breeding, and military and political science. For example, drugs that are commonly used in North America and other countries such as *Quinin*, *Aspirin*, and, specifically, *Ipecac* (which is a drug still used in traumatic medicine to expel stomach contents) as well as 500 other important drugs, are discovered and used by Native American healers (Snively & Corsiglia, 2001). Moreover, TEK has been used in many environmental researches and impact assessments in North America. Recently, the federal government of Canada decided to utilize TEK in environmental impact assessments (EIAs) as the biologists and chemists working in the field acknowledge that the native practitioners can often detect changes in taste, water, tissues, and other substances at levels below those of contemporary testing equipment (Snively & Corsiglia, 2001; Tsuji & Ho, 2002).

Moreover, TEK is considered one of the possible ways to foster *all* students' learning in science including Aboriginal students. The significance of teaching TEK to all students has been emphasized by many provincial and territorial ministries of education in Canada. For example, British Columbia's Ministry of Education (2005) asserts in its grades 7 and 8 official science curricula that "this Knowledge [TEK] with its characteristic respect for sustaining community and environment offers proven conceptual approaches which are becoming increasingly important to all B.C. residents" (p. 11). Kimmerer (2002) also adds that TEK is considered to be a valuable teaching source because of the wealth of biological information it contains as well as the cultural framework of respect, reciprocity, and responsibility in which it is embedded. Integrating TEK in science curricula has also been suggested as a way to provide culturally relevant curriculum for Aboriginal students in science which might foster their learning in science. Despite the recognition given to TEK in both scientific and education fields, Kimmerer

(2002) argues that in curricula we are unknowingly or knowingly “ignoring an entire body of knowledge that has potential significance to contemporary science and policy: TEK” (p. 432).

To date, there have been few studies (e.g., Aikenhead, 2006; McGregor, 2000; Ninnes, 2003) attempting to provide a better understanding of the importance and the representation of Aboriginal perspectives in the science curriculum. These previous studies primarily focused on the representation of Aboriginal perspectives and people, conducting a discursive analysis of textbooks and action research or observation of instructional strategies in science classroom for Aboriginal students (Aikenhead, 2006; Ninnes, 2003). However, no study has focused on the official curriculum documents for science education across Canada particularly. These official curriculum documents are important sources that provide a basis of content and pedagogies used in science classrooms. All Canadian scholastic textbooks used in classrooms are expected to correspond with the official curriculum documents published by ministries of education (Montgomery, 2005). Teachers in Canada are also expected to follow the official curriculum documents to plan their lessons and evaluate students’ learning process (Posner, 2003). Therefore, these official science curriculum documents were chosen for this study. The objectives of this study are:

- 1) to identify the prevalence of TEK integration in the official science curriculum documents across the nation;
- 2) to study the representation of TEK content within the official provincial and territorial science curriculum documents; and,
- 3) to explore the perception of TEK held by each provincial and territorial ministry of education in Canada presented in their official science curricula.

The focus for this study has been placed in the intermediate level, grades 7 and 8 in particular, because intermediate science acts as a bridge between basic scientific principles from elementary science and advanced science from secondary science classes. Further detailed information on the data source for this study is discussed in the methodology section.

Conceptual Framework

Different knowledge systems and science(s) exist in our world and there is a need to explore what *Knowledge* and *Science* denote in this study's context. *Knowledge* is described as a concept or a belief that is correct and justified by community members (Hunt, 2003). Moreover, Goldblatt (2000) defines knowledge as “a body of skills, practices and understandings that we possess and use in practical ways” (p. 2). This study follows Snively and Corsiglia's (2001) definition of *Science* which is “a rational perceiving of reality where perceiving means both the action constructing reality [methods, process of science] and the construct of reality [previous existing knowledge]” (p. 9). Therefore, a new set of knowledge arises from the existing knowledge and methodology used to construct the knowledge.

According to Saavedra-Vargas (2012), Knowledge and Science are “dynamically interdependent with each other” (personal communication). Indeed, before the evolution of natural philosophy by British Association of Advanced Science (BAAS), science (derived from the Latin *scientia*) simply meant knowledge (Hatcher, Bartlett, Marshall and Marshall, 2009, p. 142). Therefore, Snively and Corsiglia (2001) stated that without knowledge there is no science. To illustrate the idea that knowledge and science are interconnected and inseparable, Saavedra-Vargas (2012) uses the analogy of *cup of water*.

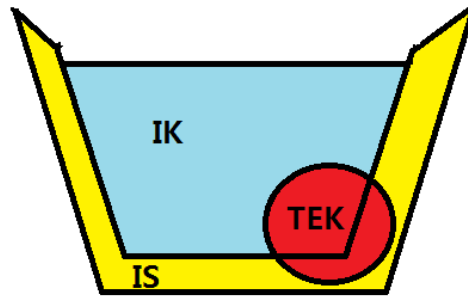


Figure 1. Connections among IK, IS and TEK

As shown in Figure 1, knowledge is the water inside of a cup when science is explained as the cup that holds the water. In other words, science is a set of knowledge and techniques that shapes the perception of knowledge (as the cup shapes the water inside the cup); knowledge is perceived differently according to the shape of the science. Therefore, as Hatcher et al. (2009) assert, “What is defined as science is deeply steeped in cultural tradition and reflects the world view of the definer” (p. 142). Here, *Tradition* is defined as “knowledge where authority is linked to antiquity and where its status is entirely accepted” (Goldblatt, 2000, p. 33). Thus, cultures, traditions and worldviews, all together, play a big role in shaping the *cup* (i.e., science) and the shape of the cup, (i.e., science) is molded differently according to definers’ worldview, culture and the society he/she is embedded in (Aikenhead, 2006; Jegede, 1999; Ogawa, 1995). Therefore, based on cultures and locations, science can exist in many forms and knowledge systems (Jegede, 1999). This view can be seen in the idea of *Multiculturalism*. Multiculturalism in science believes in the idea that science “is embedded in the context of a cultural group; that all systems therefore are culture laden” (van Eijck & Roth, 2009, p. 929).

Within the framework of multiculturalism, there are multi-sciences. What is normally referred to as Western Modern Science (WMS) is anchored in the culture, worldview of Western (i.e., Euro-American) people (Aikenhead, 2006; Ogawa, 1995). Indigenous Science (IS) is hence

anchored in the culture, worldview of indigenous peoples (Ogawa, 1995). Therefore, European Knowledge (EK), otherwise known as Western Knowledge (WK), is shaped by WMS; Indigenous Knowledge (IK) is shaped by IS (Hatcher et al., 2009; Snively & Corsiglia, 2001).

Semali and Kincheloe (1999) define Indigenous Knowledge (IK) as,

an everyday rationalization that rewards individuals who live in a given [Africa, Latin America, Asia, and Oceania] locality....[IK] reflects the dynamic way in which the residents of an area have come to understand themselves in relationship to their natural environment and how they organize that folk knowledge of flora and fauna, cultural beliefs, and history to enhance their lives. (p. 3)

Here, with the *cup of water* analogy IS can be seen as shaping the perception of IK (Saavedra-Vargas, 2012).

Indigenous Science (IS) is described as “a large range of coming to know processes [which includes the construct of reality and action of constructing reality as Ogawa (1995) describes] that result from human experiences in the natural world” (Hatcher et al., 2009, p. 143). As Snively and Corsiglia (2001) assert, “without knowledge there can be no science, thus the definition of science should be broadened” (p. 8). Therefore, the study follows Goldblatt’s definition of science: the knowledge and methods developed in communities like Royal Society or indigenous communities came to be known [which] give people a number of tools they could use when looking for proof (2000, p. 14). Here, the *proof* is defined as “a very strong case that something is true [correct, verified by its community], at least beyond all reasonable doubt” (p. 14). Therefore, the definition of IS for this paper is, “a large range of coming to know process” including knowledge and methods developed by Indigenous communities, which provides a tool for people to use when looking for a very strong case, that is verified by the community members.

IS is also described as a system which interprets how the world works from a particular cultural perspective or science in a given culture (Snively & Corsiglia, 2001). Ogawa (1995) and Aikenhead (2005) suggest that every culture has its own science, thus science is a sub-culture of a community (or a society). Therefore, the term Indigenous Science(s) is also a plural term rather than a singular term because it represents the diversity of sciences related to the strongly rooted place-based traditions of their cultural foundation (Hatcher et al., 2009).

Snively and Corsiglia (2001) state that “the branch of biological and ecological science that has become known as TEK can be thought of as either the *knowledge* itself or as documented *ethno-science* enriched with analysis and explication provided by natural science specialists” (p. 8). In turn, Traditional Ecological Knowledge (TEK), described as a subset of IK and IS, derived from the experience acquired over years of direct human contact with the environment (Snively & Corsiglia, 2001; van Eijck & Roth, 2007). Snively and Corsiglia (2001) explain that TEK “uses methodology [that are parts of IS], guided by traditional wisdom [that are also a part of IS], disciplines of scientific knowledge [such as ecology, biology, etc.] all integrated in a local cultural perspective results in long-term sustainable societies, implications for resolving global environmental problems” (p. 12) thereby including TEK as science (Snively and Corsiglia, 2001). As illustrated in Figure 1, TEK therefore, consists of both IK and IS on the topics of scientific disciplines.

This study focuses on TEK from a Canadian perspective for this project. Therefore, the term *Aboriginal* people is used to address the indigenous peoples who reside in Canada. The conceptual framework for data analysis was developed based on the four foundations of scientific literacy suggested in the *Pan-Canadian framework* (1995). Science curricula in Canada are developed based on these four foundations of literacy.

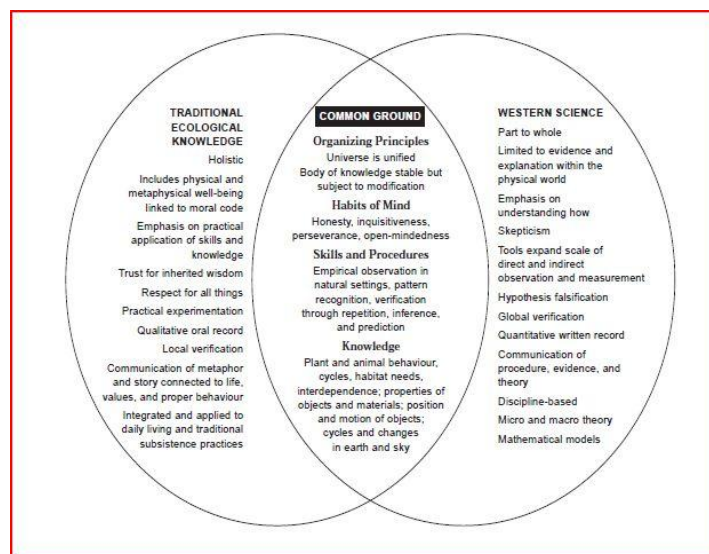


Figure 2. Common ground between WMS and TEK. (adapted from Manitoba and Youth 2003, p. 3)

As demonstrated in Figure 2, these four foundations of scientific literacy are also considered to be common ground of TEK and WMS (Manitoba Youth and Education, 2003): Organizing principles (e.g., Ideas such as that the body of knowledge is stable but subject to modification or developing an understanding of the relationships between science and the social and environmental contexts of science and technology); Habits of Mind (e.g., holistic); Skills and Procedures (e.g., observation) and Knowledge (e.g., animal behaviour). Under these four common ground dimensions, the characteristics of TEK described by various authors including Kimmerer (2002), Manitoba Youth and Education (2003), Snively and Corsiglia (2001) and Tsuji and Ho (2002) were put together in order to serve as a guideline for data analysis (Appendix i).

Research Questions

The present research paper is meant to deepen the understanding of TEK in science educational context by examining the integration level of such knowledge in the current science curriculum. The overarching question guiding this research is “How are TEK topics treated

quantitatively and qualitatively in grades 7 and 8 official science curriculum documents in Canada?” With the overarching question, this study was guided with more pointed questions which consist of quantitative and qualitative views as follow:

Quantitative Questions

- How prevalent is TEK content within provincial intermediate science curriculum documents (grades 7 and 8) across Canada?
- To which learning domains (i.e., curriculum organizers, clusters: life science, physical science or earth and space sciences) are TEK content found in the studied documents?
- Based on the four foundations (e.g., organizing principles [STSE], habits of mind, skills and procedures, knowledge) from the Pan-Canadian Framework (1995), which foundations contain the most/least TEK content?

Qualitative Questions

- How is TEK content represented in each provincial curriculum documents?
- To which extent is TEK recognized (i.e., given the significance) by ministries? For this question there are sub-guiding questions
 - e) Were there any acknowledgments to the Aboriginal worldviews in science and TEK in documents?
 - f) Are elders or Aboriginal scholars encouraged to participate during the process of curriculum design or to share their knowledge to students?
 - g) Was there any other policy framework that suggests the integration of TEK in science education?

- h) Importance placed on TEK curriculum contents in documents? (based on the priority scale developed for this analysis, which will be discussed in the methodology section)

Methodology

This section discusses the data source for this research and the procedure performed. As well as exploring the representation and prevalence of TEK in the curriculum, there was also a search for each provincial/ territorial ministry's conception of TEK mentioned (or silenced) in documents. Detailed descriptions on the data analysis as well as the guiding questions asked for data analysis are also illustrated.

Data Source and Collection

Every official Canadian grades 7 and 8 official science curriculum document currently in use was analyzed for this study. Grades 7 and 8 were chosen for the study because it had been noted that the level of academic achievement that students attain by eighth grade has a greater impact on their college and career readiness than anything (American College Testing, 2008). The study at hand particularly focused on intermediate grades 7 and 8 because intermediate science acts as a bridge between basic scientific principles from elementary science and advanced science from secondary science classes. Therefore, students' experiences in intermediate science classes have a significant impact on their views on pursuing further study in advanced science. For example, the courses that grade 8 students choose for their grade 9 year influence their future course choice options which further impacts on the choice of future careers. Indeed, according to the Ontario curriculum guidelines (Ontario Ministry of Education, 2008), at the end of their grade 8 year, students are expected to choose either a grade 9 academic course

which leads to the university preparation, or a grade 9 applied course which leads to work/college preparation (Appendix ii).

Official curriculum documents were chosen for the project because they provide a scope to see the actual science content delivered in classrooms (Posner, 2003). Each provincial and territorial ministry of education in Canada publishes their own curriculum documents or utilizes curriculum from other provinces. Content in the curriculum documents is mandated by the provincial governments. Thus, studying the official curriculum documents allows us to identify each provincial/territorial ministry's perception on TEK.

Because this study looks at the current state of the issue, the only data sources collected are the official curriculum documents that are presently effective. Electronic copies of all documents were obtained from the websites of the ministries of education. The documents studied for this project are shown in Appendix iii. Confirmation of the usage of each document was done by contacting each provincial/ territorial ministry representatives.

Posner (2003) describes official curriculum as “the curriculum described in formal documents” (p. 14). Here, *curriculum* is defined as “the content, standards, or objectives for which schools hold students [or] the set of instructional strategies teachers plan to use” (Posner, 2003, p. 5). These curriculum contents are the knowledge that ministries promote for students to learn. Thus, curriculum studied for this project is *Knowledge* [already constructed by the ministry] side of TEK rather than the science side [shaping part] of TEK.

Data Analysis

- A total of 19 official documents were reviewed. In addition, in order to summarize each provincial/territorial ministry's general perception on TEK in science education, other policy frameworks and documents such as the foundations of science were

reviewed as well. Specific analyzed content for each document is explained in detail in the results section.

- A set of qualitative and quantitative content analysis was undertaken for this study. This study required both quantitative and qualitative data analysis, thus a mixed method framework for content analysis developed by Bergman (2010) was adopted for the methodology. This framework also serves the purpose of a sequential complimentary suggested by Creswell and Plano Clark (2007). This sequential complimentary mixed method framework for data analysis involves three steps:
1. An initial qualitative content analysis
 2. A quantitative dimensional analysis
 3. A second qualitative analysis

For initial qualitative content analysis, thematic analysis was conducted to build a framework for consecutive quantitative and qualitative analysis, based on the common themes that emerged. As a result of this initial analysis, a priority scale (Table 1) was developed to guide the next analysis process. This priority scale indicates the importance placed on curriculum content in each document.

Table 1

A priority scale: built from common curriculum categories found within all documents

Priority	Definitions.
5	The content is mandated by the ministry; students are expected to master the learning topic. This content (skills/knowledge) will be tested. The content is the basis of the chapter (unit); incorporated throughout the unit.
4	The content is mandated by the ministry. Students are expected to master the learning topic. This content (skills/knowledge) will be tested
3	The content is suggested by the ministry. The content provides a basis for the assessment. However it is not mandated.
2	The content is suggested by the ministry. Additional activities or teaching strategies can be included for this section
1	The content is an additional material for suggested activities.

Once all curriculum documents were reviewed under the priority scale, the quantitative frequency analysis was performed on the curriculum content. As Kimmerer (2002) noted, in order to protect and use TEK in a respectful and appropriate manner, “the identity of the practitioners, informants and the community should always be fully referenced and acknowledged with the same diligence that scientists apply to the contributions of their academic colleagues” (p. 437). During the data analysis, there was a search for TEK content though curriculum applies to the characteristics of TEK mentioned in a chart, if there is no reference to the content; it was not counted as the integration of TEK. Then, a second qualitative analysis was conducted. These TEK related curriculum contents were put into a table based on learning domains (e.g., life science, physical science and earth and space science) and curriculum content categories (i.e., priority scales).

After the frequency analysis, a second qualitative analysis was conducted. During this phase, the representation of found TEK content and each provincial and territorial ministry’s perception on TEK were analyzed. These ministries’ perceptions on TEK were explored by studying the significance given to TEK by each ministry. The significance given to TEK was

studied with sub-guiding questions which look at: the acknowledgment of educational values of TEK; involvement of Aboriginal scholars and elders in curriculum designing and suggested instructions; importance placed on TEK content (i.e., priority scale) and other policy frameworks on integrating TEK in science education.

This project, a curriculum analysis, is “an attempt to tease a curriculum apart into its component parts, to examine those parts and the way they fit together to make a whole, to identify the beliefs and ideas to which the developers were committed and which either explicitly or implicitly shaped the curriculum” (Posner, 2003, p. 14). A curriculum analysis that looks at prevalence, representation and ministries’ perceptions shows the current state of integration of TEK and Aboriginal perspective in different provincial/territorial science curricula (Posner, 2003, p. 33). Here, *prevalence* implies how frequently TEK content shows up within official curricula (i.e., amount of coverage). *Representation* looks at in which way TEK content has been presented in the curricula (i.e., the portrayal of TEK and Aboriginal perspective). *Perception* indicates how each ministry views and understands TEK and Aboriginal perspective in science. Posner (2003) states that every curriculum represents “a choice as to how to approach the education of students” (p. 43) and this approach depends on the beliefs and assumption (often termed “philosophies” or “perspectives”) of the developers. Acting as “political texts” -- as Ng-A-Fook and Reis (2011) describe -- studying developers’ perceptions on TEK in the official curricula would provide a background of “theoretical and historical context” of the curriculum on TEK (Posner, 2003, p. 33).

The *overview* sections from all studied documents serve their purpose to provide a general view of learning domains. However, they do not provide any learning outcomes (expectations) that this study focuses on. Thus, these sections were not analyzed for the study.

At first, each curriculum document was analyzed separately. Then all data was reviewed concurrently since the process involved moving back and forth between the entire data set for the second analytic process (Bergman, 2012). After the analysis of all documents was completed, results were displayed in tables before interpretation. Each document was analyzed twice by the researcher alone. The conclusion was drawn from the interpretation; it was reviewed by an external auditor, Dr. Marcelo Saavedra-Vargas, a professor in the Faculty of Aboriginal Studies, University of Ottawa.

Results

After the priority scale was developed as a result of the first qualitative data analysis, a quantitative analysis was followed in order to identify the total estimated number of curriculum content and TEK content in documents. Based on the results from the analysis, the estimated coverage of TEK in studied documents was calculated as shown in Table 2.

Table 2

TEK content found in grades 7 and 8 official science curriculum documents in Canada

Provinces or territories/ grades	Life science	Physical science	Earth and Space science	Others* (e.g., techniques, attitudes, strategies.)	Total	Percentage (%)
AB / 7	4 (118)	3 (118)	1 (60)		8 (296)	2.70
AB / 8+ AB / 8 ^a	0.5 (49.5)	2.5 (160.5)	1 (58.5)		4 (268.5)	1.50
Atlantic / 7	0 (107)	0 (153)	1 (117)		1 (377)	0.27
Atlantic / 8	0 (76)	0 (166)	0 (86)		0 (328)	0
BC / 7	6 (100)	1 (93)	0 (106)	0 (33)	6 (332)	1.81
BC / 8	1 (104)	1 (187)	3 (88)	2 (73)	7 (452)	1.53
MB / 7	2 (60)	2 (144)	0 (54)	0 (50)	4 (308)	1.30
MB / 8	0 (79)	0 (132)	0 (78)	0 (50)	0 (339)	0
Nunavut: NWT/ 7 & 8	12 (112)	6 (116)	4 (115)		22 (343)	6.23
Nunavut: Diversity / 7 & 8	42 (200)				42 (200)	21
ON / 7	1 (19)	0 (40)	0 (19)		1 (78)	1.28
ON / 8	0 (17)	1 (42)	1 (18)		2 (77)	2.60
QC (2004) / 7 & 8	0 (44)	0 (105)	0 (60)	1 (48)	1 (257)	0.39
QC (2011) / 7 & 8 ^b	0 (114.5)	0 (297.5)	0 (75)	0 (105)	0 (592)	0
SK / 7	6 (38)	0 (62)	1 (35)	2 (25)	9 (160)	5.63
SK / 8	2 (38)	0 (77)	3 (29)	0 (21)	5 (165)	3.03
Total	76.5 (1276)	16.5 (1893)	15 (998.5)	5 (405)	113(4572.5)	100
Total content Percentage (%)	6	0.87	1.5	1.23	2.47	2.47

Note. Numbers in parentheses indicate the total numbers of lines or paragraphs in the studied document; numbers outside the parentheses indicate the numbers of TEK found within the same document studied.

^aFor Alberta Grade 8: numbers indicated are the mean value from grade 8 curriculum document and grade 8 knowledge and employability document together. The percentage was calculated based on the mean of total numbers.

^bFor QC (2011): numbers indicate the mean value from applied path and general path and together. The percentage was calculated based on the mean of total numbers.

As demonstrated in Table 3, these identified TEK contents were then categorized into the four foundations of the conceptual framework, also known as, the foundations of scientific literacy.

Table 3

TEK content based on the conceptual framework

	STSE	Attitudes	Knowledge	Skills	Total
AB 7	3	5	0	0	8
AB 8	0 (1)	0 (6)	0 (0)	0 (0)	3.5
Atlantic 7	0	0	1	0	1
Atlantic 8	0	0	0	0	0
BC 7	0	2	4	0	6
BC 8	0	3	4	0	7
MB 7	2	0	2	0	4
MB 8	0	0	0	0	0
NU (NWT)	8	6	4	4	22
NU (resource pack)	7	25	8	2	42
ON 7	0	0	1	0	1
ON 8	1	0	1	0	2
QC (2004)	0	1	0	0	1
QC (2011)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
SK 7	2	1	6	0	9
SK 8	0	1	4	0	5
Total	24	50	35	6	115
%	20.87	43.48	30.43	5.22	100

Note. Numbers in parentheses indicate the content from applied path document.

Finally, in the third step, a second qualitative analysis was performed in order to study how these TEK contents are represented in the documents. Here, each educational ministry's perception on TEK was also studied. Based on the amount of TEK coverage (Figure 3) and the results from qualitative analyses (i.e., the representations and perceptions of TEK found in the documents), studied provinces and territories were categorized into three clusters for discussion as illustrated in Table 4. Both the quantitative and qualitative data were put together for discussion.

INTEGRATION OF TEK IN SCIENCE CURRICULUM IN CANADA

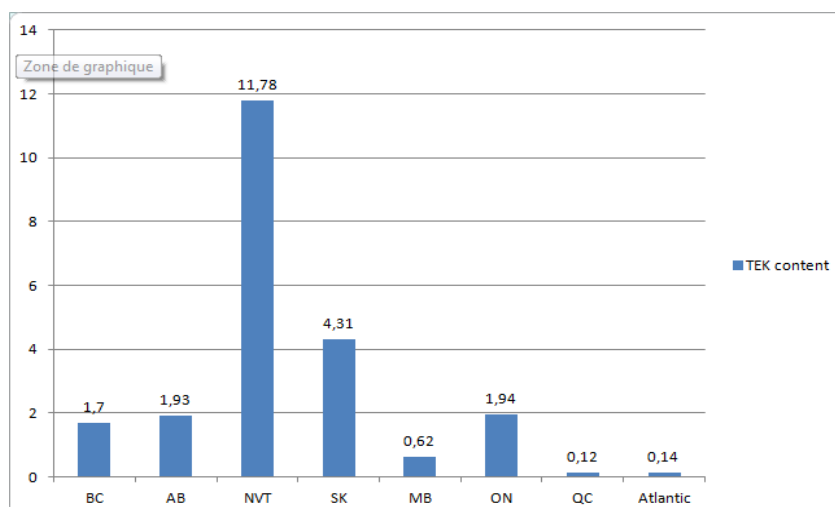


Figure 3. Estimated percentage of curriculum dedicated to TEK content in Canada

Table 4

Three clusters for data interpretation

	Quantitative Results	Qualitative Results
Cluster1: MB, Atlantic (NB, PEI, NS, NL) and QC	Provinces/Territories which dedicate less than 1 % of its entire curriculum to TEK content	- No acknowledgment to TEK or Aboriginal Elders' involvement - Science program for a multicultural society (culture) - Priority Scale: 1 - Primarily on the subjects of sustainability and stewardship - Portrayed as "other culture" - No other policy frameworks for incorporating Aboriginal knowledge in science
Cluster2: ON, AB (NWT) and BC (YT)	Provinces/Territories which dedicate between 1 to 4 % of its entire curriculum to TEK content	- Some acknowledgment to educational values of TEK in curriculum documents and policy frameworks - No acknowledgment of Aboriginal Elders' involvement - Mutual respect or appreciating different views of science - Priority Scale: 1(AB) and 5 (ON; BC) - Primarily on the subjects of sustainability and stewardship - Linked with current social issues
Cluster3: NVT and SK	Provinces/Territories which dedicate more than 4% of its entire curriculum to TEK content	- Detailed acknowledgment to educational values of TEK in curriculum documents and policy frameworks. - Acknowledgment of Aboriginal Elders' involvement - Difference and similarities between WMS and TEK - Priority Scale: 1-5 - Linked traditional Aboriginal technology with modern invented technology - Contributions of TEK in the society and science were emphasized

1.0. Cluster 1: MB, Atlantic (NB, NS, NL and PEI) and QC

This cluster had a lower TEK coverage in comparison to other provincial/territorial documents. Generally, the documents in this cluster give no acknowledgment or credit to the

integration of TEK and the involvement of Aboriginal Elders and scholars in curriculum development. Table 5 describes the content analyzed for this cluster.

Table 5

Curriculum content analyzed for Cluster 1

Provinces/ Territories	Documents studied	Curriculum categories	Examples of TEK curriculum
MB	Grades 5 to 8 Science: Manitoba Curriculum Framework of Outcomes. Grades 5 to 8 Science: A Foundation for Implementation. Grades 5 to 8 Topic Chart	General and prescribed (i.e., specific) learning outcomes Learning indicators Suggestions for instruction, assessment, learning resources Teachers notes	Grade 7 Cluster 1: Interactions within Ecosystem Teachers' Note The terms <i>living</i> and <i>non-living</i> are problematic for some cultural groups, particularly Aboriginal groups. These groups use different criteria than Western scientists to determine whether an object is animate. Teachers should be sensitive to the potential conflict between Western science and other views and indicate that students can hold multiple views at the same time, recognizing the value of each (p. 8).
Atlantic	Foundation for the Atlantic Canada Science Curriculum (2002)	Learning outcomes, Tasks for instruction assessment and Elaboration section which describes learning environments and experiences that will support students' learning.	Grade 7 Unit 2: Earth's Crust Different cultures throughout history have had ideas and theories about the origins and causes of volcanic and earthquake activity and mountain formation. Students can be challenged to investigate a particular group or culture in order to learn about peoples' ideas about these events in the past. Some possible research ideas might include: - Pele (Hawaiian goddess who makes the mountains shake and lava flow at Kilauea, Hawaii) - Glooscap (Mi'kmaq legend about the Sugarloaf Mountains) - Ovid (Roman poet who claimed that earthquakes occurred when the earth became too close to the sun and trembled from the great heat) - Anaxagoras (Greek who believed that volcanic eruptions were caused by great winds within the earth) - René Descartes (French philosopher who believed incandescent earth core was the source of volcanic heat) (pp. 36- 38).
QC	Quebec education program: Secondary School Education, Cycle one (2004)		Attitude: Respect for life and the environment (p. 248, 2004).

	Progression of Learning in Secondary School Science and Technology Cycle one: Environmental Science and Technology (August, 2011) (i.e., General Path) Progression of Learning in Secondary School Science technology Cycle one: Applied Science and Technology (august, 2011) (i.e., applied path) Framework of evaluation.		
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All aforementioned content was analyzed to identify the prevalence, representation of TEK and each ministry's perception of TEK.

1.1. Prevalence and Representation of TEK

Documents in this cluster demonstrate less than 1% of TEK content in their grades 7 and 8 science curricula. Some documents did not include any TEK-related content (e.g., MB grade 8, Atlantic grade 8, and Quebec documents). In relation to the conceptual framework of this study, documents in this cluster generally associate TEK content with one foundation of the scientific literacy, except for MB grade 7 documents where TEK-related contents were associated with two different foundations of scientific literacy: *STSE* (i.e., organizing principles) and *knowledge*. Atlantic documents linked TEK with the subject of *knowledge* from the conceptual framework; TEK content from Quebec documents was related to *attitude*. As illustrated in Table 2, these TEK contents were introduced mostly in the *life science* domain.

Qualitative data suggests that TEK content in this cluster was primarily associated with the topics of sustainability and stewardship. For example, a learning outcome found in the QC document (2004) promotes an attitude, which encourages students' "respect for life and the environment" (p. 248). Moreover, two curriculum texts from MB's grade 7 *Cluster 1: Interaction within ecosystem*, suggest the use of the article called, "*Aboriginal Perspective* (BLM

7-A)” for learning activities and assessment (p. 16). This article highly emphasizes the ideas of sustainability and stewardship linking with Aboriginal worldviews:

Traditionally, Aboriginal people have exemplified the qualities of good stewardship in their interactions with the environment...Aboriginal people are rich in environmental knowledge and can provide important perspectives when considering the impact of economic decisions on the environment” (p. 16).

The ideas of the seven generations; respect for the environment - respect for the mother earth; interconnectedness and interdependence of all life forms were also mentioned in this article. This article also acknowledges the importance of TEK and the Aboriginal peoples’ contributions in the society. Though this particular resource article conveyed a lot of TEK that could be linked to various curriculum outcomes, the usage of this article was suggested for only one activity in the entire document.

Secondly, many of these documents primarily situate Aboriginal people and their knowledge to be incorporated in order to pursue “science programs for a multicultural society” (Atlantic science curriculum document, 2002, p. 41). Therefore, when introduced, the cultural aspect of TEK is emphasized more than the scientific knowledge aspect. In doing so, some documents construct otherness when introducing TEK. For example, Aboriginal people’s traditional building structures such as *tipi*, *quinzhee* and *igloo* were introduced as examples in MB’s grade 7 science: forces and structure. These buildings and other scientific contributions of the Aboriginals were linked with building structures from different countries, such as the *Eiffel Tower* or *The Great Wall*. Moreover, the contributions of Canada’s Aboriginal people were often mentioned as an example of “other cultures” in the Atlantic Provinces’ curriculum as well. In the document, Native people’s contribution to science was mentioned alongside the contributions of

“other cultures”- such as Ancient Egypt, India, the Aztecs and Mayans (1998, p. 42). Such curriculum, contextualizing TEK and people’s contributions as “other” does not focus on the knowledge aspect of TEK, but rather, it promotes TEK as an example of primitive, non-innovative view that “teachers should acknowledge that there are many views of the origin of life” (1998, p. 42). Consequently, rather than acknowledging the scientific values of TEK which would benefit *all* Canadian students, the ministry views TEK as something that could potentially be integrated into the science curricula to accommodate multicultural classrooms. Such representation of TEK, focusing solely on the cultural values, might bring Aboriginal cultural awareness and promote the idea of multiculturalism in science. However, it does not provide any scientific knowledge from TEK for students to learn.

1.2. Ministry’s Perception of TEK Presented in the Official Curriculum Document

Each provincial ministry’s perception of TEK was measured by: the priority given to TEK in relation to other curriculum contents in documents; the ministry’s descriptions on Aboriginal cultures, perspectives and knowledge systems; and the Aboriginal Elders and knowledge holders’ participation in curriculum development and instruction.

With regard to the priority given to TEK, many documents in this cluster present TEK and Aboriginal cultures as examples and a suggestion for activities or assessments (i.e., priority scale: 1).

In this cluster, there is no evidence of the ministry’s treatment of TEK as a special or particular scientific knowledge. Rather, they treat inclusion of TEK as a tool to facilitate the multicultural science classrooms. None of the studied documents contained acknowledgment of the elders or Aboriginal scholars’ involvement in the curriculum development or review process. There was also no response related to the importance of TEK in science or of Aboriginal

perspectives in science. Instead, learning Aboriginal perspective was mentioned as pedagogy to insure the “inclusiveness in education” (Manitoba, grade 7 cluster 1, p. 8). *Foundation for the Atlantic Canada Science Curriculum for K-12* (1998) was the only document in this cluster that describes the importance of the culture and knowledge of Aboriginal people in science education:

The history of science needs to be part of a balanced science curriculum so students can see that all cultures have made great contributions to science. The Native people of Atlantic Canada, for example, developed an advanced understanding of naturally occurring compounds found in plants and animals before Europeans colonized the region. This type of knowledge has assisted the development of medicine, and many of these compounds are used in modern pharmaceuticals. (p. 41)

There was no mention of TEK by QC ministry in their documents. However, the QC ministry argues that “in the early twenty-first century there is a lot of artistic, philosophical and scientific work of all origins that it is not possible to choose to introduce students to a single cultural universe” (2004, p. 7). Albeit mentioned as an aim for education, there was no sign of the introduction of TEK or any other non-WMS knowledge in the QC’s curricula. Quebec science official curriculum, in fact, is solely based on European-western science (i.e., WMS). The Quebec ministry (2004) asserts that it is impossible to teach only one single cultural universe or knowledge system. TEK, however, provides scientific and educational aspects in science. TEK is mentioned as a knowledge system that all students need to acquire in order to make a decision around these environmental issues (BC Ministry of Education, 2005; Snively and Corsiglia, 2001). Indeed, the QC ministry argues that the program for secondary cycle “integrates all the subjects into a coherent whole focused on the major issues of contemporary life” (Quebec Ministry of Education, 2004, forward). The integration of TEK in official science

curriculum would be beneficial for our science education since many environmental issues are becoming major concerns in our contemporary lives.

All in all, there was no acknowledgement of the values of either TEK or the Aboriginal scholars' involvement in curriculum development. Results show little coverage of TEK in cluster 1. The TEK content in this cluster is mainly associated with the topics of sustainability and stewardship as well as promotion of multiculturalism in science.

2.0. Cluster 2: ON, AB (NWT) and BC (YT).

Documents from cluster 2 demonstrate some level (more than 1%) of TEK integration. Some documents in this cluster state that they have integrated the Aboriginal perspective, culture or knowledge into their science curriculum and explicitly discuss the definition and the values of TEK whereas some documents discuss the reason why the ministries incorporated Aboriginal perspectives with no specific reference to TEK.

Table 6

Curriculum content analyzed for Cluster 2

Provinces/ Territories	Documents studied	Curriculum categories	Examples of TEK curriculum
ON	The Ontario curriculum: Grade 1-8 Science and Technology (2007)	Overall expectations and Specific expectations. Learning outcomes and examples from these two types of expectations were analyzed for the study.	Grade 7 Understanding life systems: Interactions in the environment. 3.9 describe Aboriginal perspectives on sustainability and describe ways in which they can be used in habitat and wildlife management(e.g., the partnership between the Anishinabek Nation and the Ministry of Natural Resources for managing natural resources in Ontario) (p. 123)
AB (NWT) These Alberta curriculum documents are also being used in Northwest Territory and Nunavut.	Programs of Study Grade 7 to 9 (2003). Highlights of Revision Grades 7 to 9 (2009). Knowledge and employability Science Grade 7 to 9 (2006)	Overview, focusing questions, and outcomes.	Grade 7 Interactions and ecosystems Describe examples of interaction and interdependency within an ecosystem (e.g., Identify examples of depending between spaces, and describe adaptations involved; identify changing relationships between humans and their environments, over time and in different cultures- as, for example, in Aboriginal culture) (p. 11) Illustrate through examples, the limits of scientific and technological knowledge in making decisions about life-supporting environments (e.g., identify limits in scientific knowledge of the impact of changing land use on individual spaces; describe examples in which Aboriginal knowledge- based on long term observation- provides an alternative source of understanding) (p. 12)
BC (YT) The grade 7 and 8 science curriculum documents for British Columbia are also in use in Yukon territory.	Science Grade 7 - from integrated resource package 2005 Science Grade 8- from integrated resource package 2005	All key elements, learning outcomes, indicators, suggested assessment and activities mentioned in documents are analyzed.	Research Aboriginal practices within a specific ecosystem (e.g., river: salmon fishing; intertidal waters: herring roe; forestry: trapping) (p. 67). Working in groups, have students identify the pros and cons of Aboriginal practices within a specific ecosystem (e.g., controlled burns, fish wheels, culturally modified trees) (p. 67). Discuss the Aboriginal value (concept) of “giving back to the environment what you take” and how it may affect a specific ecosystem (i.e., reforestation, protecting stream beds, and harvest rotation) (p. 67).

Aforementioned contents were analyzed except for overviews. Overview was excluded for the data analysis as its content was revisited by other content and it does not describe specific learning outcomes.

2.1. Prevalence and Representation of TEK

Based on the results, documents in this cluster found to have more than 1% and less than 4% of TEK integrated in their official science curricula (Table 2). When presented, TEK content was introduced in two different foundations, mainly *attitude* and *knowledge*, of the scientific literacy. TEK content found in AB documents was mostly on the topic of developing *attitudes* and many of these TEK content discussed developing mutual respect or appreciating different views of science. For example, an AB grade 7 curriculum asks students to: “show awareness of and respect for Aboriginal perspectives on the link between humans and the environment” (p. 14). In BC and ON documents as well, studied TEK content appeared mostly as *attitude* and *knowledge* in the conceptual framework (Table 6). These studied TEK contents in Cluster 2 were mostly introduced in *life science* domain.

TEK in this cluster was represented mostly as a knowledge system that is relevant to many contemporary scientific issues in Canadian society. For instance, in BC grade 7 document (2005), students were asked to “research how Aboriginal people’s practices affect ecosystem” (p. 67), and the document provides both historical and current information on the use of aquatic resources by First Nations peoples in BC. These TEK contents were also primarily associated with the life science and developing attitudes for stewardship such as “respect for the environment”. Along with the TEK content in the BC curriculum, TEK content in the ON curriculum also was often related to develop attitudes for stewardship while represented as a knowledge system that is relevant to contemporary scientific issues. A specific expectation from

the ON grade 7 science asks students to “describe Aboriginal perspectives on sustainability and describe ways in which they can be used in habitat and wildlife management” (p. 123). Another specific expectation from ON grade 8 (2007) states that students need to research about “Aboriginal communities’ views on water issues while they need to research other various government agencies and environmental groups’ view learning about long-term sustainability issues” (p. 150). As shown in the examples above, TEK, linked with current scientific issues and promoting attitudes for stewardship and sustainability, was highly emphasized in this cluster.

TEK content in this cluster was also mostly in association with promoting multiculturalism in science thus provided non-WMS view of science in curricula. For example, a TEK content found in AB documents (2008) is represented as an understanding system “involving people with different views and backgrounds” (p. 14), including Aboriginal people’s worldviews in science.

2.2. Ministry’s perception of TEK presented in the official curriculum document.

The priority given to TEK in this cluster varies among the studied documents. In AB, for example, Aboriginal perspectives were normally found as examples in the curriculum rather than main learning outcomes (i.e., priority scale: 2). TEK was suggested as an example in grade 7: “e.g., show awareness of and respect for Aboriginal perspectives on the link between humans and the environment” (p. 14). However, in ON and BC documents, TEK was listed as a main knowledge or an organizing principle for students to learn (i.e., priority scale: 5).

Documents in this cluster generally state that TEK is needed for *all* students. The ministries mention the benefits and importance of integrating Aboriginal knowledge and perspective including TEK in either their official policy frameworks or their science curriculum documents. First of all, the ON ministry (2007) suggests the implementation of “a curriculum

that reflects First Nation, Métis, and Inuit cultures and perspectives” in *The Ontario First Nation, Métis and Inuit Education Policy Framework* (p. 7). It was stated that such curriculum is needed for not only the Aboriginal students but for “*all* students in Ontario [because they] will have knowledge and appreciation of contemporary and traditional First Nation, Métis, Inuit traditions, cultures and perspective” (Ontario Ministry of Education, 2007, p. 7). In turn, the ON ministry is committed to “provide a curriculum that facilitates learning about contemporary and traditional First Nations, Métis and Inuit cultures, histories and perspectives among all students and that also contributes to the education of school board staff, teachers and elected trustees” (Ontario Ministry of Education, 2007, p. 8). The ON ministry also argues that, in Ontario science curricula, they have integrated the content which reflects the Aboriginal perspectives, culture, knowledge and histories as “they relate to science and technology” (Ontario Ministry of Education, 2007, p. 37).

Similar to ON, BC science curriculum documents also explicitly emphasize the importance of TEK in science education for *all* students as they state:

The inclusion of Aboriginal examples of science and technologies can make the subject more authentic, exciting, relevant and interesting for *all* students This knowledge system [TEK] with its characteristic respect for sustaining community and environment offers proven conceptual approaches which are becoming increasingly important to all BC residents. (p. 8)

Indeed, the British Columbia Ministry of Education greatly acknowledges the importance and benefits of TEK through its science curriculum documents. Both grades 7 and 8 documents consist of a section called *Integration of Aboriginal content in the prescribed learning outcomes*, which provides description of what TEK is and shows educators how useful TEK is in our

society, especially in learning about the environment (British Columbia Ministry of Education, 2005). Described as an *integrative science curriculum* (i.e., curriculum that integrates both TEK and WMS), the BC science curricula “provide a meaningful context for aboriginal students and enhance the learning experience for all students” (British Columbia Ministry of Education, 2005, p. 10).

AB’s grade 8 *knowledge and employability* (2009) also discusses the importance of integrating Aboriginal culture and knowledge in science curriculum:

For historical, constitutional and social reasons, an understanding of First Nations, Métis and Inuit (FNMI) experiences and perspectives....is necessary to enable all students to be respectful and responsible citizens. Knowledge and Employability courses serve to facilitate positive experiences that will help Aboriginal students better see themselves in the curriculum and assist non-Aboriginal students to develop a better understanding of Alberta’s First Nations, Métis and Inuit peoples. (pp. 2-3)

Other than this Knowledge and employability document (2009), there was no mention of the ministry’s vision of integrating the Aboriginal culture and knowledge in other grades 7 and 8 AB science curriculum documents.

Overall, some documents in this cluster explicitly mention the ministry’s intention to integrate TEK in curriculum including description of the values and benefits of TEK. However, there is a lack of evidence that they included Aboriginal scholars or elders’ involvement in curriculum designing and the pedagogies that include elders’ involvement. For instance, the ON policy framework document (2007) states that “as part of the curriculum review process, First Nation, Métis, and Inuit content has been integrated into the revised curriculum as appropriate in consultation with Aboriginal organizations” (p. 28). However, it has not been confirmed by the

ministry that the review for the science curricula has been completed by Aboriginal scholars and elders, while other subjects such as social science were mentioned as the curricula underwent the review process by Aboriginal organization (Ontario Ministry of Education, 2007, p. 28).

The same case is also seen in BC and AB curricula. According to BC grades 7 and 8 official science curriculum documents (2005), a teaching model, involving a parallel process of learning both WMS and TEK, was suggested by “the participants of the ministry of education Aboriginal science meetings” (p. 10). However, the documents do not mention the identity of the participants in the assembly which cannot confirm the participation of Aboriginal scholars and elders’ participation in curriculum designing or review process. Because the ministry does not give out information of the curriculum development committee, it was not possible to confirm the involvement of Aboriginal elders in curriculum development process. However, from the curriculum documents and other policy frameworks studied for AB, there was no evidence of any elders’ involvement in AB’s curriculum design in science.

3.0. Cluster 3: NVT and SK

In comparison to other studied documents in this study, documents used in this cluster demonstrate the detailed acknowledgment of the values and benefits of teaching TEK. As shown in Figure 3 they also show the most amount of TEK coverage in this study.

Table 7

Curriculum content analyzed for Cluster 3

Provinces/ Territories	Documents studied	Curriculum categories	Examples of TEK curriculum
NVT	Junior High Science: Grades 7 to 9 Curriculum Document (NWT, 1991) Diversity: A teacher's resource package for grades 7 and 9 science (2005) To accommodate Aboriginal students' learning, Inuit in particular, the Nunavut ministry developed a learning module (2005). With this learning module, the official AB and NWT curriculum documents are also used for grade 7 and 8 science education in Nunavut. To identify the TEK coverage in Nunavut's official science curriculum, both the AB and NWT's curriculum documents and Nunavut's learning module (2008) were analyzed.	learning outcomes, activities, evaluation, classroom reinforcement cross-curricular details suggested	How "we" interact with the environment traditional and western perception of ecological concepts, use of renewable and non-renewable resources, population management, conservation and environmental problems, cycles, present and alternative energy sources (NWT, 1991, p. 21). Attitudes and behaviours Appreciation of the value of traditional and scientific knowledge to society (NWT, 1991, p. 28). The students will appreciate the importance of observation for understanding both Western science and learning IQ from their Elders. (NVT, 2005, p. 23) The students will understand and demonstrate a respect for all life in accordance with Inuit tradition. (NVT, 2005, p. 23) Read the following quote from <i>Thunder on the Tundra</i>. Do you agree with Elder Paul Omilgoitok? Why or why not? <i>People have asked that no mining take place near calving grounds because they are afraid it would diminish the number of caribou.</i> Paul Omilgoitok, 1998 (NVT, 2005, p. 43)
SK	Science 7 (2009) Science 8 (2009)	Outcomes and Indicators. Outcomes describe the knowledge, skills, and understandings that students are expected to attain by the end of a particular grade. Indicators are a representative list of the types of things a student should know or be able to do if they have attained the outcome (Saskatchewan Ministry of Education, 2009). In other words, outcomes are general expectations and indicators are specific expectations. All outcomes and indicators from the curriculum documents were analyzed for this study.	Grade 7 Life Science: Interaction within Ecosystem Outcome: IE7.1 Relate key aspects of Indigenous knowledge to their understanding of ecosystems. (p. 30) Indicators: a. Gather information about traditional Indigenous practices with respect to the relationships and connections between people and their ecological environment. b. Examine key aspects of Indigenous knowledge and First Nations and Métis people's practices that contribute to understanding of ecosystems and the interactions of their components. c. Provide specific examples of Indigenous knowledge in understanding the components of their ecosystems. d. Describe the ways that traditional Indigenous knowledge about respect and responsibility for the land, self, and others has been transmitted over many years, including the oral tradition (p. 30). IE. 7.2 Indicator d. Show respect for all forms of life when examining ecosystems (p. 30).

			Earth and Space Science Connecting with other subjects. Arts Education Create arts expressions using First Nations stories and Indigenous knowledge of ecosystems as inspiration for the work (p. 43). Grade 8 Earth and Space Science W.S 8.3 a. Examine the ways in which First Nations and Métis people traditionally valued, depended upon, and cared for aquatic wildlife and plants in Saskatchewan and Canada (p. 41).
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^aThe curriculum document: Junior High Science (1991), published by NWT ministry of education however is also being used in Nunavut. Hence this document has been included for the data analysis in Nunavut. The analysis of the AB document will be discussed in the later section.

3.1. Prevalence and representation of TEK

These two provinces in Cluster 3, as shown in Figure 2, contain the highest percentage of TEK coverage. All documents studied in both SK and NVT contain more than 4% of TEK content (Table 1). Especially, Nunavut’s learning module (2005) dedicated 21% of its entire curriculum to introducing TEK. It is so far the highest percentage ever found in grades 7 and 8 science curriculum documents in Canada.

When TEK content was present in the documents, they were well-integrated in all four foundations of scientific literacy. Generally, other provincial documents introduce TEK mainly in the concept of *attitudes* from the conceptual framework. However, more than 50% of TEK found in both SK’s grades 7 and 8 documents is introduced as *knowledge* from the conceptual framework. Especially, eight out of 22 total studied TEK contents from *Junior High Science* (1991) were introduced in the context of *STSE relationships* (i.e., organizing principles in science) from the foundations of the scientific literacy. It is the highest number of TEK content dedicated for this particular STSE principle in this study. For example, Junior High Science (1991) includes curriculum that asks students to learn “how ‘we’ interact with the environment: traditional and western perception of ecological concepts” (1991, p. 21) and “an appreciation of

both cultural and scientific ways of explaining phenomenon” (1991, p. 30). Such curriculum that links TEK in STSE context emphasizes the contribution of TEK in our society and science and also helps students to develop a scope to see scientific phenomena in both Western and Indigenous way (Snively and Corsiglia, 2001). With the relation to STSE principle, TEK in this cluster was introduced along with the knowledge and technology from WMS. Such curriculum allows students to develop understanding that both TEK and WMS are important and useful in our current society. The NVT ministry’s intention to promote two-eyed learning is clearly stated in the NVT’s learning module (2005):

Much more value, importance and significance is being assigned to traditional knowledge. It is very important that during this module, the teacher recognize and respect the contribution of Inuit (Aboriginal) knowledge, values and beliefs as well as the concepts and methodologies of western science. It is now accepted that when used together, both western science and traditional can provide a more complete understanding or picture of the world. (p. 7)

For instance, physical science domain entails curriculum content such as “Work, motion and energy in terms of traditional tools and simple machines” (p. 30) and “Appreciation of the value of traditional and scientific knowledge to society” (p. 28). By using the term “traditional”, some argue that TEK is implicated in antiquity and represented as primitive (Snively & Corsiglia, 2001). *Tradition* is defined as “knowledge where authority is linked to antiquity and where its status is entirely accepted” (Goldblatt, 2000, p. 33). Nunavut specifically states that, by *traditional* -- they mean the traditions of Aboriginal people in Canada (Nunavut Ministry of Education, 2008). Allowing students to look at both traditional (from Aboriginal culture) tools and knowledge along with simple modern machines and modern scientific knowledge promotes

students to appreciate scientific ideas and technology from both Traditional and Modern sciences (Hatcher et al., 2009).

Similar to NVT, SK's curriculum documents highly emphasize the contributions of TEK in society and science. In grade 8 earth and space science domain, one of the indicators asks students to "explain the meaning and significance of the forces that shape the landscape to First Nations and Métis people" (p. 40). The life science domain from grade 7, as well, consists of various indicators which includes TEK as a main concept of learning. For example, one asks the students to "examine key aspects of Indigenous knowledge and First Nations and Métis people's practices that contribute to the understanding of ecosystems and the interactions of their components" (p. 30). Such representations of TEK, as a main concept which emphasizes the contributions and knowledge of Aboriginal people in society, facilitate students' understanding of TEK in the STSE context and develop appreciation of the scientific values of TEK in our society.

Moreover, many suggested pedagogies within this cluster facilitate the connection between students and elders or knowledge experts. For example, to learn about plants, an activity was suggested to invite an elder or someone from the community who is knowledgeable about the names and uses of plants (Nunavut learning module, 2005, p. 59). TEK is known to be orally transmitted (Tsuji & Ho, 2002). Such curriculum, which includes inviting elders into classrooms, allows students to obtain and explore the knowledge directly from the knowledge holder. TEK content found in this cluster appeared primarily in *life science* domain; as shown in Table 2, many numbers of TEK content also appeared in *Earth and Space science* domain.

3.2. Ministry's perception of TEK presented in the official curriculum document.

TEK content in this cluster is mostly presented as a main learning outcome but it appears in all five points in priority scale. The ministries of education in this cluster perceive TEK as a knowledge system that should be taught in their science education program. Both NVT and SK provide a detailed acknowledgment to the knowledge system and knowledge holders, and encourage educators to learn more about TEK, and to connect with local knowledge holders.

Nunavut is a territory with the highest Aboriginal (Inuit in particular) population. It may be the reason why the ministry highly acknowledges the values of TEK and promotes the teaching of TEK. Under Article 32 of the *Inuit Land Claim Agreement*, the Nunavut Social Development Council (NSDC) is mandated to “encourage government to design and implement social and cultural development policies and programs appropriate to Inuit” (Nunavut ministry of education, 2005, p. 5). In turn, goals, expectations and specific recommendations made for the revitalization and application of TEK were explained thoroughly in a discussion paper published by the ministry, *Towards an Inuit Qaujimajatuqangit (IQ) Policy for Nunavut* (Nunavut ministry of education, 2005). With all its policy frameworks and mandates for teaching Indigenous Knowledge in science (i.e., TEK), the ministry endeavours to create an educational system that facilitates the linguistic and cultural needs of Inuit students, which includes creating new curricula that address these needs (Nunavut ministry of education, 2005). IQ was mentioned as the knowledge system that is “holistic, dynamic and cumulative in its approach to knowledge, teaching and learning” (Nunavut ministry of Education, p. 6). IQ is another name used for TEK in Nunavut.

Junior high science (1991) used in Nunavut lists five goals of the junior high science curriculum: intellectual, social, spiritual, physical and emotional goals. These goals are clearly linked to the learning of TEK. For example, one of the intellectual goals states “to develop in the

student an understanding and appreciation of traditional and local knowledge”; a spiritual goal is “to develop and reinforce in the student a respect for ‘the land’” (1991, p. 5). With its distinct educational goals to teach students Aboriginal perspective and TEK in science, the NVT ministry notes that they have integrated TEK in their curriculum because “traditional and local knowledge [that] is considered a component of the curriculum. The similarities and differences between Western [i.e., Euro-American] science and Traditional [indigenous] science are discussed and the topic areas for the integration of traditional knowledge are identified” (1991, p. 7). With its curriculum documents, the NVT ministry provides a very detailed description of TEK; a description on pedagogy suggested for teaching TEK; and an explanation of the differences and similarities between TEK and western science which depict the prestige and values TEK carries (*Junior high science*, 1991). All in all, Nunavut ministry of education acknowledges the values and the importance of teaching TEK; it was evident that they have integrated the pedagogies and curricula which reflect TEK.

Along with Nunavut, Saskatchewan also gives a detailed acknowledgment of TEK in science education. As the ministry states, “[TEK] enables all Saskatchewan students to develop scientific literacy (grade 7, p. 5)”, the SK grades 7 and 8 science curriculum documents greatly emphasize learning about both “First Nations and Métis cultures (Indigenous knowledge) and Euro-Canadian cultures (science)” in science education (grades 7-8, p. 20). These documents also state the ministry’s aims to achieve “a strong science program [which] recognizes that modern science is not the only form of empirical knowledge about nature and aims to broaden student understanding of traditional and local knowledge system” (p. 5). These SK ministry’s efforts to implement (i.e., actualize) Aboriginal content is evident in both grades 7 and 8 science curriculum documents. According to the SK’s Aboriginal Education Advisory Committee Action

plan (2005), 17 recommendations were made to build an equitable educational environment for Aboriginal students. One of the recommendations was *Actualization of Indigenous knowledge in Curriculum*:

Now, many teachers – especially those involved in the implementation of new curricula – express their desire to know more about Aboriginal content and perspectives, and their willingness to participate in in-service programs. Although this increased awareness is only a beginning, we see it as a major step forward and the foundation for progress in the future. (p. 8)

This recommendation, however, “pertain[s] not only to Aboriginal students, but to all students in the province” (Saskatchewan Ministry of Education, 2005, p. 7). In turn, both grades 7 and 8 science curriculum documents are published in 2009; it is evident that these grades 7 and 8 curricula implemented actualization of TEK. SK ministry also provides an acknowledgment of the involvement of Aboriginal scholars and indigenous knowledge experts from both academic field and school boards.

All in all, both NVT and SK acknowledge the scientific and educational values of TEK and explicitly mention their intention to integrate TEK in their grades 7 and 8 science curricula. TEK content presented in this cluster appeared in all four foundations of scientific literacy and all priority scale which suggest that TEK has been integrated throughout the curricula. Acknowledgment and activities involving Aboriginal elders were also shown in all documents studied in this cluster.

Discussion

Prevalence of TEK in the Canadian Grades 7 and 8 Official Curriculum Documents

The Canadian educational system is at a stage where we “acknowledge the distinctiveness and attempt to balance the knowledge systems [TEK and WMS]” (Battiste, 2008, p. 88). Therefore, many provincial and territorial ministries in Canada have developed educational policy frameworks for integrating knowledge and contributions of Aboriginals (British Columbia Ministry of Education, 2005; Ontario Ministry of Education, 2007; Saskatchewan Ministry of Education, 2008; Nunavut Department of Education, 2005).

Based on the results of this study, TEK coverage (i.e., TEK prevalence level) highly varied among the studied documents in general. Especially, the documents in cluster 3 illustrate a higher level of TEK coverage than documents from other clusters. Nunavut’s grades 7 and 8 curriculum documents integrated the highest percentage of TEK in Canada. One of NVT’s documents contained approximately 21% of its curriculum content dedicated to TEK (Table 2). The high population of the Aboriginal people, 98% of the NVT’s entire population, might have played a big role in establishing the curriculum with the high TEK coverage (Statistics Canada, 2006). Indeed, generally the provincial Aboriginal population seemed to correlate with the prevalence of TEK in science curriculum except for MB and ON. As shown in Table 2, ON curriculum documents contain more TEK contents than Manitoba, where 15.5% of its population are identified to be Aboriginals. Only 2.0% of its population are identified as Aboriginals in Ontario (Appendix iv).

The provinces studied in cluster 1 show the least TEK integrated and low provincial Aboriginal population percentage in comparison to other provinces. Quebec is the province with the least amount of TEK integrated in their grades 7 and 8 science official curriculum documents.

There are 108,430 residents in Quebec who are identified as Aboriginal, which consists of 1.5% of all Quebec residents. This percentage is the second lowest provincial Aboriginal percentage in Canada (Appendix iv). Including Quebec, documents in cluster 1 contained none or less than 1% of TEK content. For this, Kimmerer (2002) argues that in curricula we are unknowingly or knowingly, “ignoring an entire body of knowledge that has potential significance to contemporary science and policy: TEK” (p. 432). Additionally, he emphasizes the importance of creating a place for TEK in our science education as he asserts, “TEK has a legitimate role in the education of the next generation” (p. 432). The Canadian science education system should consider focusing on this knowledge system and attempt to not ignore, but embrace TEK in the science curricula.

The educational values of TEK had been recognized internationally and many other countries such as Australia, New Zealand and Japan have attempted to integrate TEK in their science curricula. McConney, Oliver, Woods-McConney and Schibeci (2011) speak about an initiative in Australia. Australia Ministry of Education has attempted to foreground indigenous perspective in science by including *Science as a Human Endeavour* in Australia’s new national curriculum. *Science as a Human Endeavour* is one of the strands in curriculum which provides students with an understanding of how science has evolved from a variety of perspectives including Australian indigenous cultures. McConney et al. (2011) state that this inclusion of the Australian Indigenous Knowledge (i.e., TEK) in national science curricula is a “further recognition of the need to make more visible, and therefore useful, indigenous Australian knowledge and understanding in school science” (pp. 2028-2029). But these initiatives in Australia to integrate TEK in science curricula were argued as “undoubtedly challenging”. Thus, McConney et al. (2011) suggest that Australian policy makers, curriculum developers and

teachers look at “international precedent”, especially Canadian initiatives, which “could provide some direction” (p. 2030). Although there have been attempts to integrate TEK in the science curricula, both nationally and internationally, as illustrated above, there have not been any studies investigating the current state of the prevalence and representation of TEK in the official science curricula, nor have any recommendations been made regarding how much TEK should be incorporated in official curricula in Canada. That being said, this study, with its own purpose, is significant in studying the current state of TEK integration in Canadian science curriculum and making such recommendations. In terms of the prevalence of TEK integration, documents from cluster 3: Nunavut and Saskatchewan considered providing a higher representation of prevalence of TEK in comparison to other provinces and territories studied in Canada. Therefore, the author suggests that more than 4% of TEK integration may be considered as a standard demonstration of prevalence of such knowledge system.

Representation of TEK and Other Aboriginal Contributions in Scientific Field and Society

In reference to the conceptual framework of this study: The four foundations of scientific literacy developed by *Pan-Canadian Framework* (1995), TEK contents from cluster 1 and 2 were primarily focused on one or two particular foundations and mainly represented TEK as *attitude* while documents from cluster 3 attempted to integrate TEK in all four foundations of scientific literacy. Moreover, these TEK studied contents were mostly introduced in the life science domain; physical science domain contained the least number of TEK (Table 2). In fact, Snively and Corsiglia (2001) argue that albeit numerous TEK in scientific and technological fields by Aboriginal people have been incorporated in modern applied science such as medicine, architecture, engineering pharmacology and more, existing literature tends to focus TEK in the field of life science (e.g., biology, botany, ecology, and geology). As explained previously, TEK contains rich information about the environment as it is a system of “knowledge built up through generations of living in close contact with the land” (Snively & Corsiglia, p. 11).

Kimmerer (2002) asserts that TEK can be a source of new biological insights and potential model for conservation biology and sustainable development. Indeed, many documents in this study introduced TEK on subjects of sustainability and stewardship. It is because “embracing indigenous perspectives on sustainability and land care seems a particularly ready arena around which fruitful discussions and planning in school science could happen” (McConney et al., 2011, p. 2029). With respect to sustainability and stewardship, clusters 2 and 3 primarily introduced these TEK contents with various contemporary environmental issues arising in our society, while documents from cluster 1 tend to link TEK solely with the ideas of developing attitudes for sustainability (e.g., “respect for environment”).

The contributions and significances of TEK in various fields of science and technology along with *two-eyed learning* were highly emphasized in cluster 3. Many TEK content in cluster 3 was mentioned together with Western ways of thinking and the contributions of Western technology. Such pedagogy assists the process of students' understanding of *two-eyed learning* -- both Western and Indigenous technology and scientific knowledge for our society and ecosystem.

Linking TEK with contemporary social issues as well as knowledge and technology from WMS do not evoke condescending images of TEK as primitive or inferior (Snively & Corsiglia, 2001). As Simpson (1999) describes, for a number of years, TEK and other philosophies of Aboriginal people have been represented as “primitive” in comparison to the industrialized, technologically advanced, “civilized” Western society (p. 3). Battiste (2008) argues that “fragmented, negative and distorted” pictures of indigenous peoples are offered publicly in curricula, with TEK being characterized as, “primitive, backward, or superstitious” (p. 86). For example, some TEK contents from clusters 1 and 2 tend to be associated to cultures that are no longer progressing such as ancient Greek or Mayan. Omura (2003) notes that “in reality, contemporary indigenous groups have experienced continual socio-cultural change.... the society and culture of every contemporary indigenous group is...still in the process of change” (p. 395). Linking TEK, which is still in use and developing in indigenous communities, with no longer progressing ancient knowledge systems, creates the image of TEK as a primitive and not-progressing knowledge system. Such representation of TEK created by Western scientists and educators may cause students to see TEK as inferior to WMS, which often represented as “industrialized, modern and advanced” (Simpson, 1999, p. 3). It may also discourage people who use these curriculum documents (i.e., both learners and teachers) to see TEK in a contemporary context (Simpson, 1999, p. 3). Bringing these incorrect representations of TEK are examples of

what Dei et al. (2001) call the *Crisis of knowledge* -- “disjunction of theory and practice” or “misrepresentation of knowledge.” (p. 8). Representing TEK as a primitive and non-evolving knowledge system is definitely a misrepresentation of knowledge system as TEK is contemporary and still developing (Dei, 2001; Tsuji & Ho, 2002).

Such representation of TEK seems to be established when reflecting multiculturalism in science. In the context of multiculturalism, some documents construct *otherness* when introducing TEK. Some documents from clusters 1 and 2 illustrated TEK in a context of *other* cultural views of science. Here, *other* is defined by difference, typically difference marked by outward signs like race and gender, where *difference* indicates “some kind of weakness or superior strength or intellect depending on the sympathies of the dominant cultural voice [i.e., Western]” (Onbelet, 2012). Omura (2005) affirms that the perpetuated status-quo and difference marked by scientists between WMS and TEK is “a result of the socio-political construction of otherness” (p. 339). Indeed, TEK content studied in clusters 1 and 2 was mainly represented as an example of “other cultural views” along with the contributions that had been made outside of Canada such as the Eiffel Tower in France and The Great Wall in China, which are not associated with the land in which Canadian students currently live, and that is relevant to all Canadian students. This could be a result of *constructing the other*, “a process whereby members of socially, culturally, economically or politically dominant groups create stereotypical and detrimental identities for members of minority groups by studying them and writing and teaching about them” (Omura, 2005, p. 612).

The evidence of *constructing the other* or the *crisis of knowledge* is not shown in cluster 3. Cluster 3 established examples of a representation of TEK which could provide some guideline when introducing TEK in science curricula. The studied documents in cluster 3 show

the following characteristics which were illustrated earlier: TEK introduced in all four foundations of scientific literacy (i.e., conceptual framework); appropriate credits given to the knowledge holder and its local Aboriginal communities; a holistic curriculum with cross-curricula activities and providing spiritual aspects of science; units integrating both IS and WMS or TEK and knowledge in WMS (i.e., *two-eyed learning*); providing curricula and pedagogies that encourage integration of the lessons from Aboriginal Elders ; no TEK content represented as primitive; and, finally, TEK was introduced in a contemporary context. Avoiding incorrect representation of TEK (e.g., representing TEK as primitive and inferior and construct otherness) and providing representations of TEK as contemporary scientific knowledge system in science curricula could be established by participation of local elders and Aboriginal knowledge holders in curriculum development and instruction (Simpson, 1999).

Ministry's Perception on TEK and Aboriginal Perspectives in Science, and its Relation to the Representation of TEK in Documents

Studying the official acknowledgment of the values of TEK as well as the participation of elders in curriculum development and instructions reflects the ministries' perceptions towards TEK. The perceptions of the ministries on TEK reflected in their official science curriculum and policy frameworks varied considerably. McConney et al. (2011) discuss the importance of ministries and policy makers' official acknowledgment of TEK: "Acknowledging and publicly valuing, indigenous science and knowledge and interest thus seems an important approach to engaging students and, by extension, members of indigenous communities" (p. 2028).

As illustrated earlier in the results section, official curriculum documents in cluster 1 lack the evidence of acknowledging the elders or Aboriginal scholars' involvement in curriculum development and integration of TEK. Simpson (1999) introduces the idea of the "packaging

process” of TEK while she discusses the problematic of silencing the voices of the actual Aboriginal knowledge holders and elders, and excluding their participations in teaching TEK (p. 6). According to her, TEK has been packaged in a way that is easily accessible to the mainstream society, but excluding Aboriginal people’s voices. Through these packaging processes, “knowledge is physically separated from the [Aboriginal] people, the land, the spiritual realm, the oral tradition and from the values and philosophies that provide its context.... this production of TEK greatly increases the chances of misrepresenting and misinterpreting the knowledge of Aboriginal people” (p. 6). Indeed, the earlier discussed documents from cluster 1, which did not provide acknowledgment of the involvement of local Aboriginal scholars or elders, either evoked a primitive image of TEK or othered the Aboriginal knowledge system. As mentioned earlier in this article, if the credit of information and knowledge shared is not given properly, it is not an appropriate manner of sharing TEK in the classroom (Kimmerer, 2002). While the participation of Aboriginal elders in curriculum development is unknown, if no Aboriginal scholars or elders were involved in these curriculum development processes, it becomes problematic. Western educators would not understand indigenous knowledge and worldview thoroughly since they are orally transmitted (Simpson, 1999). Therefore, a lack of evidence of Aboriginal elders and knowledge holders’ participation in curriculum development might have been one of the factors that led to the misrepresentations of TEK shown in cluster 1. A further detailed investigation on the involvement of Aboriginal scholars and elders in curriculum design is needed in order to obtain a better understanding in the integration of TEK in curriculum development process followed by each province and territory.

While some of cluster 2 follows the trend of cluster 1 in showing the evidence of the crisis of knowledge, cluster 3 and some other documents from cluster 2 acknowledge the values

and the importance of integrating TEK in science education. These documents overtly credit the elders' involvement in curriculum review and greatly encourage elders' participation in deliberating the knowledge in the classroom. Simpson (1999) argues that people who have indigenous knowledge are the true experts in TEK; involvements of these true experts in curriculum design and instruction are crucial to represent TEK in an appropriate way. Aboriginal cultures and communities are diverse and TEK is a local and a unique knowledge system by nations and communities (Simpson, 1999; Tsuji & Ho, 2000). Therefore, local elders' involvement in designing curriculum and instruction, shown in cluster 3, helps to avoid misrepresentation of TEK in science curricula. Indeed, rather than represented as primitive or *othered*, TEK content in cluster 3 is mainly represented as a knowledge system that benefits *all* students which provides the extensive body of knowledge that has applied values (Battiste, 2008; Kimmerer, 2002). Regarding the priority scale developed in the study (Table 1), cluster 3 introduced TEK in various aspects of curriculum, from a main general learning outcome to a specific learning activity and an example, while many TEK contents from clusters 1 and 2 were limited to appear in suggested activities and examples. Especially, cluster 3 included a high number of mandated learning outcomes and activities that require the involvement of the knowledge holders or elders (e.g., "Invite an Elder to class who knows how to light a *qulliq* traditionally using the cotton grass and/or moss" in NVT learning module). Such curriculum integrating TEK thoroughly in document would facilitate *two-eyed learning*, thus studying similarities as well as differences between WMS and TEK, and illustrating how a synthesis of both WMS and TEK can work together to solve problems (Snively & Corsiglia, 2001).

All in all, ministries from cluster 3 and some from cluster 2 perceive TEK as a valuable teaching source, "not only [for] Aboriginal students, but [for] all students in the province"

(Saskatchewan Ministry of Education, 2005, p. 7). Based on the aforementioned ministries' perceptions on teaching TEK, cluster 3(i.e., NVT and SK) could be a model case in integrating TEK. They give a detailed acknowledgment to the knowledge system and knowledge holders in "an appropriate manner", and encourage educators to learn more about TEK, and connect educators and students with local knowledge holder by incorporating a lot of learning outcomes and activities that require the knowledge holders' participation in curriculum development and instruction process (Kimmerer, 2002). The participation of local elders and knowledge holders will help curriculum developers in each ministry to perceive TEK in proper way, without silencing their voices; this will also provide a guideline to establish a suitable prevalence and representation of TEK in science curricula (Simpson, 1999).

Conclusion

To introduce TEK into "a much wider scope of societies," Canadian science education needs to take another approach to integrate TEK (Omura, 2005, p. 323). According to Snively and Corsiglia (2001),

Non-Western and minority culture students of Western science may be forced to accept Western values and assumptions....in the course of receiving instruction on Western science. At the same time, mainstream students can be prevented from examining important values, assumptions, and information imbedded in other cultural perspectives. Thus students from Aboriginal culture (as well as many mainstream students) inadvertently face a dilemma whenever they study Western science. (p. 24)

A lack or misrepresentation of TEK may lead to the loss of students' opportunity to learn about such a rich knowledge of the Aboriginal people. Instead of viewing TEK as primitive or *the other*, we need to take other avenues to educate our students and educators about this

knowledge system. Ninnes (2003) argues that representation of a particular indigenous lifestyle as “traditional” needs to be reconsidered because “such a discourse of traditionality can be viewed as a means by which non-indigenous people create and control identities for indigenous people” (p. 614). In order to provide instructions and curricula that reflect TEK in a contemporary and appropriate way, the results of this study suggest that, when integrating TEK, the curriculum documents should integrate pedagogies that include lessons from local Aboriginal elders or scholars as shown in Nunavut’s learning module (2005). This approach may include both, bringing knowledge holders into the classroom as well as bringing students to the knowledge holders outside the classroom (Saavedra-Vargas, 2012). Such pedagogies would allow students to see TEK as a modern and progressive knowledge system that is relevant to their daily lives, rather than a primitive and othered one. Snively and Corsiglia (2001) also acknowledge the need of a “curriculum that recognizes a community’s indigenous knowledge or worldview in a way that creates a need to know Western science” (p. 27). Consulting with local indigenous elders and knowledge holders would facilitate in developing such curriculum. Because of its oral tradition, bringing knowledge holders from local communities will facilitate two-eyed learning, where students learn concepts from both TEK and WMS view.

This study also suggests the need of a national policy framework that would allow all provincial and territorial documents to integrate proper representation of TEK in our science education along with WMS (Canadian Council on Learning, 2011). Proper representations of TEK content with WMS content through all four learning domains and foundations of scientific literacy in all provincial and territorial documents will facilitate students and teachers to see “similarities as well as differences, areas where TEK helps fill the gap where knowledge in WMS is lacking, and vice versa” (Snively & Corsiglia, 2001, p. 28).

Snively & Corsiglia (2001) argue that science education must help all students understand how science [both IS and WMS] relates to action by emphasizing the relationship between science and technology and the culture, values and decision-making processes of the society within which we operate (i.e., four dimensions of the conceptual framework of this study). As seen in cluster 3, with the partnership and consultation with indigenous knowledge holders in the communities, linking TEK and the concepts from WMS in the four foundations of scientific literacy which are STSE organizing principle, attitudes, knowledge and skills, will be the one possible way of endeavouring the “crisis of knowledge”, connecting the theory and practice together in science education.

Limitations

The major limitation of this study is that there was only one coder for the analysis. Neuendorf (2002) suggests using multiple coders to establish intercoder reliability. However, there were no co-coders for this study, which might have potentially interfered with the reliability of the study. Another limitation of this study is that the actual pedagogies and curricula deliberated in the classroom are unknown. This study was based on the assumption that all content from the official curriculum documents was taught in the classroom. As Temple (2005) explains, albeit the unobtrusiveness of content analysis, it is restricted to written material. This analysis excludes the supplementary resources, classroom dynamics, and teacher initiatives that may influence students’ overall learning experience. This said, however, this study provides important insights about the presence of TEK in key educational materials (Temple, 2005). As mentioned previously, studying official curriculum documents would give a glimpse of the prescribed pedagogy and curriculum used in the classroom. Therefore, future studies can focus on a more qualitative approach, such as classroom observation, interviewing and surveying

teachers and students, and a discourse analysis on science textbooks used. Finally, there is a possibility of missing some information for the analysis. The author only focused on the official grades 7 and 8 science documents for this study. There might have been some documents developed after the analysis or might have been missed for the analysis process. For example, official curriculum documents from other disciplines such as social science or environmental education might have some cross-curricula activities that are linked to the official science curricula, which might have been the sample target for this study. Hence, future study could confirm the usage and study other official resource documents, such as environmental education, Aboriginal education or any other official documents.

CODA

This study has attempted to establish the current state of TEK integration in Canadian science curriculum. Despite the recognition given to TEK in educational and scientific communities, there was a disparity in the depth of coverage in grades 7 and 8 science curriculum documents used in Canada. Based on the results, Nunavut consists of the most number of TEK content integrated, while the Atlantic curriculum documents consist of the least number of TEK content integrated (Table 2, p. 80). The representation of TEK within the studied documents varied among provinces. Some provinces and territories including NVT, SK, ON viewed TEK as a knowledge system that could help solve many social, environmental, and scientific problems in our current society. However, provinces such as MB, BC presented TEK content as primitive or in a multicultural context. Although a number of general studies of Aboriginal content in curriculum exist (e.g., Aikenhead, 2005; Ninnes, 2003), to the present knowledge, no published study has analyzed the prevalence and integration levels of Aboriginal knowledge and topics in official science curriculum documents in Canada. This research project will also provide future

researchers with data which can be used as a basis for comparison with their results in order to judge if and how the coverage of Aboriginal topics and knowledge in Canadian science curriculum has changed over time. It may also help to re-articulate the strength and weakness of the knowledge within TEK integration to science education. Through reading this work, current science educators and educational ministries may see TEK, as Omura (2005) puts, “neither pre-science nor primitive science, which has failed to develop into modern science, nor an alternative, which is essentially incommensurable with Western Modern Sciences” (p. 340) but as an extensive body of knowledge that our science education could benefit.

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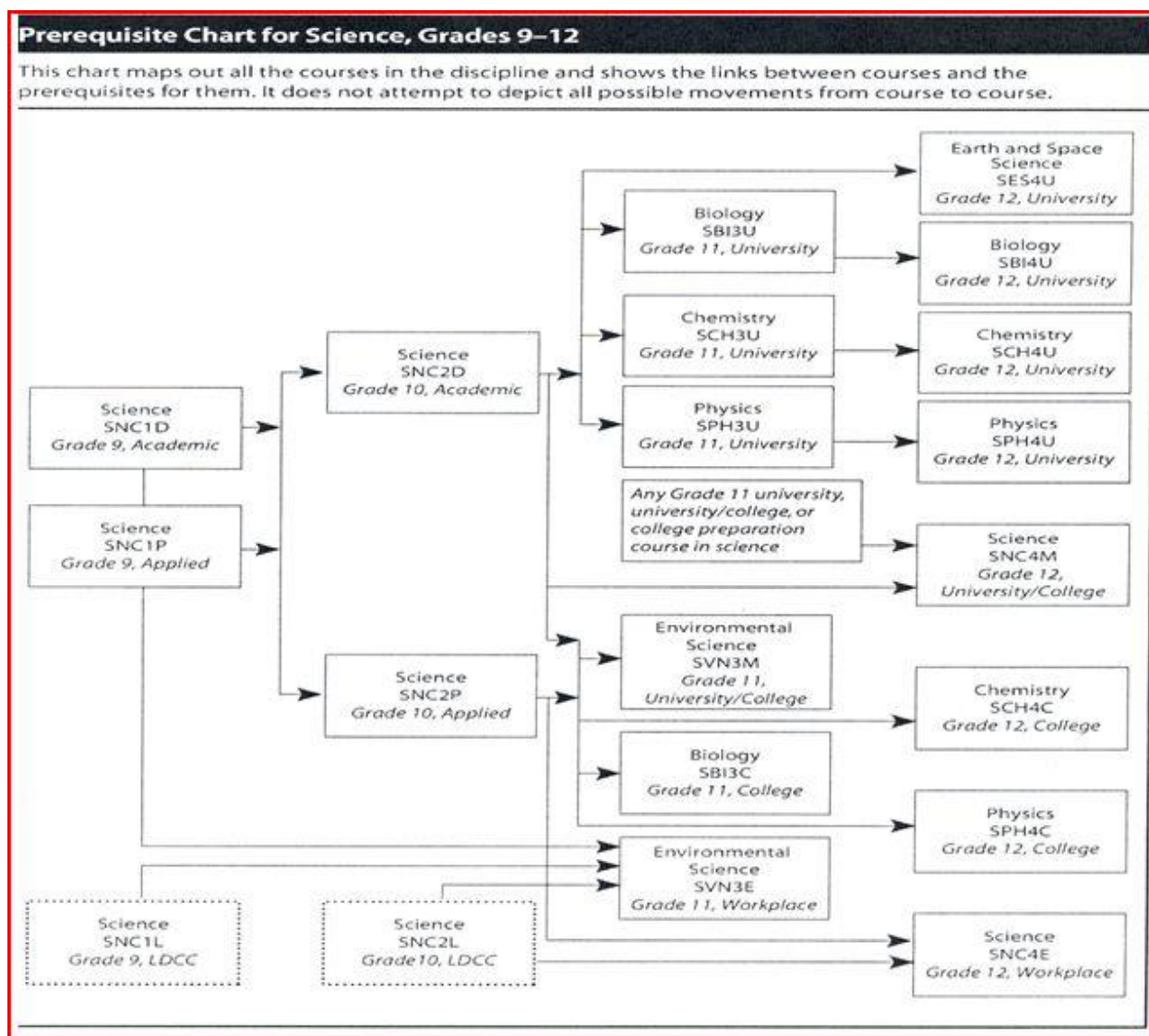
Appendix i

TEK characteristics in Four dimensions of Science Education

Organizing Principles	Habits of Mind	Skills and Procedures	Knowledge
a) Understanding nature of science - Universe is unified - Body of knowledge stable but subject to modification (Manitoba Youth and Education, 2003) - Trust for inherited wisdom (Manitoba Youth and Education, 2003) b) Understanding Relationship among science, culture and environment - Emphasis on practical application of skills and knowledge - TEK exists in a particular cultural and ecological context and should be presented in relation to that intellectual tradition (Kimmerer, 2002) - Interpreting the local landscape in light of traditional resource management practice (Kimmerer, 2002)	a) Holistic - Includes physical and metaphysical well-being linked to moral code (Manitoba Youth and Education, 2003). b) respect and values - Honesty, inquisitiveness, perseverance, open-mindedness. - Communication of metaphor and story connected to life, values, and proper behaviour (Manitoba Education and Youth, 2003) - TEK guided by traditional wisdom such as: respect, ethics, controls, sharing, harmony, reciprocity, holism, spiritually (Snively and Corsiglia, 2001)	a) Understanding relationships - Empirical observation in natural settings - Pattern-recognition - Verification through repetition, inference, and prediction (Manitoba Education and Youth, 2003) b) Experimentation - Practical experimentation - Qualitative oral record Local verification (Manitoba Education and Youth, 2003) - Interpreting Wisdom through Stories, Legends, myths, e.g., brining TEK into the classroom as guest speakers (Kimmerer, 2002) c) Critical Thinking Skills Observing, questioning, inferring, predicting, problem solving, classifying, monitoring, interpreting, adapting (Snively and Corsiglia, 2001)	a) Facts About the environment - Plant and animal behaviour, cycles, habitat needs, interdependence; properties of objects and materials; position and motion of objects; cycles and changes in earth and sky (Manitoba Education and Youth, 2003) - TEK corresponds variously to WMS categories: ecology, botany, biology, medicine, horticulture, agriculture, glaciology, climatology, geology. (Snively and Corsiglia, 2001) b) Daily living and Sustainability Integrated and applied to daily living and traditional subsistence practices (Manitoba Education and Youth, 2003) Integrated in a local cultural perspective, results in long term sustainable societies, implications for resolving global environmental problem (Snively and Corsiglia, 2001)

Appendix ii

Prerequisite chart for science, Grades 9-12



Appendix iii

Documents used for the study

Provinces/territories	Curriculum documents analysed
Alberta Northwest territory	- Programs of study Grades 7 to 9 (2003) - Highlights of Revision Grades 7 to 9 (2009) - Knowledge and employability Science. Grades 8 and 9 (2006)
Manitoba	- A foundation of Implementation (1999) - Grades 5-8 Science: - Manitoba Curriculum Framework of outcomes (1999) - Grades 5-8 topic chart
British Columbia Yukon	- Science Grade 7 – from integrated resource package 2005 - Science Grade 8- from integrated resource package 2005
Atlantic (New Brunswick, Newfoundland and Labrador, Nova Scotia, and Prince Edward Island)	- Atlantic Canada Science Curriculum (2002) Grade 7. - Atlantic Canada Science Curriculum (2002) Grade 8 - Foundation of the Atlantic Canada Science document (1998)
Nunavut	- Junior High Science: Grades 7-8 Curriculum Document (NWT, 1991). - Diversity: A teacher's resource package for grades 7 to 9 science (2005)
Quebec	- Quebec Education Program (2004) Secondary School Education, Cycle One - Progression of learning - Framework of Evaluation
Ontario	- The Ontario curriculum Grades 1-8. Science and Technology (2007)
Saskatchewan	- Science 7 (2009) - Science 8 (2009)

Appendix iv

Aboriginal Population in Canada

Province/Territory	Number	% provincial ^[16]	% national ^[16]	Indian , (First Nations)	Métis	Inuit	Multiple ^[16]	Other ^[16]
Ontario	242,495	2.0%	20.7%	158,400	73,610	2,040	1,910	6,540
British Columbia	196,075	4.8%	16.7%	129,575	59,445	795	1,655	4,605
Alberta	188,365	5.8%	16.1%	97,280	85,495	1,605	1,220	2,760
Manitoba	175,395	15.5%	15.0%	100,645	71,805	565	680	1,695
Saskatchewan	141,890	14.9%	12.1%	91,400	48,115	220	625	1,530
Quebec	108,430	1.5%	9.2%	65,085	27,980	10,950	955	3,450
Nunavut	24,915	85.0%	2.1%	100	125	24,640	30	20
Nova Scotia	24,175	2.7%	2.1%	15,240	7,680	320	100	830
Newfoundland and Labrador	23,450	4.7%	2.0%	7,765	6,470	4,715	290	4,205
Northwest Territories	20,635	50.3%	1.8%	12,640	3,580	4,160	105	145
New Brunswick	17,655	2.5%	1.5%	12,385	4,270	185	100	710
Yukon	7,580	25.1%	0.6%	6,275	800	255	50	190
Prince Edward Island	1,730	1.3%	0.1%	1,230	385	30	10	75
Canada	1,172,790	3.8%	100.0%	698,025	389,785	50,480	7,740	26,760
Sources: 2006 Census ^{[17][18][19]}								

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Appendix I

Studied TEK curriculum content

Provinces/Grade	learning domains	Curriculum Organizer	Content
BC 7	Life Science Ecosystems	Skills and Attitudes:	Show respect for the environment (p. 40)
BC 7	Life Science Ecosystems	Suggested Achievement Indicators	Describe, using examples, how practices of Aboriginal peoples in BC affect environmental sustainability in a specific ecosystem (p. 67)
		Planning for Assessment	Research Aboriginal practices within a specific ecosystem (e.g., river: salmon fishing; intertidal waters: herring roe; forestry: trapping) (p. 67). Working in groups, have students identify the pros and cons of Aboriginal practices within a specific ecosystem (e.g., controlled burns, fish wheels, culturally modified trees) (p. 67). Discuss the Aboriginal value (concept) of “giving back to the environment what you take” and how it may affect a specific ecosystem (i.e., reforestation, protecting stream beds, and harvest rotation) (p. 67).
		Suggested Assessment Activities	Students research and discussion should reflect - understanding of Aboriginal practices and values; sensitivity to Aboriginal concerns (p. 67)
BC 8	Process of Science:	Proscribed learning outcomes	demonstrate ethical, responsible, cooperative behaviour (p. 41) suggested achievement indicator describe and demonstrate - ethical behaviour (e.g., honesty, fairness, reliability) - open-mindedness (e.g., ongoing examination and reassessment of own beliefs) - willingness to question and promote discussion - skills of collaboration and co-operation - respect for the contributions of others (p. 41)
	Life science	Skills and Attitude	show respect for living things (p. 42)
	Physical Science:	Skills and Attitude	show respect for living things (p. 44)
	Earth and space science	Skills and Attitude	show respect and sensitivity for the environment (p. 89)
	Earth and space Science	Suggested Achievement indicator	relate human activities to the distribution of aquatic species, with specific reference to First Nations peoples in BC (e.g., harvesting technologies, preservation techniques, use of resource) (p. 94)

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		Planning for assessment	Provide students with historical and current information on the use of aquatic resources by First Nations peoples in BC. Resources could include information on whales, salmon, eulachon, shellfish (clams, oysters, and abalone), seals, otter, sea urchins, whitefish and white sturgeon. Information should cover the following topics: - season and location obtained - method of capture - preservation techniques - uses - concerns with this resource today (p. 94)
BC 7 Shared learning			Distinct Aboriginal values and beliefs are associated with resource use. Aboriginal peoples use resources in both traditional and contemporary ways. Aboriginal peoples used a variety of traditional technologies for transportation, shelter, and food gathering. Aboriginal peoples developed both traditional and contemporary technologies and scientific innovations. Many traditional Aboriginal technologies can be constructed with available resources. Traditional Aboriginal technologies and use of resources changed in many ways following European contact.
	Physical Science: (Gr 7)		There is likely to be local Aboriginal chemistry in the area in which you are teaching. Ask a knowledgeable person from the local community to come and demonstrate (e.g., using moose brains for tanning hides, making paint, using local medicine and combinations of plants to make specific medicines, whipping soapberries to make froth). – does not match up with any of prescribed learning outcomes or key elements in physical science section in the curriculum document. Resources: (NONE of them are listed as recommended learning resource in curriculum documents)
Grade 8			Aboriginal peoples used the land and resources in distinct ways. Many traditional Aboriginal technologies can be constructed and examined using available resources. Aboriginal peoples use herbs and roots for nutritional and medicinal purposes.
	Life Sciences	Instructional strategies	Ask students to investigate and research local traditional environmental practices (e.g., removing bark without hurting the tree, taking only what is needed, moving or leaving sites to let the land renew, and rotating hunting and trapping sites). Information may be gathered from

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			resources such as books and magazines, videos, interviews with Elders, and/or on-line sources. Students may work individually or in pairs to prepare a class presentation of their findings. Create a learning centre that contains samples of a variety of edible and medicinal herbs and roots labelled with traditional Aboriginal and contemporary names. Wherever possible, include information on the uses, location, and appearance of the roots and plants. Ask students to make a drawing of each root and plant and to write a summary of the corresponding information for display at the centre. Ask students to investigate and research traditional food preparation practices (e.g., interviewing Aboriginal people from the local community regarding food preparation, researching the library and/or the Internet). Ask students to choose a locally available food and use a traditional preparation technique to cook it. Ensure that only traditional tools, materials, and cooking facilities are used. Students may share the cooked food with the rest of the school. Construct a display for the classroom of various food preparation practices and ask students to create charts explaining and illustrating the step-by-step processes of preparing these foods. Invite an Elder or knowledgeable community member to guide students on a field trip to find and examine local edible and medicinal plants. Ask the guide to present information on the plants (e.g., contemporary botanical names, traditional Aboriginal names, and traditional and contemporary uses). In a field trip booklet, ask students to make drawings of the plants and record information about their names, locations and uses.
	Physical science		Ask students to attempt the following exploration activity: "Can the periodic table or parts of the periodic table be put into a circular format or structure as opposed to the grid that exists now, and can it be analyzed using the medicine wheel?"
	Earth and space sciences	..	Ask student to explore the area in which they live by examining the creation stories of local Aboriginal culture. Examine other sacred stories to see if there is a link with the ancient past, such as dinosaurs, movement of the earth's crust, etc. Determine if there has been any research done locally on the topic of ancient cultures (e.g., culturally modified beaches that exist under the ocean off of Haida Gwaii).

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AB 7	Interactions and ecosystems	STSE specific	Describe examples of interaction and interdependency within an ecosystem (e.g., Identify examples of depending between spaces, and describe adaptations involved; identify changing relationships between humans and their environments, over time and in different cultures- as, for example, in Aboriginal culture) (p. 11)
	Interactions and ecosystems	STSE specific	Illustrate through examples, the limits of scientific and technological knowledge in making decisions about life- supporting environments (e.g., identify limits in scientific knowledge of the impact of changing land use on individual spaces; describe examples in which Aboriginal knowledge- based on long term observation- provides an alternative source of understanding) (p. 12)
	Interactions and ecosystems	Attitude general	Mutual Respect: Students will be encouraged to ; appreciate that scientific understanding evolves from the interaction of ideas involving people with different views and backgrounds (e.g., show awareness of and respect for Aboriginal perspectives on the link between humans and the environment) (p. 14)
	Plant for food and fibre	Attitude general	Mutual Respect: Students will be encouraged to: Appreciate that scientific understanding evolves from the interaction of ideas involving people with different views and backgrounds (e.g., show awareness of the diversity of agricultural practices used by societies around the world at different times through history; appreciate the role of Aboriginal knowledge in identifying useful herbs and medicines) (p. 18)
	Heat and Temperatures	Attitude general	Students will be encouraged to: Appreciate that scientific understanding evolves from the interaction of ideas involving people with different views and backgrounds (e.g., appreciate Aboriginal home designs of the past and present that use locally-available materials; recognize that science and technology develop in response to global concerns, as well as to local needs; consider more than one factor or perspective when making decisions on STSE issues) (p. 22)
	Structures and Forces	STSE specific	describe and compare example structures developed by different cultures and at different times; and interpret differences in functions, materials and aesthetics (e.g., describe traditional designs of indigenous people and peoples of other cultures; compare classical and current designs; investigate the role of symmetry in design) (p.

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			23)
	Planet Earth	Attitude general	Mutual Respect Students will be encouraged to: Appreciate that scientific understanding evolves from the interaction of ideas involving people with different views and backgrounds (e.g., appreciate the idea of “Mother Earth,” and recognize different forms of this idea developed by different cultures; recognize the role of legend and myth in conveying understandings about Earth; recognize that scientific ideas about Earth have developed over time) (p. 30)
AB 8 Academic	Fresh water and salt water system	Attitude general	Mutual Respect Students will be encouraged to: Appreciate that scientific understanding evolves from the interaction of ideas involving people with different views and backgrounds (e.g., show awareness of and respect for the contributions of indigenous peoples to knowledge of the environment) (p. 50)
AB 8 Knowledge and Employability	Mix and Flow of Matter	Attitude general	Mutual Respect Students will be encouraged to: appreciate that scientific understanding evolves from the interaction of ideas involving people with different views and backgrounds (e.g., show awareness that knowledge of fluid characteristics has developed in many societies and cultures, including Aboriginal cultures) (p. 9) Stewardship Students will be encouraged to: demonstrate sensitivity when pursuing a balance between the needs of humans and the requirements for a sustainable environment (p. 9)
	Cells and Systems	Attitude general	Stewardship Students will be encouraged to: demonstrate sensitivity when pursuing a balance between the needs of humans and the requirements for a sustainable environment (p. 12)
	Light and Optical Systems	Attitude general	Stewardship Students will be encouraged to: demonstrate sensitivity when pursuing a balance between the needs of humans and the requirements for a sustainable environment (p. 15)
	Mechanical System	STSE specific	examine simple machines by describing the structures, functions and component parts of the overall system • identify and classify a variety of simple,

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			everyday machines and mechanical systems, including those of traditional Aboriginal societies, such as travois and teepees (p. 16)
	Mechanical Systems	Attitude General	Students will be encouraged to: demonstrate sensitivity when pursuing a balance between the needs of humans and the requirements for a sustainable environment (p. 18)
	Fresh and Salt water system	Attitude General	Stewardship Students will be encouraged to: demonstrate sensitivity when pursuing a balance between the needs of humans and the requirements for a sustainable environment (p. 21)
SK 7	Life Science: Interaction within Ecosystem	Outcome	IE7.1 Relate key aspects of Indigenous knowledge to their understanding of ecosystems. (p. 30)
		Indicators	a. Gather information about traditional Indigenous practices with respect to the relationships and connections between people and their ecological environment. b. Examine key aspects of Indigenous knowledge and First Nations and Métis people's practices that contribute to understanding of ecosystems and the interactions of their components. c. Provide specific examples of Indigenous knowledge in understanding the components of their ecosystems. d. Describe the ways that traditional Indigenous knowledge about respect and responsibility for the land, self, and others has been transmitted over many years, including the oral tradition (p. 30). d. Show respect for all forms of life when examining ecosystems (p. 30).
SK 7	Earth and Space Science: Earth's Crust and Resources	Indicator	b. Provide examples of past theories and ideas, including cultural mythology, that explain geological phenomena such as volcanic activity, earthquakes, and mountain building (p. 38).
		Connecting with other subjects	Arts Education Create arts expressions using First Nations stories and Indigenous knowledge of ecosystems as inspiration for the work (p. 43). Analyze how traditional arts, world music instruments, and dance often have deep connections to the local environments and interconnected ecosystems (e.g., Australian didgeridoos, Inuit throat singing, beading, First Nations drums and flutes) (p. 44).

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SK 8	Life science: Cells, Tissues, Organs and Systems	Indicators	C.S 8.3b. Research various ideas and theories, past and present, used to explain the composition of the human body (e.g., living organisms were made of air, fire, and water; and body is animated by spirit) (p. 31). C.S 8.3b. Research various ideas and theories, past and present, used to explain the composition of the human body (e.g., living organisms were made of air, fire, and water; and body is animated by spirit) (p. 31). C.S. 8.4.a. Examine First Nations and Métis perspectives on the interdependence and connectedness of human body systems and the sacredness of life (p. 31).
	Earth and space science: water systems on earth	Indicators	W.S 8.1c. Examine the significance of water to First Nations and Métis people of Saskatchewan, including water as an essential element of life, transportation, water quality, fishing practices, and treaty rights regarding fishing (p. 39). W.S 8.2 c. Explain the meaning and significance of the forces that shape the landscape to First Nations and Métis people (p. 40). W.S 8.3 a. Examine the ways in which First Nations and Métis people traditionally valued, depended upon, and cared for aquatic wildlife and plants in Saskatchewan and Canada (p. 41).
MB 7	Cluster1:Interactions Ecosystem	Teachers' Note.	The terms living and non-living are problematic for some cultural groups, particularly Aboriginal groups. These groups use different criteria than Western scientists to determine whether an object is animate. Teachers should be sensitive to the potential conflict between Western science and other views and indicate that students can hold multiple views at the same time, recognizing the value of each (p. 8).
SK 7			Aboriginal Perspectives Have students read “Aboriginal Perspectives” (BLM 7-A) and discuss the following questions: 1. What can Aboriginal perspectives contribute to society’s goal of sustainability? 2. How can environmental knowledge from Aboriginal people be accessed and included in a decision-making process? (p. 16).
	Cluster3: Forces and Structures	Suggestions for instruction	Classifying Structures According to Design Provide students with pictures (from pamphlets, travel brochures, or magazines) of the three types of structures: solid, frame, and shell. Examples: • solid: Great Wall of China, castle, dam, cliffs along the sea, iceberg • frame: house (frame), tower, umbrella, stairway, skeleton • shell: quinzhee, tent, ball, wasp nest, cocoon,

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			freshwater clamshell, canoe, tipi (p. 4)
		Suggestions for Assessment	Restricted Response Provide students with the following: Classifying Structures: Solid, Frame, or Shell? Identify the following as solid, frame, or shell structures. 1. stone bridge2. Igloo3. Eiffel Tower4. Dam5. staircase Look for: 1. solid2. Shell3. Frame4. Solid5. Frame (p. 5)
ON 7	Understanding life systems: Interactions in the environment	Specific expectation	3.9 describe Aboriginal perspectives on sustainability and describe ways in which they can be used in habitat and wildlife management(e.g., the partnership between the Anishinabek Nation and the Ministry of Natural Resources for managing natural resources in Ontario) (p. 123)
ON 8	Understanding Structures and Mechanisms: Systems in Action	Specific expectation	3.1 identify various types of systems (e.g., mechanical systems, body systems, optical systems, mass transit systems, Aboriginal clan systems, healthcare systems)(p. 145)
ON 8	Understanding earth and space systems: water	Specific Expectation	1.2 assess how various media sources(e.g., Canadian Geographic; the science section in newspapers; Internet websites; local, national, and international news on television and radio)address issues related to the impact of human activities on the long-term sustainability of local, national, or international water systems Sample issues: (a) You are doing research on the implications of exporting water from Canada to other countries. Your sources area national newspaper, a scientific magazine, and some selected Internet sites. Each has a slightly different opinion on the issue. (b) A farmer wants to ensure that her nutrient management strategies are not adversely affecting the local water system. She consults the agriculture section of a local newspaper, a Canadian magazine with an environmental focus, and local farm reports. She finds conflicting information. (c) The Protocol for Safe Drinking Water in First Nations Communities addresses drinking water concerns in First Nations communities. Various government agencies, news agencies, and interest groups have different perspectives on its development and release (p. 150).
QC		Attitude	Respect for life and the environment (p. 248, 2004).
Atlantic 7	Earth's Crust	Elaboration – strategies for learning and	Different cultures throughout history have had ideas and theories about the origins and causes of volcanic and earthquake activity and mountain

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		teaching	formation. Students can be challenged to investigate a particular group or culture in order to learn about peoples' ideas about these events in the past. Some possible research ideas might include: - Pele (Hawaiian goddess who makes the mountains shake and lava flow at Kilauea, Hawaii) - Glooscap (Mi'kmaq legend about the Sugarloaf Mountains) - Ovid (Roman poet who claimed that earthquakes occurred when the earth became too close to the sun and trembled from the great heat) - Anaxagoras (Greek who believed that volcanic eruptions were caused by great winds within the earth) - René Descartes (French philosopher who believed incandescent earth core was the source of volcanic heat) (pp. 36- 38).
Nunavut (Junior High Science, 1991)	Life and the Environment	Concepts/ Major Understandings	Students will develop an understanding of: how "we" interact with the environment traditional and western perception of ecological concepts, use of renewable and non-renewable resources, population management, conservation and environmental problems, cycles, present and alternative energy sources (p. 21). Traditional and local knowledge as it pertains to the perception and understanding of their environment: cultures of N.W.T and other world views (p. 21).
		Attitudes and behaviours.	Respect for one's self, for others and for "the land" (p. 22).
		Common learning experience and activities	It is important that the actual content for these learning activities be determined locally so that the learning experience is relevant for the student. Students will be provided with the opportunity to participate in activities which: Classify using traditional information, knowledge, process (p. 22)
		Cross-referencing the curriculum details to the stated goals of the junior high science curriculum Intellectual dimension:	Traditional and local environmental knowledge (p. 26)
		Emotional dimension	Respect for self (p. 26) Awareness and appreciation of others' views and the ability to articulate one's own feeling about the issue (p. 26)

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		Social dimension	Respect for other and “the land” (p. 26) Utilizing local resources, people and field trip (p. 26)
		Spiritual dimension	Awareness and appreciation of traditional perception of ecological relationship (p. 26) Respect for self, others and “the land” (p. 26) Examining concepts from both a traditional and a western perspective (p. 26)
	Matter and Energy	Attitudes and behaviours	Appreciation of the value of traditional and scientific knowledge to society (p. 28).
		Common learning experience and activities	Design and illustrate traditional tools as well as simple machines (p. 28). Utilize local resource people and local excursions, field trips (p. 28).
		Intellectual dimension	Work, motion and energy in terms of traditional tools and simple machines (p. 30)
		Social dimension	Utilizing local resources, people and field trips (p. 30)
		Spiritual dimension	Appreciation of the value of traditional and scientific knowledge to society (p. 30)
	Earth, space and time	Attitudes and Behaviours	An appreciation of both cultural and scientific ways of explaining phenomena (p. 32)
		Common learning experience and activities	It is important that the actual content for these learning activities be determined locally so that the learning experience is relevant for the student. Students will be provided with the opportunity to participate in activities which: Utilize local resources, people and excursion and field trips (p. 32)
		Emotional dimension	An appreciation of both cultural and scientific ways of explaining phenomena (p. 34)
		Spiritual dimension	An appreciation of the complexity and beauty in the creation of and order in our universe (p. 34)
NVT Learning Module			Please refer to the original document published by the ministry as the module contains too much TEK content to be put in as Appendix for this manuscript. (Generally each unit in the module contains one or more TEK content)